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Background Information for Quinquennial Review Team of

ICAR- National Bureau of Agricultural Insect Resources & All India Co-ordinated Research Project on Biological Control of Crop Pests (2017-2022)

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PART – B

All India Coordinated Research Project on Biological Control of Crop Pests

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All India Coordinated Research Project on Biological Control of Crop Pests

XIX. Historical Background

The National Agricultural Policy has laid special emphasis on Integrated Pest Management (IPM) and use of biocontrol agents in order to minimize the indiscriminate and injudicious use of chemical pesticides, which is also the cardinal principle of the Government of India on plant protection. The IPM implementation at national level has proved effective not only in reducing pesticide usage, but also in reducing pest induced losses in the country, amply evidencing a bright future for the successful use of biological control agents in pest control programmes. India is rich in natural enemy biodiversity and facilitated as many as 27 natural enemies of Indian origin being established in other countries for crop pest suppression. Thus, there is ample opportunity in India for effective management of pests, diseases and weeds through effective utilization of its vast natural enemy fauna.

Biological control of crop pests and weeds made its humble beginning with the launching of the All India Coordinated Research Project (AICRP) in 1977 at Bangalore with full financial support by the Department of Science and Technology, Government of India. Recognition of the importance of biological control came during the VIII plan with the creation of **Biological Control Centre** (BCC) which was functioning under the administrative control of NCIPM, Faridabad. A greater thrust for planned biological control programme started in 1987 when ICAR took over the erstwhile ***Commonwealth Institute of Biological Control*** (CIBC), its insect collections, physical facilities including the prime land on Bellary Road on NH-7, Bangalore. The BCC which was functioning as the PC Cell of AICRP on Biological Control of Crop Pests and Weeds was upgraded to the ***Project Directorate of Biological control*** (PDBC) with headquarters at Bangalore. The Directorate started functioning from 19th October 1993 with six laboratories and 16 AICRP centres. In the XI plan, the PDBC was renamed and reoriented into ***National Bureau of Agriculturally Important Insects*** (NBAII) on 25th June, 2009 and the mandate was redefined and in the 12th five year plan, it was rechristened to the present name **(ICAR - National Bureau of Agricultural Insect Resources)** with effect from 24th September, 2014. The AICRP-BC has 36 centres (11 regular centres and 25 Voluntary centres).

XX. Mandate and Objectives

❖ Mandate

- Promotion of biological control as a component of integrated pest and disease management in agricultural and horticultural crops for sustainable crop production. Demonstration of usefulness of biocontrol in IPM in farmers' fields.

❖ **Objectives**

- Development of effective biocontrol agents for use in biological suppression of crop pests and diseases.
- Evaluation of various methods of biological control in multi-location field trials.
- Develop biointensive integrated pest management strategies for cotton, rice, sugarcane, pulses, oilseeds, potato, coconut and a few selected fruits and vegetables and crop pests of protected cultivation.
- Demonstration of usefulness of usefulness of biocontrol in IPM in farmer's fields.

XXI. 3. Organization and Structure

A. North West Zone

1. AAU, Anand
2. G.B. Pant University of Agriculture & Technology, Pantnagar
3. PAU, Ludhiana
4. MPUAT, Udaipur
5. CISH, Lucknow
6. IIVR,Varanasi

B. North East Zone

1. AAU, Jorhat
2. CAU, Pasighat
3. College of Agriculture, Lembucherra, Agartala

C. North Central Zone

1. MPKV, Pune
2. OUAT, Bhubaneswar
3. UBKV, Pundibari
4. NRRI, Cuttack
5. PDKV, Akola

D. North Zone

1. NCIPM, New Delhi
2. SKUAST, Srinagar
3. SKUAST – Jammu
4. YSPUHF, Solan

E. South Zone

1. ANGRAU, Anakapalle
2. KAU, Thrissur
3. PJTSAU, Hyderabad
4. TNAU, Coimbatore
5. UAS, Raichur
6. CPCRI, Kayangulam
7. IIHR, Bangalore
8. IIMR (Millets), Hyderabad
9. IIRR, Hyderabad
10. IGKV, Raipur
11. KAU, Kumarakom
12. KAU, Vellayani
13. UHAS, Shivamogga,
14. DRYSRUH, Tirupati
15. ICAR-SBI, Coimbatore
16. WNC-ICAR-IIMR, Hyderabad
17. NIPHM, Hyderabad
18. DRYSRUH, Ambajapeta

Sactioned strength		**2017 to 2018 & 2018 to 2019**	**2019 to 2020 & 2020 to 2022**	**No of post vacant**
Scientific	**Scientist**	12	10	0
	Senior Scientist	8	6	0
	Principal Scientist	2	1	0
Technical Cadre		27	4	0
Total		49	21	0

Centres	**Principal Scientist**	**Senior Scientist**	**Scientist**	**Technical**	**Total**
AAU, ANAND	1	0	1	0	2
AAU, JORHAT	0	0	2	0	2
RARS-ANAKAPALLI	0	0	1	0	1

PJSTAU, TELANGANA	0	1	0	0	1
DR.YSPUH&F, SOLAN	0	1	1	0	2
GBPUAT, P'NAGAR	0	0	1	1	2
KAU, THRISSURE	0	0	1	1	2
MPKV, PUNE	0	1	1	0	2
PAU, LUDHIANA	0	1	1	1	3
SKUAST, SRINAGAR	0	1	1	0	2
TNAU, COIMBATORE	0	1	0	1	2
Total	1	6	10	4	21

XXII. ATR for the specific recommendations for your AICRP-BC centre of the previous QRT (refer previous QRT report 2012-17)

Sl.No	Centres	Recommendations	Action taken
1.	AAU, Anand	Vice Chancellor AAU expressed interest in providing funds for generating toxicological data for the NBAIR isolates. To explore the possibility of preparing a joint MOU between AAU and NBAIR for the same.	ICAR-NBAIR has generated the toxicological data for their microbial biopesticide isolates on their own. However, MoU has been made between AAU-Anand and NBAIR for the licensing of the technology of mass production of *Pseudomonas fluorescens* PFDWD and *Metarhizium anisopliae* Ma-4.
		Standard chemical check to be included in all experiments.	Implemented
		Quantification of spider diversity and its predatory potential and relationship with pest incidence are to be	Spider diversity has been quantified in rice growing fields in the village Tarapur, Dist. Anand and observed the predatory potential in relation to incidence of pest rice leaf roller.

		included. Production of macrobials to be intensified.	The centre has intensified the production of macrobials. During the period, centre has produced Tricho-cards – 5000/annum
2.	KAU, Thrissur	Promosing microbials may be supplied/distributed to farmers on a non commercial basis (free of cost). Attempts to be made to obtain licence for supplied bio-agents. Technical bulletins/brochures to be brought out in local languages for wider dissemination of the value of bio-control agents. Enough budget provision to be made for meeting the registration costs for registration of biopesticides. Financial support for popularizing providing biocontrol agents may be sought from funding agencies viz. RKVY and MOEF.	Recommendation complied with (Supplied to tribal famers in Thissur and Wayanad districts under TSP) Steps for registration in progress A short video on biological control in local language has been prepared. Budgetary support for meeting the registration costs obtained from GoK under RKVY and plan funds. Project on popularisation of bioagents completed under ATMA scheme of DoA
3.	PAU, Lhudiana	Success stories on Organic Basmathi, Maize and Sugarcane to be disseminated through booklets and website	Three folders namely (i) Biological Control of Borers in Sugarcane; (ii) Biointensive Integrated Pest Management inorganic Rice; and (iii) Biocontrol technologies in PAU Package of Practices were published and disseminated. The softcopies were also sent to ICAR-NBAIR for AICRP Website One e-folder on “Mass production and utilization of Trichogramma for the bio-suppression of insect pests” was prepared and uploaded at AICRP website Two videos, “Biocontrol Technologies in PAU Package of Practices”(Slide show) and “Farmer explaining use of tricho-cards - feedback” were sent to ICAR-NBAIR for AICRP website

		White fly genetic groups to be checked and to be related with early and late sown crops.	The whitefly populations were collected from different regions of Punjab, Haryana and Rajasthan from cotton crop. The mitochondrial cytochrome oxidase1 gene(mtCO1) nucleotide sequence which has been accepted worldwide to identify the cryptic species of whitefly was amplified, sequenced and analyzed. All the populations collected were identified as Asia II-1 genetic group Whitefly damage was comparatively more on late sown crop, so farmers were advised to sow the cotton crop timely (upto15th May) as part of IPM Strategy
		Parasitisation of white flies to be studied in detail.	Regular field surveys were conducted in cotton growing areas (Bathinda, Mansa, Fazilka, of Punjab to collect the immature stages of whitefly during 2017-18 to 2021-22. Two parasitoids, *Encarsia lutea*and *Encarsia Sophia* were recorded parasitizing whitefly in cotton crop. The mean parasitization by *Encarsia* spp. Indifferent cotton growing areas of Punjab varied from 5 to 10 per cent. The parasitization was comparatively more in unsprayed plots as compared to sprayed plots.
		Production of macrobials and microbials and area coverage to be committed as fixed targets to commensurate with the contingency funding.	Macrobials are being produced to capacity as per targets. The contingency was increased during the period of reporting though presently it is not sufficient. Funding from state schemes (RKVY, Misc, NHM, NABARD etc) being used to meet the targets. Microbial production up scaling limited due to registration issues
4.	SKUAST, Srinagar	Strengthen mass production of EPN and supply to farmers.	The EPN tested against codling moth are not effective in cold arid desert region of Ladakh because of no humidity. So no diseases on apple plants are being observed till to this date. However, the mass production of

			egg parasitoids, pheromone baited traps, lures for different traps are being produced and supplied to farmers.
		A complete comprehensive management protocol for codling moth.	A complete comprehensive management protocol for codling moth already in place
		Success story for Codling moth to brought out in three months time and put up on University/NBAIR website.	Success story of coding moth will be provided in due course of time and will be put on both the web pages of NBAIR & SKUAST-K Yes, PI/Co-PI will visit to YSPUHF to get hands on training and also the culture of predatory mite and shall be mass produced.
		The technology for predatory mite proved developed at YSPUHF to be adopted at SKUAST.	
		Unidentified species of natural enemies including spider to be sent to NBAIR for identification.	The unidentified specimens of insect pests/ Spiders/ other natural enemies are being already been sent to NBAIR for identification Yes, we are in the process of sending the fresh duplicate specimens in the ongoing summer season
		Identification duplicate specimens may be sent to NBAIR museum.	
		Attempts to be made to publish/patent the refind production structure for *Corcyra* developed by the centre with supporting data.	There is no such variation in the production of Corcyra culture which is so different from the rest of the world or India that needs patent filing and no merit in patenting this technology.
5.	ANGRAU	Sugarcane community fund – under sugar mills can be explored for the activities related to biological control of sugarcane pests.	Management of sugarcane white grub using entomopathogenic fungi in white grub endemic areas (200 ha) with the funds from Navabharath sugars, Samarlakota, East godavari district, Andhra Pradesh during 2017-2018. Technical support in

			Establishing Biocontrol labs at Navabharath sugars, Samalkota and Parrysugars, Sankila and KCP sugars Vuyyuru for production of *Trichogramma chilonis* and Popularization of Biocontrol against sugarcane borers. Technical support to farmer producer organisation (FPO) groups and NGO resulted in establishment of Trichocard production unit and Biocontrol lab at two villages benefitting tribal farmers of Araku and chinthapalliin Andhra Pradesh
		Data to be generated on resources supplied to be obtained from farmers, area of adoption, benefits obtained and economics.	Data generated on biocontrol resources supplied to the farmers, area of adoption, benefits obtained and cost economics for the Biocontrol technologies (heat tolerant *Trichogramma chilonis*) against sugarcane shoot borers ; Entomopathogenic nematode, *Heterorhabditis indica* (NBAIR-H38) against sugarcane white grub; entomopathogenic fungus, *Metarhizium anisopliae* against sugarcane white grub ; Biosuppression of *Chilo partellus*, *Sesamia inferens* with *Trichogramma chilonis* ; Management of maize fall armyworm using biocontrol agents (*Trichogramma choilonis*) and biopesticides (*Bacillus thuringiensis* NBAIR Bt25, *Metarhizium anisopliae* NBAIR Ma35) ; Efficacy of *Bacillus thuringiensis* NBAIR Bt G4 against pod borer complex in red gram; BIPM practices in rice. Popularized Biocontrol using *Trichogramma chilonis* (Heat tolerant and normal) (34,352 CC); *Metarhizium anisopliae* NBAIR Ma 35 and *Isaria fumosorosea* NBAIR Pfu5 (3555 kg) in 7582 acres of Rice, Maize, Sugarcane, Vegetables, Ginger, Coconut benefitting 2800 farmers of Andhra Pradesh. Under TSP, Biocontrol agents (9700 No. Trichocards), Biopesticides (378 kg

			Trichoderma asperellum; 489 kg *Pseudomonas fluorescense*; supplied to 461 tribal farmers in an area of 520 acres resulted in increased yields and net income in rice, rajma, ginger, vegetables and data was documented.
		Important to map the visibility of bioagents – the spread and adoption rates to be quantified to indicate the impact of the technologies.	Sugarcane, Vegetables, Ginger, Coconut in Andhra Pradesh state. Under TSP, Spread and adoption of Biocontrol agents from one crop- rice in one village of 40 acres by 41 farmers in 2015-16 to 4 crops – rice, rajma, ginger, vegetables in 50 villages of 520 acres during 2017-18 to 2021-22 benefitting 461 tribal farmers with increased yields and net income. One Tribal farmer adopting biocontrol realized increased production in rice (4550 kg/ha), ragi (1000 kg/ha), ginger (3500 kg/ha), turmeric (750 kg/ha) and vegetables (2200 kg/ha) with net income of Rs. 2,98,500/- per ha during 2021-22 compared baseline period 2015-16 production in rice (2100 kg/ha), ragi (500 kg/ha), ginger (2000 kg/ha), turmeric (280 kg/ha) and vegetables (1250 kg/ha) with net income of Rs.1,15,700/- per ha .
6.	PJTSAU	Spider fauna recorded may be identified in collaboration with NBAIR.	1) Insect and spider specimens are being sent to NBAIR for identification. The identified spider spwecies are *Argiope anasuja, Pardosa* sp, *Chalcotropis* sp, *Telamonia dimidiata, Tetragnatha versicolor, Clubiona* sp. in rice crop
		The trials on maize with biocontrol agents may be dropped/deleted as there is no pest incidence.	Trials on maize for the stem borer have been dropped and trial on Fall Armyworm are being done as the pest has been damaging the crop severely since last 4 years
		Local strains of *Metarhizium* and *Lecanicillium lecanii* may	Our University did not have its own strains of *Metarhizium* and *Lecanicillium* Hence, we validated the

		be provided by the centre for evaluation by other centres.	strains of NBAIR. If we get our own strains in future we will share to other centres.
		Monitoring of the programmes must be ensured based on the requirements if the farmers are and the recommendations made under package of practices by the University.	Trials of the scheme are proposed based on the requirements of the farming community and the technical programme is also ratified upon in the state level technical programme conducted by the University each year.
7.	Dr YSPUHF, Solan	Search for local isolates/strains of bioagents.	*Heterorhabditis bacteriophora* and *Trichoderma asperellum* were local isolates and have been utilized for the control of insect-pests of apple and diseases ofpea. Further efforts are made to isolate more local strains and utilized for insect-pests anddiseases management of crops.
		Success story to be prepared on apple root borer in three months time.	Success story in hindi has been prepared.
		Metarhizium and predatory mites to strengthen mass production program.	Mass production of *M. anisopliae* and predatory mite, *Neosiulus longispinosus* have strengthened and is being produced regularly.
		Not working with state Biocontrol labs and KVKs for mass production and dissemination of proved technologies.	The university has good linkages with State Biocontrol Laboratory and Krishi Vigyan Kendras. The proven technology is demonstrated through KVKs and Research Stations of the University.
		It was recommended that the pathology/nematology component can be included for the centre for specific crops without any financial commitment.	The nematology and pathology components have been included in research trials for the management insect-pests of apple and pea.
		The centre should focus on supply of *metarhizium* and mites to farmers.	The centre is continuously supplying the *Metarhizium anisopliae* and predatory mite to the farmers for the management of insect-pests of crops.
		Success stories in English and Hindi to be sent to NBAIR and University.	The Success story in hindi has been prepared and in English it will also be prepared.

		All proved technologies to be brought out by the centre to be included in the University POP.	The proven technologies will be included in POP in the state level officers workshop of POP for horticultural crops. For inclusion of *M. anisopliae* technologies in POP, the toxicological data is required.
		Quantum of production of bioagents, supply to farmers, area covered under biocontrol. Farmer feedback on impact should be documented.	The quantum of production of bioagents and area covered and supply of bioagents to farmers are done on need basis of farmers. The impact of biocontrol agents is documented on the basis of farmers feedback.
8.	TNAU	Parasitism to be measured as percentage parasitism (not as number of adults emerged / percent adult emergence).	Complied
		Status of pin worm *Tuta absoluta* in Tamil nadu to be re-checked in Erode and surrounding areas.	*Tuta absoluta* damge was 15-20 percent in Erode District.
9.	AAU, jorhat	Search for local isolates/strains of bio agents.	Budgetary support for meeting the registration costs obtained from GoK under RKVY and plan funds. Project on popularisation of bioagents completed under ATMA scheme of DoA
		Success story on biocontrol of cabbage diamond back moth and potato cut worm to be prepared in three months' time and to be hosted on University and ICAR-NBAIR websites.	A success story of Mr. Atul Missong, (45 years), and Rajiv Morang was already uploaded in the NBAIR website (databases.nbair.res.in).
		Centre to strengthen the mass production program for tricho-cards and other biocontrol agents.	About 2725 numbers of Tricho-cards were produced covering 270 ha area during 2017-22 and biopesticide 1950 kgs covering area 65 ha in 2020-22.
		Networking with state Biocontrol labs and KVKs for mass production and dissemination of proven	Enabling large scale adoption of proven bio control technologies in rice, maize, and vegetables were through KVK Jorhat, Golaghat, Nagaon, Sibasagar and Diphu during

		technologies. Identified duplicate specimens may be sent to ICAR-NBAIR museum.	2017-2022. Mass production of Trichogramma was started with KVK Kamrup, Guwahati to cover lower Assam area. Up to 2019 it was sent during Covid 19 period, it was not sent.
10.	MPKV, Pune	The centre should have tie up with biocontrol agent producers. Important to compare the local commercial products with the products formulated by the centre. Status paper on quality control of biopesticides to be prepared. A programme has to be launched to take up Quality analysis of commercial products without revealing the source of the products.	There is a good association of this centre with Biocontrol agent producers. The biopesticide producers particularly for the production of *Lecanicillium lecani*, *Beaveria bassiana*. *Pseudomonas fluorescense*, *Trichoderma viride* etc. consulted for their constraints to the AICRP, Pune centre. Besides *Trichogramma. chilonis, Cryptolaemus. montrouizieri* are also produced by the few bioagent producers with the help of this centre. This centre has referral laboratory for testing quality parameters of biopesticides allotted by DBT (CIB & RC) since 2006. During last 5 years this lab tested 242 biopesticides samples for obtaining CIB & RC registration for quality parameters received from different biopesticides producers. The marketed samples of biopesticides were taken from the market and analyzed in the laboratory for the quality parameters
11.	GBPUAT	To aim towards commercialization registration the centre to generate toxicology data for the potential isolates through applying for lateral funding. The potential isolates to be shared with other AICRP/Institutes for generation of field efficiency data in different agroecological zones. To prepare success stories for the potential isolates PBAT-3 and the fourteen in English and local languages and put	According to new CIBRC the commercialization and registration of potential isolates is being negotiated. The potential isolates are shared with PAU, AAU Anand, YSPUHF Solan, SKUAST Jamu, IGKV Raipur and KAU, Vellayani. Three folders of success stories (Hindi and English), one video film prepared for the potential isolates PBAT-3 and PBAT-14. These folders and film were uploaded

		up on website of University and NBAIR	on website of GB Pant University and NBAIR.
12.	UAS, Raichur	Continuous monitoring of treated fields during successive seasons. Quantified data to be prepared on area covered with bio-agents, number of farmers benefitted, economic benefits and impact analysis.	Follow up monitoring of treated fields of farmers over a period of five years is done and collected farmers feedback about use of bio control agents. Over a period of five years, 50 tonnes of bio pesticides was produced and distributed over an area of 20,000 ha on various crops viz., rice, cotton, chilli, and sugarcane, and data will be presented during the QRT meet.
13.	MPUAT	To prioritize crop/pest/ bio agents for future work. To focus on production of specific bioagents, maximum area coverage and farmers involvement.	Focus on the production of *Trichogramma* sp. and produced 6967 Trichocards and release in 330 hectare area of tomato, maize and other kharif crops.
14.	CAU, Pasighat	Experiments on rice may be stopped as pest incidence for last 3-4 years is much below ETL level, and work on *Pseudomonas* may be continued for rice blast disease. Since the PI is Nematology background, it was suggested that PI should propose experiments on nematology work in one month time and should be incorporated in AICRP-BC technical programme for 2017-18 & 2018-19 e.g. Management of Root-Knot nematodes in vegetables. More study should be on documentation of diversity that includes both insect pests and natural enemies. Unidentified species of	Experimental field trials were not conducted on Rice Carried out experiment on Bio-intensive RKN insect and RKN management in Brinjal. Isolated Steinernematid spp. from Arunachal reserve Forest, Ruksin block using 30 soil samples First report of RSW on Coconut, First record of Anisopteromalus calandrae, a parasitoid on Bruchids in Green gram. on Broom plant, *Formicoccus polysperes* on Colocasia, *Aphis craccivora* on Faba bean and Pinaspisbuxi on Bush pepper. Submitted spider samples and parasitoids from yellow pan trap

		natural enemies including spiders to be sent to ICAR-NBAIR for identification.	collection for identification
15.	OUAT	Adequate funding support to be provided by the University for the AICRP-BC work. Experiments on plant disease management with *Trichodermitalics* and other biocontrol agents may be taken up. Strains from NBAIR to be evaluated. Centre to focus on few bioagents with large coverage area to be followed up with proper monitoring.	Two lakh rupees provided by the University in Revolving fund mode to increase the production of bio agents for farmers of the state . Experiments will be taken up during coming financial years in association with pathology department of our University and Strains from NBAIR will be evaluated Large scale demonstrations of Rice, Sugarcane (5 ha each) and Brinjal crop (3 ha) were taken up in the farmers field)during this QRT period under BIPM packages.

General Recommendations	**ATR**
Accountability for contingencies to be provided for AICRP centres	
Safety precautions to be followed by all workers while handling bio-agents/pesticides.	Complied
Digitization of data and submission by all co-ordinating centres.	Complied
Production of macrobials and microbials and area coverage to be committed as fixed targets to commensurate with the contingency funding.	Complied
All centres should contribute towards the NBAIR museum in terms of specimens/digitized materials.	Samples are being submitted by all the centres
When required, Young Professionals may be hired as per ICAR norms for SAU centres.	YPs are being recruited by the centres
Success stories English, Hindi and local languages to be sent to ICAR-NBAIR and University for putting up on the websites.	Success stories have been prepared in different languages.
Attempts to be made to include all proven technologies brought out by the respective AICRP centre in the University package and practices.	Good technologies have been included in PoPs
Attempts to be made to register/commercialise the proven isolates/technologies.	Potential isolates have been registered
All centres should document the quantum of bioagents production, supplied to farmers and	Documented the production of bioagents by various centres

area covered under biocontrol. Farmer feedback on impact should also be documented. This information should be presented in all reports.	
Cost benefit not only in terms of economics but also based on environment safety since, North Eastern region mainly focusing on organic farming.	C: B ratio calculation was done based on environmental safety.
\Approved pesticides by the Registration Committee should be selected for all comparative efficacy trials with biopesticides.	Complied
Centres should establish effective linkages with other departments/ institutions/organisations	Established linkages with organizations

Specific Recommendations	ATR
Travel grant should be enhanced	25 % increased
Funding of AICRP centres should be linked to performance	Complied
Contingency grant must be enhanced	25% increased
AICRP -BC to be retained	Retained

Main Report

Sl. No.	Centres	Mandatory Crops
State Agricultural University-based centres		
1.	Punjab Agricultural University, Ludhiana	Rice, Sugarcane, Maize, Cotton, Pulses, Vegetables (open and polyhouse)
2.	SKUAST-K	Apple and other temperate fruit crops Cole crops
3.	Professor Jayashankar Telangana State Agricultural University	Rice, Cotton, Maize, Pulses, Soybean, Groundnut
4.	ANGRAU, RARS, Anakapalle	Rice, Maize, Sugarcane, Pulses (Red gram, Green gram, Black gram) , Oilseeds (Sesame, Groundnut), Coconut
5.	MPKV (Rahuri), Pune	Cotton, Rice, Vegetables, Sugarcane, Pulses and Maize
6.	TamilNadu Agricultural University, Coimbatore	Brinjal, Bhendi, Tomato, Jasmine, Cabbage, Maize, Chickpea, Pigeonpea, Cassava and Coconut
7.	AICRP on Biological Control, Department of Entomology, Assam Agricultural University, Jorhat	**2017-18 to 2019-20** Rice, Mustard, banana, brinjal, Cabbage (included in 2019-20) **2020-21 to 2021-22** Rice, Cowpea, Okra, Cabbage, Cucumber, Banana (dropped in 2021-22), Black Rice,

		Maize, Ginger
8.	YSPUHF, Solan	**Apple, Tomato, Capsicum, Cucumber and Pea**
9.	KAU Thrissur	Rice, Coconut, Banana, Vegetables and Spices
Voluntary centres (Contingency funded)		
10.	KAU Vellayani	Rice, Coconut, Banana, Vegetables – Cowpea, Amaranthus, Brinjal
11.	Regional Agricultural Research Station, Kumarakom	Coconut, Vegetables
12.	CHF, Central Agricultural University (I), Pasighat	Rice, Tropical Fruits & Vegetables
13.	AICRP on Biological Control of Crop Pests and Weeds, OUAT centre, Bhubaneswar	Rice ,Sugarcane, Brinjal and Maize crop
14.	Citrus Research Station, Dr. YSR Horticultural University, Tirupati (Non-Contingency centre)	Citrus
15.	ICAR-Indian Institute of Vegetable Research, Varanasi, U.P.	Vegetables
16.	ICAR-IIRR	Rice
17.	ICAR-IIHR, Bengaluru	Tomato, Chilli, Brinjal, Okra
18.	ICAR-IIMR, Hyderabad	Sorghum, and Small Millets (Finger, Barnyard, Little and Proso millet)
19.	Dr. YSRHU-HRS, Ambajipeta	Coconut and Cocoa
20.	ICAR-NRRI	Rice
21.	Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.)	**a)** Rice (BIPM conducted – 3 trials) during the year in 2018-19, 2019-20 and 2020 – 21. **b)** Chickpea (2 years) during the year 2021 – 22, 2022 – 23. **c)** Okra (2 years) during the year 2021 – 22, 2022 – 23

XXIII. Research Programmes 2017 to 2022

1. Biodiversity of biocontrol agents from various agro-ecological zones
2. Surveillance for pest outbreak and alien invasive pests
3. Biological control of pests and diseases of cereals
4. Biological control of pests and diseases of pulses and oilseeds
5. Biological control of pests and diseases of commercial crops (Cotton and Sugarcane)
6. Biological control of pest and diseases of fruits
7. Biological control of pests and diseases of vegetables, polyhouse pests and flowers
8. Biological control of pest and diseases of plantation crops, spices and tubers
9. Capacity Building Programmes
10. Tribal Sub Plan

Sl.no	Experiments /Trials	Duration during review	Status of the Trail
1.	Management of rice stem borer and leaf-folder using entomopathogenic nematodes and entomopathogenic fungi	2018 to 2021	Concluded
2.	Management of plant hoppers through BIPM approach in organic basmati rice	2018 to 2021	Concluded
3.	Large scale bio-intensive pest management on rice	2018 to 2020	Concluded
4.	Evaluation of bio-agent consortium in glasshouse (pot experiments) and in field for crop health management in rice	2017 to 2020	Concluded
5.	Bio-intensive pest management on rice at the Instructional Research Farm of IGKV, Raipur.	2018 to 2022	Concluded
6.	Improved formulation of *B. bassiana* against Rice leaf roller *Cnaphalocrocis medinalis*	2017 to 2021	Concluded
7.	Comparative efficacy of entomopathogenic fungi against sucking pests of rice, *Leptocorisa acuta*	2017 to 2020	Concluded
8.	Validation of BIPM practices against pest complex of organic Black rice	2018 to 2021	Concluded
9.	Management of rice stem borer and leaf-folder using entomopathogens	2020 to 2022	Ongoing
10.	Evaluation of entomopathogens against sucking pests of rice (Rice bug *L. acuta,* and Green leafhopper and Plant hopper (*Sogatella* sp)	2020 to 2022	Ongoing
11.	Field evaluation of entomopathogens and plant growth promoting bacteria against Rice stem borer (*Scirpophaga incertulas*), Leaf folder (*Cnaphalocrocis medinalis*), Brown plant hopper (*Nilaparvata lugens*)	2020 to 2022	Ongoing
12.	Large scale demonstration of bio-intensive pest	2020 to	Ongoing

	management on rice	2022	
13.	Evaluation of entomopathogenic fungi and *Bt* against maize stem borer	2018 to 2022	Ongoing
14.	Biological control of maize stem borer, *Chilo partellus* using *Trichogramma chilonis*	2018 to 2020	Ongoing
15.	Bio-ecological engineering for the management of major insect pests of maize and benefit of their natural enemies	2018 to 2022	Ongoing
16.	Field trial against Fall Armyworm in maize at AICRP-BC centres	2018 to 2022	Ongoing
17.	Large scale demonstration of *Trichogramma chilonis* against maize stem borer *Chilo partellus*	2020 to 2022	Ongoing
18.	Laboratory bioassay of *Metarhizium rileyi* (Anakapalle strain AKP-Nr-1) against Fall armyworm, *Spodoptera frugiperda*	2020 to 2022	Concluded
19.	Field efficacy of *Metarhizium rileyi* (Anakapalle strain AKP-Nr-1against Fall armyworm, *Spodoptera frugiperda* in maize	2020 to 2022	Concluded
20.	Demonstration of BIPM module against fall army worm, *Spodoptera furgiperda* on *rabi* maize	2020 to 2022	Concluded
21.	Evaluation of BIPM module for fall armyworm, *Spodoptera frugiperda* in maize ecosystem	2020 to 2022	Concluded
22.	Large scale demonstration of Management of fall armyworm using biological control agents and Biopesticides	2020 to 2022	Concluded
23.	Evaluation of BIPM module for fall armyworm, *Spodoptera frugiperda* in maize ecosystem	2020 to 2022	Concluded
24.	Studies on abundance of natural enemies of borers in Millets	2018 to 2020	Concluded
25.	Evaluation of entomopathogenic fungi formulations against *millet* borers in Finger millet	2018 to 2022	Ongoing
26.	Field trial against Fall armyworm in sorghum at AICRP-BC centres	2018 to 2020	Concluded
27.	Management of FAW in Sorghum using biocontrol agents	2020 to 2022	Concluded
28.	Evaluation of NBAIR *Bt* formulation on pigeon pea against pod borer complex	2018 to 2022	Ongoing
29.	Demonstration of *Trichoderma* spp for the management of *Fusarium* wilt in pigeon pea	2018 to 2020	Concluded
30.	Evaluation of entomopathogenic fungi against pod bug, *Riptortus pedestris*on cowpea *Vigna unguiculata*	2018 to 2022	Ongoing
31.	Field evaluation of ICAR-NBAIR entomopathogenic strains against cowpea aphid (*Aphis craccivora*)	2018 to 2022	Ongoing

32.	Screening of promising fungal and bacterial isolates for management of anthracnose disease in cowpea (*Vigna unguiculata* sub sp. *sesquipedalis*)	2018 to 2020	Concluded
33.	Evaluation of entomopathogenic biopesticide against *Aphis craccivora* in cowpea (*Vigna unguiculata*)	2020 to 2022	Concluded
34.	Evaluation of oil formulation of *Lecanicillium* spp against sucking pests (aphids and pod bugs) of cowpea	2020 to 2022	Concluded
35.	Integration of botanicals, microbials and insecticide spray schedule for the management of *Helicoverpa armigera* on chickpea	2018 to 2020	Concluded
36.	Biological suppression of pod borer, *Helicoverpa armigera* infesting chickpea on-farm and farmers field	2018 to 2021	Concluded
37.	Evaluation of bio-agent consortium in glasshouse (pot experiments) and in field for crop health management in chickpea	2018 to 2021	Concluded
38.	Habitat manipulation / Bio-ecological engineering for the management of *Helicoverpa armigera* in chickpea	2018 to 2020	Concluded
39.	BIPM module for management of *Helicoverpa armigera* on chickpea	2018 to 2020	Concluded
40.	Evaluation of Biointensive Integrated Pest Management against pod borer in chickpea in Bundelkh and region	2020 to 2022	Concluded
41.	Large Scale Demonstration of *Ha*NPV Kalaburgi strain against chickpea pod borer	2020 to 2022	Concluded
42.	Integration of botanicals/microbials and insecticide spray schedule for the management of pod borer complex in Greengram	2020 to 2022	Concluded
43.	Large scale demonstration of entomopathogenic fungi, *Metarhizium rileyi* against soybean defoliators in Bidar district	2020 to 2022	Concluded
44.	Biointensive management of pink bollworm on *Bt* cotton	2018 to 2020	Concluded
45.	Evaluation of entomofungal agents and botanicals for the management of sucking pests in cotton	2018 to 2021	Concluded
46.	Bio-intensive pest management in *Bt* cotton	2018 to 2020	Concluded
47.	Population dynamics of whitefly, *Bemisia tabaci* and its natural enemies in cotton: A study in farmers' field in North Zone	2018 to 2020	Concluded
48.	Evaluation of entompthogenic fungi, *Beauveria bassiana* (NBAIR-Bb-5a) against sucking insect pests of cotton	2020 to 2022	Concluded
49.	Efficacy of entomopathogenic nematodes and entomofungus for the management of white grub in	2018 to 2020	Concluded

	sugarcane ecosystem		
50.	Efficacy of entomopathogenic fungi for the management of white grub in sugarcane ecosystem	2020 to 2022	Concluded
51.	Field efficacy of EPN strains against white grubs in sugarcane	2020 to 2022	Concluded
52.	Large Scale Demonstration of *Trichogramma chilonis* against sugarcane borers (early shoot borer, top borer and stalk borer)	2018 to 2022	Ongoing
53.	Field efficacy of dose application of EPN against white grubs in sugarcane	2020 to 2022	Concluded
54.	Field evaluation of ICAR-NBAIR endophytic entomopathogenic strains against shoot borers (*Chilo infuscatellus* and *Chilosacchariphagus indicus*) in sugarcane	2020 to 2022	Ongoing
55.	Bio-efficacy of entomopathogenic fungus and neem against mustard aphid	2018 to 2021	Concluded
56.	Evaluation of entomopathogens against mustard aphid	2020 to 2022	Ongoing
57.	Field efficacy of EPN strains against white grubs in groundnut (Trial by Dr. Nagesh in collaboration with AICRP-AAU, Anand; MPUAT, Udaipur); sugarcane	2018 to 2022	Concluded
58.	Field efficacy of dose application of EPN against white grubs in groundnut (Trial by Dr. Nagesh in collaboration with AICRP-AAU, Anand; sugarcane	2018 to 2020	Concluded
59.	Evaluation of locally isolated potential entomopathogenic fungi, *Metarhizium rileyi* and *Beauveria bassiana* (NBAIR-Bb-5a) against groundnut leaf miner and tobacco caterpillar in ground nut ecosystem	2020 to 2022	Ongoing
60.	Bio-efficacy of entomopathogens against Banana fruit and leaf scaring beetles, *Nodostoma subcostatum*	2018 to 2021	Concluded
61.	Biological control of Papaya/mulberry mealybug/ complex with *Acerophagus papayae* & *Cryptolaemus montrouzieri*	2018 to 2021	Concluded
62.	Integrated Pest Management of apple Codling moth, *Cydia pomonella*	2018 to 2020	Concluded
63.	Validation and large scale field demonstration of IPM Technology of Codling moth, *Cydia pomonella* infesting apple in Ladakh	2020 to 2022	Concluded
64.	Evaluation of predatory bug, *Blaptostethus pallescens* against European red mite, *Panonychus ulmi* and two spotted spider mite, *Tetranychus urticae* on apple	2018 to 2022	Concluded
65.	Management of apple root borer using *Metarhizium*	2018 to	Concluded

	anisopliae	2022	
66.	Evaluation of some biocontrol agents against leopard moth, *Zeuzera multistrigata* in apple	2018 to 2022	Concluded
67.	Effect of biopesticides for the management of mango hopper, *Idioscopus* spp. in field condition	2018 to 2020	Concluded
68.	Bio-efficacy of bio-pesticides for the management of mango hoppers	2018 to 2020	Concluded
69.	Bioefficacy of entomopathogenic fungi formulations in suppression of mango leaf webber	2018 to 2020	Concluded
70.	Habitat manipulation for conservation of bioagents for management of mango insect pests	2018 to 2020	Concluded
71.	Habitat manipulation for conservation of bioagents for management of mango insect pests	2020 to 2022	Concluded
72.	Bioefficacy of entomopathogenic fungi formulations in suppression of mango tortricid borers	2020 to 2022	Concluded
73.	Bio-intensive management of mango hopper	2020 to 2022	Concluded
74.	Field evaluation of microbial biocontrol agents for the management of mango thrips	2018 to 2022	Concluded
75.	Management studies for inflorescence thrips on mango with bio pesticides in field conditions	2018 to 2022	Concluded
76.	Evaluation of bio-agents against root-knot nematode and *Fusarium* wilt complex infection in guava under controlled conditions	2018 to 2021	Concluded
77.	Biological control of guava mealy bug and scales using entomopathogens	2018 to 2021	Concluded
78.	Development of biocontrol based ipm module for the management of guava fruit borers	2020 to 2022	Concluded
79.	Biological control of root knot nematode in guava	2020 to 2022	Concluded
80.	Evaluation of entompthogenic fungi, *Beauveria bassiana* (NBAIR-Bb-5a) against mealy bug in guava ecosystem	2020 to 2022	Concluded
81.	Biological control of anola mealy bug and scales using entomopathogens	2018 to 2021	Concluded
82.	Field evaluation of bio pesticides for the management of sucking pests of citrus	2018 to 2022	Concluded
83.	Evaluation of potential isolates of microbials against citrus thrips and green mites (rust and green mites)	2018 to 2022	Ongoing
84.	Bio-intensive management of litchi fruit borer, *Conopomorpha sinensis* (Bradley) in litchi	2020 to 2022	Ongoing
85.	Surveillance of rugose whitefly in coconut and assessing the population of natural biocontrol agents	2018 to 2021	Concluded

86.	Management of Coconut black headed caterpillar using *Goniozus nephantidis* and *Bracon brevicornis* in endemic areas of Kerala	2018 to 2020	Concluded
87.	Screening of coleopteran specific *Bt* formulation (NBAIR strains) against red palm weevil (*Rhynchophorus ferrugineus*)	2018 to 2020	Concluded
88.	Field evaluation of bio agents against rugose spiraling whitefly on coconut	2020 to 2022	Concluded
89.	Management of Coconut Rugose spiralling whitefly using entomopathogenic fungi, *Isaria fumosorosea*	2020 to 2022	Concluded
90.	Area-wide demonstration of biological suppression of black headed caterpillar using *Goniozus nephantidis* and *Bracon brevicornis*	2020 to 2022	Ongoing
91.	Converging biological suppression approaches for area-wide management of coconut rhinoceros beetle	2020 to 2022	Concluded
92.	Biological suppression of rugose spiralling and nesting whitefly in coconut.	2018 to 2022	Ongoing
93.	Evaluation of microbial insecticides against bagworm, *Pteroma plagiophelps* in cocoa	2018 to 2020	Concluded
94.	Field evaluation of bioagents against pod rot and stem canker (*Phytophthora* sp.) in cocoa	2018 to 2020	Concluded
95.	*In vivo* evaluation of effective bio control agents against *Phytophthora* Pod rot management in cocoa	2020 to 2022	Concluded
96.	Field evaluation of bio-pesticides against red spider mites	2018 to 2020	Concluded
97.	Bio-intensive pest management of *Helicoverpa armigera*, *Tuta absoluta* and sucking pests of tomato	2018 to 2022	Concluded
98.	Large scale field trials for the management *Helicoverpa armigera* on tomato (MPUAT – 2 ha)	2018 to 2021	Concluded
99.	Demonstration on bio-intensive management of insect pests of tomato (0.5-1.0ha)	2020 to 2022	Concluded
100.	Role of Habitat manipulation for pest management in Tomato	2020 to 2022	Concluded
101.	Bio-intensive insect and nematode (RKN) management in brinjal	2018 to 2021	Concluded
102.	Bio-efficacy of microbial agents against *Myllocerous subfasciatus* on brinjal	2018 to 2022	Concluded
103.	Biointensive pest management of brinjal fruit and shoot borer and whitefly on brinjal	2018 to 2020	Concluded
104.	Development of biocontrol based IPM module for the management of fruit and shoot borer, *Leucinodes orbonalis* (Guenee) in brinjal	2020 to 2022	Concluded
105.	Bio-efficacy of microbial agents against leaf hopper in	2020 to	Concluded

	brinjal	2022	
106.	Efficacy biocontrol agents for management of fruit borer, *Earias vittella* on bhendi	2018 to 2021	Concluded
107.	Management of *Tetranychus truncatus* using *Neoseiulus indicus* on Okra	2018 to 2020	Concluded
108.	Management of hoppers, aphids and Whitefly on Okra by oil based formulation of *Metarhizium anisopliae*	2020 to 2022	Concluded
109.	Evaluation of *Neoseiulus indicus* for the management of spider mites on okra	2020 to 2022	Concluded
110.	Evaluation of biointensive IPM module against key pests of okra	2020 to 2022	Concluded
111.	Bio-intensive pest management in okra	2020 to 2022	Concluded
112.	Evaluation of *Steinernema carpocapsae* and *Heterorhabditis indica* (NBAIR strain) against lepidopteran pest complex	2018 to 2020	Concluded
113.	Biological control of lepidopteran pest complex and aphid on cabbage (CAU 0.1 ha)	2018 to 2020	Concluded
114.	Field evaluation of ICAR-NBAIR entomopathogenic strains against cabbage aphid (*Brevicoryne/Myzus*) and *Plutella xylostella* (DBM)	2018 to 2021	Concluded
115.	Management of cabbage pest, *Plutella xylostella* through biological control agents (in farmer field, 1 ha)	2018 to 2020	Concluded
116.	Influence of habitat manipulation on incidence and severity of pest damage on cabbage	2020 to 2022	Concluded
117.	Bio-intensive pest management in cabbage	2020 to 2022	Concluded
118.	Screening of promising isolates of entomopathogenic fungi for management of white flies in chillies	2018 to 2020	Concluded
119.	Evaluation of fungal pathogens against chilli yellow mite, *Polyphagotarsonemus latus* on chili	2018 to 2020	Concluded
120.	Management of thrips, aphids and Whitefly on chilli by oil based formulation of *Metarhizium anisopliae (IIHR Strain)*	2020 to 2022	Concluded
121.	Screening of promising isolates of entomopathogenic fungi for management of mites in chillies (continuing experiment)	2020 to 2022	Concluded
122.	Bio-efficacy of some bio-pesticides against sucking pests (Whiteflies and Jassids) in cucumber	2018 to 2020	Concluded
123.	Evaluation of BIPM against fruit flies *Deccausbactrocera* sp. against cucumber	2020 to 2022	Concluded
124.	Efficacy of different biocontrol agents against onion thrips (*Thrips tabaci* L.)	2020 to 2022	Ongoing

125.	Evaluation of entompthogenic fungi, *Beauveria bassiana* (NBAIR-Bb-5a) and *Lecanicillium leccani* (NBAIR-VL 15) against sucking insect pests of capsicum in open field condition	2020 to 2022	Concluded
126.	Efficacy of capsule formulations of *Beauveria bassiana* in managing amaranthus leaf webber *Hymenia recurvalis*	2020 to 2022	Concluded
Polyhouse pests			
127.	Management of sucking pests on cucumber using anthocorid predator, *Blaptostethus pallescens* under polyhouse condition	2018 to 2020	Concluded
128.	Management of red spider mite, *Tetranychus urticae* infesting rose in polyhouse conditions	2018 to 2020	Concluded
129.	Evaluation of biocontrol agents for the control of sucking pests in capsicum under polyhouse	2018 to 2020	Concluded
130.	Integrated management of root-knot nematodes in polyhouses using *Pochonia chlamydosporia*	2018 to 2020	Concluded
131.	Management of sucking pests on cucumber using anthocorid predator, *Blaptostethus pallescens* under polyhouse condition	2020 to 2022	Concluded
132.	Management of sucking pests in Tomato under polyhouse condition	2020 to 2022	Concluded
133.	Evaluation of biocontrol agents for the control of sucking pests in capsicum under polyhouse	2020 to 2022	Concluded
134.	Management of phytophagous mites on cucumber using *Blaptostethus pallescens* and *Neoseiulus longispinosus* under polyhouse condition	2020 to 2022	Concluded
135.	Field evaluation of anthocorid bug, *Blaptostethus pallescens* against spider mite, *Tetranychus urticae* infesting carnation in Kashmir (Poly house)	2020 to 2022	Concluded
136.	Evaluation of biocontrol agents for the control of sucking pests in capsicum under protected cultivation	2020 to 2022	Concluded
137.	Biological control of bacterial wilt of capsicum under protected cultivation	2020 to 2022	Concluded
138.	Casava KAU all the centres, TNAU, NBAIR New	2020 to 2022	Concluded
Crop disease management			
139.	Large scale demonstration of bioagents based IPM module for white grub in groundnut	2018 to 2020	Concluded
140.	Biological control of ginger rhizome rot	2018 to 2020	Concluded
141.	Evaluation of microbial biopesticides against wilt disease of chickpea in Bundelkh and region	2020 to 2022	Concluded

142.	The bio-control efficacy of identified biocontrol agents towards rice sheath blight (*Rhizoctonia solani)* disease will be assessed by potted plant method ICAR-NRRI, Cuttack in collaboration with ICAR-NBAIR, Bengaluru	2020 to 2022	Concluded
143.	The bio-control efficacy of identified biocontrol agents towards Rice Blast (*Magnaporthe oryzae*) and Rice brown spot (*Bipolaris oryzae*) strain will be assessed by potted plant method	2020 to 2022	Concluded
144.	Field evaluation of ICAR-NBAIR strains against Rice Blast (*Magnaporthe oryzae*), Brown spot (*Bipolaris oryzae*) and sheath blight (*Rhizoctonia solani*)	2020 to 2022	Ongoing
145.	Evaluation of bio-agents consortia in glasshouse and in field for crop health management in rice	2020 to 2022	Concluded
146.	Demonstration of *Trichoderma* spp for the management of *Fusarium* wilt in pigeon pea (1 ha)	2020 to 2022	Concluded
147.	Biological control of plant disease using antagonistic organisms in brinjal	2020 to 2022	Ongoing
148.	Large Scale Demonstration of biocontrol technologies against the soft rot of ginger	2020 to 2022	Concluded
149.	Field efficacy of different combinations of *Trichoderma harzianum* and *Pseudomonas fluorescens* against the early blight of tomato	2020 to 2022	Concluded
150.	Field efficacy of different combinations of *Trichoderma harzianum* and *Pseudomonas fluorescens* against the early blight of potato	2020 to 2022	Concluded
151.	Evaluation of microbial antagonist for the management of ginger rot disease	2020 to 2022	Ongoing
152.	Ecofriendly management of stem rot, *Macrophomina phaseolina* in sesame using biocontrol agents	2020 to 2022	Concluded
153.	Development of IPM module for the management of rhizome rot (Fungi and bacteria) and shoot borer in Ginger	2020 to 2022	Concluded
154.	Management of *Phytophthora* disease in black pepper nursery using biocontrol agents (KAU, Thrissur)	2020 to 2022	Concluded
155.	Management of *Fusarium* wilt in vegetable cowpea using microbial agents	2020 to 2022	Concluded
156.	Screening of promising isolates antagonistic fungi and bacteria against bacterial wilt of Tomato (*Ralstonia solanacearum*)	2020 to 2022	Concluded
157.	Management of Powdery mildew (*Uncinula necator*) of Grape by using Biocontrol agents	2020 to 2022	Concluded
158.	Screening of promising isolates of antagonistic fungi and bacteria against bacterial wilt of Tomato (*Ralstonia*	2020 to 2022	Concluded

	solanacearum) under field conditions		
159.	Evaluation of microbial antagonists for the management of diseases (Powdery mildew/Ascochyta blight/Rust) in pea (PAU-Ludhiana)	2020 to 2022	Concluded
160.	Evaluation of microbial antagonists for the management of foot rot of kinnow caused by *Phytophthora* spp. (2nd year)	2020 to 2022	Concluded
161.	Evaluation of effective fungal and bacterial antagonists, fungicide and their integration against sugarcane red rot	2020 to 2022	Concluded
162.	Management of *Fusarium* wilt/ root rot of pea through biological control agents	2020 to 2022	Concluded
163.	Management of major diseases of rice with *Bacillus subtilis* (TNAU strain)	2020 to 2022	Concluded
164.	Bio-intensive management of wilt and dry root rot complex in chickpea	2020 to 2022	Concluded
165.	Bio-intensive management of chilli wilt and powdery mildew	2020 to 2022	Concluded
166.	Field evaluation of ICAR-NBAIR antagonistic organisms against Maize Turcicum leaf blight (*Exserohilum turcicum*)	2020 to 2022	Concluded
167.	Field evaluation of ICAR-NBAIR antagonistic organisms against Wheat Yellow rust (*Puccinia striiformis f.* sp. *tritici*)	2020 to 2022	Concluded
168.	Field evaluation of ICAR-NBAIR antagonistic organisms against Chick pea Fusarium wilt (*Fusarium oxysporum f.* sp. *ciceris*)	2020 to 2022	Concluded
169.	Field evaluation of ICAR-NBAIR antagonistic organisms against Mustard White rust (*Albugo candida*)	2020 to 2022	Ongoing
170.	Field evaluation of ICAR-NBAIR entomopathogenic strains against field Pea Rust (*Uromycesviciae-fabae*)	2020 to 2022	Ongoing

XXIV. Highlights of research accomplishments during the period (2017-2022)

CPCRI Kayankulum

Emergence of four exotic whiteflies *viz.*, rugose spiralling whitefly (*Aleurodicus rugioperculatus*), Bondar's nesting whitefly (*Paraleyrodes bondari*), non-native nesting whitefly (*Paraleyrodes minei*) and the palm whitefly (*Aleurotrachelus atratus*) on coconut system was reported during 2017-2019.Morphological and molecular identification of the four non-native whiteflies was established. Further, effective bio-suppression strategies have been evolved to halt the epidemic outbreak of the trans boundary pests. AICRP on BC centre of ICAR-CPCRI reported the occurrence of the two non-native nesting whiteflies as well as the sooty mould scavenger beetle, *Leiochrinusnilgirianus* in the country for the first time.

Aleurodicus rugioperculatus was found to be the most aggressive among the exotic whitefly species. Pesticide holiday approach and conservation biological control using the two aphelinid parasitoids *viz., Encarsia guadeloupae* and *Encarsia dispersa*, predators such as *Apertochrysa* sp., *Jauravia pallidula* and *Cybocephalus* sp. and *in situ* habitat preservation of the scavenger beetle, *L. nilgirianus* subdued the invasive potential of *A. rugioperculatus* from >80% to <10%. Augmentative release of the stage specific parasitoids *viz., Goniozus nephantidis*, *Bracon brevicornis* and *Brachymeria nosatoi* bio-suppressed the black headed caterpillar, *Opisina arenosella* infestation significantly and regained palm health. Area-wide application of green muscardine fungus, *Metarhizium majus* @ $5x10^{11}/m^3$ in the breeding zones reduced leaf damage by 80% and enhanced nut yield by 13%.

Dr YSRHU-HRS, Ambajipeta

Non-insecticidal and biocontrol based management for rugose spiraling whitefly (RSW) in coconut was successfully implemented and propagated.

Initial parasitisation of *Encarsia guadeloupae* was nil/ very meager in the state of Andhra Pradesh. Therefore, special concentrated efforts were made to augment this parasitoid through inoculative release which was regularly obtained from ICAR- CPCRI, ICAR-NBAIR, Bangalore and TNAU, Coimbatore. This parasitoids were released in the RSW infested coconut plantations during 2017 to 2019. This results parsitoid well established throughout the Andhra Pradesh and its natural parasitism recorded more than 70% during 2021.

Beside, parasitoid, the neuropteran predator, *Apertochrysa astur* eggs and grubs were found to be potential biocontrol agent, therefore, mass multiplication protocolwas standardized in laboratory and supplied about 90 lakh eggs to farmers from Andhra Pradesh, Tamil Nadu, Karnataka and Odisha for management of RSW.

The foliar application of entomopathogenic fungi *Isaria fumosorosea* @ $1x10^8$ spores/ml (5 gm /litre along with sticker 2 ml/litre) was found effective against RSW in coconut and oil palm especially when the sprayings were carried out during November – December at low incidence levels. Natural epizootics was also observed in the gardens where *I. fumosorosea* spraying was carried out. Progressive farmers, staff of Ryhtubharosakendras, Department of Horticulture officers of Government of Andhra Pradesh were trained on low cost mass multiplication of fungus.

The bio pesticide, *Metarhizium anisopliae* (NBAIR Strain Ma4) @ 5 ml/litre was effective in reducing inflorescence thrips population in mango under field conditions.

GBPUAT, Pantnagar

Microbial consortia of biocontrol agents were evaluated under glasshouse and field conditions against Rice sheath blight and chick pea wilt. Consortia such as Pant Biocontrol agent PBAT-3 (*Trichoderma harzianum* (Th) 14 + *Pseudomonas fluorescens* (Psf) 173, Th17+Psf-173, Th14+Psf-2, Th17+Psf2 and Th17+Th14) were comparatively superior than other bio agents formulations in reducing 52 % diseases and increased 25% yield in rice, lentil and chickpea crops

Conducted large scale field demonstrations using PBAT-3: 837 ha in rice; 115 ha in chickpea; 124 ha in lentil; 60 ha in pea and 59 ha in tomato and supplied 93q PBAT-3 to the farmers.

IIMR, Hyderabad

Studies on abundance of natural enemies of borers in Millets: Infestation of stem borer, *Chilo partellus* was predominant (8 - 10%) as compared to *Sesamia inferens* (< 5 %) in sorghum and about 10% larval parasitization by *Cotesia flavipes* was observed. In sorghum, incidence of *Spodoptera frugiperda* showed 5 – 6 % damage and larval parasitization was about 2-3% by *Chelonis* sp.

Management of pink borer in ragi with oil based formulations of entomofungal pathogens: Application of *Metarhizium anisopliae* 35 @ 10 ml/L at 20 & 40 DAE of crop and application of *B. bassiana* - 45 @ 10 ml/L at 20 & 40 DAE were the best and on par with soil application of Carbofuran 3G @ 20kg /ha twice at 20 and 40 DAE for the management of *Sesamia inferens* in ragi. Highest incremental yield (6.77 q/ha) over control was realized in application of carbofuran 3G granules @ 20 kg/ha which was on par with 5.62 q/ha yield gain realized in spray application of (Ma 35) @10 ml /L implying that there was 46.7% increase in grain yield over the control and 9.56% decrease in grain yield over the insecticide control.

Management of Fall army worm in sorghum with bioagents: Release of *Trichogramma chilonis* @ one card/acre twice at weekly intervals commencing at 7 & 14 DAE of sorghum followed by spray of *Metarhizium anisopliae* (Ma 35) @ 0.5 % at 20, 35 DAE was found to decrease the egg patches, larvae numbers (42.0 %) and whorl damage (59.9%) caused by *Spodoptera frugiperda*, significantly. Results revealed that there was 11.1 and 15.4 % increase in the grain and fodder yield in comparison to control.

IIHR, Bengaluru

Entomopathogens *Beauveria bassiana* (NBAIR Bb5a) @ 5 g/L followed by *Lecanicilium lecanii* (NBAIR Vl8) @ 5g/L was found significant and reduced the aphid population and showed no significant reduction in the thrips populationin capsicum under polyhouse conditions..

Heterorhabditis indica @ 2.5 10^9 IJs ha^{-1} and *M. anisopliae* NBAIR followed by *B. bassiana* NBAIR and *B. bassiana* AAU strains were found superior in controlling ash weevils in brinjal. They were significantly superior over the control, but not superior to chemical control. *B. bassiana* NBAIR and *M. anispoliae* AAU strains were showing significantly lower damage scoring compared to other treatments.

IIRR, Hyderabad

Diversity of natural enemies have been recorded with special reference to egg parasitoids of hoppers and stem borers of rice. The three-key egg parasitoids *viz., Tetrastichus schoenobii*, *Telenomus* spp. and *Trichogramma japonicum* were identified on yellow stem borer *Scirpophaga incertulas* egg masses in rice crop across the country

Indigenous bioagents *viz., Trichoderma asperellum* strain TAIK1, *Bacillus cabrialesii* BIK3and *Pseudomonas fluorescens* strain PIK1 were extended to farmers for large scale

biointensive pest management trial at Telangana, Andhra Pradesh and Odisha after initial testing at multi-location. In BIPM modules such as bund cropping, application of Phosphorous Solubilizing Bacteria, alleyways, organic manuring, owl perches for rodent management were found to reduce insecticide use and manage pests with a benefit cost of 1.95 – 2.59 as compared to 1.77 - 2.46 in farmers' practices of chemical dependence. Disease incidence was also found to be reduced – False smut was only 2.7-5.0% in BIPM plots as compared to 6.33-11.00 % in non-BIPM plots.

IIVR, Varanasi

In tomato, the maximum fruit damage due to *Tuta absoluta* was recorded during the 10^{th} SMW (5% fruit damage) whereas lowest (1% fruit damage) was during last Week of March, 2019.

Polyphagous predator, *Nesidiocoris tenuis* was observed in abundance (maximum 4.3 bugs / apical twigs) feeding on early instar larvae of *Tuta absoluta*. Besides, it also feeds on soft-bodied insects like whitefly, jassid and aphis in tomato field.

KAU Vellayani

NBAIR Bb 5 and Chitin enriched KAU Bb 6063 @ 10^8 spores mL^{-1} @ 20 g/ L was effective in managing rice leaf roller, *Cnaphalocrocis medinalis*, however KAU Bb 6063 was superior with 82.69 % reduction in pest population.

For rice bug *Leptocorisa acuta*, management the indigenous isolate *Lecanicillium saksenae* @ 10^7 spores mL^{-1} was the superior treatment with 100 % control at 21 DAS (2 sprayings) at panicle initiation and milky stages followed by Bb 5 which performed equally good at 28 DAS.

Coconut RSW was found to reach peak during summer and the mean parasitisation by *Encarsia guadeloupae* was 58.38 to75.52 %. *Isaria fumosorosea* (ICAR-NBAIR Pfu-5) and Neem oil emulsion with sticker was found to be equally effective in managing RSW.

In pulses, the major pest *Aphis craccivora* could be effectively managed by chitin enriched oil formulation of *Lecanicillium saksenae* @ 10 ml/L, followed by *Lecanicillium lecanii* (NBAIRVl8) NBAIR Bb5 and KAU Bb 6063 were effective in managing leaf webber, *Hymenia recurvali*s in amaranthus when sprayed by dispensing the bio capsules @ 10^8 spores mL^{-1} @ 3 capsules L^{-1}

Fusarium wilt in cowpea was effectively managed by soil application of *T. asperillum* at monthly intervals + soil drenching and foliar spray of *P. fluorescens* at fortnightly intervals.

BIPM in rice comprising seed priming with NBAIR Bb 5 + foliar spray at vegetative phase + Trichocards from 30 DAP + foliar spray of *L. saksenae* during panicle initiation and milky stage was effective against rice bugs. It enhanced natural enemy population and reduced cost of plant protection

KAU, Kumarakom

The fungal isolate *Hanseniaspora uvarum* (Y-73), *Trichoderma harzianum* (Th-3), *T. viride* (KAU strain) and *Pseudomonas fluorescens* (KAU strain) applied as seed treatment followed by foliar spray gave effective control of anthracnose disease of vegetable cowpea.

Foliar spray of *M. anisopliae* NBAIR Ma 4 and *Lecanicillium lecanii* NBAIR Vl8 were found effective in reducing chilli mite.

Application of *I. fumosorosea* (Pfu-5) could bring significant reduction in the live colony count of invasive whiteflies in coconut, where it could cause 57.70 % reduction in the number of colonies, at 60 DAT as compared with the untreated palms during 2020-21.

Seed treatment, seedling dip and soil drenching with NBAIR-BATP isolate of *Bacillus albus* was highly effective in reducing bacterial wilt incidence, in tomato followed by KAU strain PN026 and NBAIR-PFDWD isolate of *P. fluorescens.*

NCIPM, New Delhi

Population dynamics of whitefly, *Bemisiatabaci* and its natural enemies in cotton: A study in farmer's field in North Zone. Dynamics of whitefly *Bemisia tabaci* during the cotton crop season was studied in farmer's fields in North West India from June to October 2018-2019 which indicated that the whitefly population (adults/ 3 leaves) remained below ETL in June and crossed ETL in few locations during July-August and thereafter remained below ETL in all the study locations. Whitefly (adults/3 leaves) was maximum in Fazilka (12.77) followed by Sirsa (6.79), Muktsar (3.86), Sriganganagar (3.03) and Hanumangarh (2.33). Average population (mean of the season) of Chrysopid (egg/larvae / plant) was maximum in Sirsa (2.21) followed by Fazilka (0.89), Sriganganagar (0.67) and Hanumangarh (0.47). Spider population (adults/spiderlings / plant) was maximum in Sriganganagar (0.83) followed by Fazilka (0.81), Muktsar (0.78), Sirsa (0.61) and Hanumangarah (0.17). The population of Chrysopid in the month of June was negligible which increased in mid-July and reached its peak in August and September. Mean parasitization of whitefly nymphs by *Encarsia* spp. was recorded maximum in Fazilka (60.90%) followed by Muktsar (55.94%), Sirsa (54.25%), Hanumangarah (45.49%) and Sriganganagar (51.95%). Dynamics of parasitization of whitefly nymphs by *Encarsia* spp. indicated that maximum parasitization was in the month of July and August and thereafter it declined with the reduction in whitefly population and pesticide applications.

Evaluation of BIPM against pod borer in chickpea in Bundelkhand region : BIPM module of chick pea pod borer consists of deep summer ploughing and field sanitation, sowing in the first fortnight of November, selection of resistant variety (RVG202), seed treatment with *T. harzianum* (NCIPM-TH1) @ 10 g/kg seed, intercropping with mustard, installation of pheromone trap @ 5/ha for monitoring in November and @ 30/ha for mass trapping, erection of bird perches @ 20/ha, need based application of botanical neem azadirachtin 1500 ppm @ 5 ml/L and biopesticides *Bacillus thuringiensis* krustaki @ 2×10^8 cfu /ml was found best in comparison to farmers practice where farmers applied insecticides @ 1-2 sprays against chickpea pod borer. Over all BIPM fields recorded a significant reduction in infestation of pod borer (70.52%) and disease incidence of *Fusarium* wilt (73.77%) and dry root rot (62.5%) compared to farmers practice. Economic analysis indicated that BIPM recorded average yield of chickpea 18.60 q/ha with B: C ratio 3.87 whereas, 14.40 q/ha yield was recorded in farmers practice with B: C ratio of 3.06. Implementation of BIPM module provided >29 % increase in seed yield and >42 % increase in net return in BIPM over FP consequently farmers earned >Rs 20000/ha extra net income over farmers practice.

PAU, Ludhiana

PAU centre has developed 14 biocontrol technologies for the suppression of insect pests. Among these, 9 technologies have been included in PAU Package of Practices namely *Trichogramma* releases against stem borer in fodder maize, integration of *Trichogramma* releases with pheromone traps against early shoot borer, top borer and stalk borer in sugarcane, *Bacillus thuringiensis* 0.5 WP and HearNPV 2%. AS against gram caterpillar in chickpea, azadirachtin 50000 ppm against leafhopper in okra and azadirachtin (1500 and 50000 ppm) against stem borers and leaf folder in rice.

Large scale demonstrations were conducted over an area of 20178 hectares for the management of borers in sugarcane, stem borers and leaf folder in rice and stem borer in maize. The dissemination of biocontrol technology has significant impact w.r.t area coverage, reduction in pest incidence (52.4-58.7% in sugarcane, 50.0-60.0% in rice and 50.1-57.8% in maize), lower input cost, higher yield and additional economic benefits to farmers.

SKUAST, Srinagar

The entomopathogenic fungi of NBAIR and biopesticides *viz.,?????* were successfully evaluated against aphids and has been proposed for the package of practices for the management of woolly apple aphid.

PJTSAU, Hyderabad

Four releases of Trichocards + 4 foliar sprays of NBAIR *Bacillus thuringiensis Bt 25* @ 2%, Trichocards + Pheromone traps @15/acre recorded lesser damage in maize by FAW and higher yield among all the biocontrol treatments and were on par with the chemical check.

Three sprays of *Lecanicillium lecanii* @ 5g/L and Neem oil 1500 ppm @ 5ml/L recorded minimum leaf hopper population in cotton.

Validated BIPM package in comparison with farmer's practices to manage *Helicoverpa armigera* and *Tuta absoluta* in tomato and reported that they recorded lesser fruit damage than control plots with higher B:C ratios in BIPM package than farmer's practices.

CAU, Pasighat

Demonstration of the biocontrol module in cabbage (mustard as intercrop @ 15:2, six release of MITS of *Trichogramma chilonis* 30 DAT at weekly interval @ 1,00,000 /release against *Plutella xylostella*, two release of *Chrysoperla zastrowi sillemi* @ 2000/release at 15 days interval against aphid and two spray of *Bacillus thuringiensis* (NBAIR BtG4) 2%) yielded (161.86 quintals / ha) than farmers practice (profenophos50 EC@ 0.05%) where it was 140.80 quintals per ha.

In brinjal, BIPM module (Soil application of *P. lilacinus* @ 20 g/m^2 (Root Knot Nematode management), Azadirachtin 1500 ppm @ 2 ml/L, *Lecanicillium lecanii* NBAIR Vl8 @ 1x10^8 spores/ml @ 5g/L (Sucking Pests) and 8 release of *Trichogramma chilonis* @ 100,000/ha at weekly interval from initiation of flowering, spraying *Bacillus thuringiensis* NBAIR BtG4 @ 2% was the best treatment as compared to chemical treatment (Dimethoate 200 a.i./ha) showing 10.3% shoot and 12.40% fruit infestation and gave 213.60 q/ha yield.

Tomato intercropped with carrotand bordered with marigold recorded the lowest fruit borer's incidence (1.28 larvae/plant) compared to tomato alone (3.25/plant).

Lecanicillium lecanii NBAIR Vl-8 was found to be best among entomopathogenic fungi tested for the management of diamond back moth and aphids in cabbage (2.15 DBM larvae/plant, 2.96 aphids/plant and head yield of 22.19 t/ha).

Trichogramma chilonis @ 1 card/acre + NBAIR Bt 25@ 2% was recorded as best treatment for the management of fall armyworm in maize (1.85 larvae/10 plants, 15.19 % plant damage and grain yield of 34.13 q / ha).

Native microbials based rhizome rot management in ginger: *Trichoderma harzianum* seed treatment (0.5%), *Trichoderma* soil application (1%), *Pseudomonas P. fluorescens* soil application (1%) resulted in 89.08% germination, 15.33 tillers/plant and rhizome yield 13.50 t/ha.

CISH, Lucknow

The root-knot index of guava caused by *Meloidogyne enterolobii* was most effectively suppressed by *Purpureocillium lilacinum* + *Bacillus* spp. followed by *Pochonia chlamydosporia*, *Trichoderma asperellum* and *Bacillus* spp. respectively. The results indicated that *P. lilacinum* + *Bacillus* spp. combination was the most effective in managing the disease and enhancing the growth of plants.

MPKV

The new allian pest, Rugose spiralling whitefly (*Aleurodicus rugioperculatus*) first time observed on coconut palms in Western Maharashtra during the year 2021-22. Parasitoid, *Encarsia* sp. and predator, *Apertochrysa* sp. were seen in the colonies of rugose spiralling whitefly on coconut in all surveyed areas.

The treatment *Trichogramma pretiosum* 1 card (2 Rel) +EPN *Heterorhabditis indica* NBAIR H38 @ 4 kg/acre recorded 25.79 per cent plant damage due to fall armyworm on maize and it was at par with treatments *Trichogramma pretiosum* 1 card (2 Rel) + *Bt* 25 2 % @ 2.0 ml/l (28.20%) and *Trichogramma pretiosum* 1 card (2 Rel) + *M. anisopliae* Ma 35, 0.5% @ 2.0 g/l (29.24%). The lowest pooled mean per cent of plant damage/plot (13.47%) was observed in the chemical treatment (Emamectin benzoate 0.4g/l) which was significantly superior over rest of the treatments.

B. thuringiensis NBAIR bt G4 was at par in reducing larval population of *H. armigera* with 4.88% pod damage and recorded grain yield 16.03 q/ha as against in standard insecticidal check of spinosad 40 SC @ 150 ml/ha with larval population of 0.34 larvae/m. 3.55% pot damage and grain yield of 17.83 q/ha on chickpea.

The treatment *Heterorhabditis indica* @ 1 x 10^5 (NBAIR WP formulation) @ 12.50 kg/ha was second superior treatment in clump mortality due to white grub (8.03%) and was at par with the treatment *Heterorhabditis bacteriophora* @ 1 x 10^5 (NBAIR WP formulation) with 9.04 % clump mortality. Highest white grub reduction was recorded in chemical control (68.38%). The next best treatments are *H. indica* @ 1.0 X10^5/ m^2 (59.18 %), *H. bacteriophora* @ 1.0 x 10^5/ m^2, S. *carpocapsae* @ 1.0 x10^5/ m^2 and *S. abbasi* @ 1.0x10^5/ m^2 recorded 54.04, 49.56 and 45.55 per cent, reduction, respectively.

Large scale demonstration on biological suppression of *Spodoptera litura* with *Metarhizium rileyi* in soybean indicated that two sprays of *Metarhizium rileyi* (Farlow) *N. rileyi* 2.0 x 10^8cfu/g were significantly superior in suppressing the larval population of *S. litura* (2.46 larvae/m row) due to fungal infection with maximum soybean yield of 16.43 q/ha with BC ratio 1.62.

Eight releases of *T. chilonis* TTS @ 50,000 parasitoids/ha at weekly interval starting from 40 days after emergence of shoots found significantly superior in reducing the sugarcane early shoot borer infestation (from 22.16 to 6.41 % dead hearts) and recorded maximum cane yield (139.64 Mt/ha) with B:C ratio 2.31.

MPUAT, Udaipur

HearNPV was validated against *H. armigera* in tomato at farmer's field. The tomato plots treated with HearNPV 2% AS showed less fruit damage (11.52%)and high yield (232.34 q/ha) as compare to control where 25% fruit damage was recorded.

TNAU

Intensive surveys were conducted to assess the status of invasive pests *viz.,* coconut Rugose Spiralling Whitefly, *Aleurodicus rugioperculatus,* tomato pinworm, *Tuta absoluta,* papaya mealybug *Paracoccus marginatus,* maize fall armyworm *Spodoptera frugiperda,* sugarcane woolly aphid *Ceratovacuna lanigera* and cassava mealybug *Phenacoccus manihoti* and their natural enemies spiders in different agro-ecological zones and on different crops of Tamil Nadu.

The parasitization by *Encarsia guadeloupae* was ranged between 10.00 and 100.00 % in coconut gardens. A diverse array of predators *viz*., *Aprtochysa astur, Chilo corusnigrita, Coccinella transversalis, Mallada desjardinsi, Cheilomenes sexmaculatus, Propylea dissecta, Scymnus nubilis, Scymnus saciformis* and *Chrysoperla zastrowi sillemi* were present in association with RSW in coconut gardens.

Dipha aphidivora and *Micromus igorotus* were observed on sugarcane woolly aphid in Coimbatore and Erode Districts. Cassava mealybug *Phenacoccus manihoti* caused 30-40 % damage in cassava fields in Erode, Namakkal and Salem Districts. *Hyperaspis maindroni* was found to be the predominant coccinellid predator of the mealybug. Besides *H. maindroni, Mallada* sp. and *Prochiloneurus aegyptiacus*, *Tetrastichus* sp. were also observed. Among the parasitoid species, *Homalotylus turkmenicus* emerged from the coccinellid predator, *H. maindroni* grubs. Encyrtid parasitoid, *Copidosomyia ambiguous* has been found on *Mallada desjardinsi* eggs.

Biointensive pest management modules for the management of insect pests of brinjal, Bhendi, tomato, jasmine, cabbage, maize, chickpea, pigeonpea and coconut have been demonstrated in the farmers field. Brinjal farmers are able to manage of brinjal shoot and fruit borer with BIPM module without could spraying of 7-8 rounds of insecticides. Large scale demonstration of BIPM module for coconut has been conducted in 25 acres. Benefits of BIPM module for pink bollworm in Bt cotton has been demonstrated in 10 acres. Release of *Acerophagus papayae* for the management of *Paracoccus marginatus* in papaya, tapioca and mulberry paved the way for non-use of synthetic chemical insecticides and saved the input cost on pesticides Rs.244.5 crores annually in Tamil Nadu. *A. rugioperculatus* has been

managed with release of *Encarsia guadeloupae, A. astur* and *C. sillemi* without the use of insecticides.

Seven parasitoids *viz., Trichogramma chilonis, T. pretiosum, T. japonicum, Trichogrammatoidea bactrae, Acerophagus papayae, Bracon brevicornis* and *Goniozus nephantidis* and three predators *viz., C. silemmi, A. astur* and *Cryptolaemus montrouzeiri* have been mass multiplied and supplied to farmers. In addition, *Corcyra* eggs have been supplied to research stations and breeding centers for the production of macrobials. Forty one trainings on production of biocontrol agents and use of bioagents in BIPM were given to farmers, input dealers and students. Twenty four awareness programmes on biological control were conducted in different villages.

SKUAST-Jammu

Maize + Cowpea (inter crop) + Sorghum (border crop) may be grown to reduce the *Chilo partellus* incidence in maize. Chickpea + Linseed (inter crop) + Napier / Mustard (border crop) reduces *Helicoverpa* larvae incidence and consequent pod damage.

Spraying Lecanicilliumlecanii @ 5g/L, Beauvera bassiana @ 5g/L or Azadirachtin @ 1500 ppm was found effective in reducing 35% guava scale, *Iceryapuhasi*.

Drenching of *Trichoderma asperellum* NBAIR-TATP strain liquid formulation @ 10ml/L was found effective in reducing 45% wilt in chick pea.

OUAT

Large scale demonstration of bio-intensive pest management module of rice was conducted (Seed treatment @ 10 g/Kg, Seedling root dip @ 10 g/L, Spray 10 g/L for diseases; Spray of azadirachtin 1500 ppm @ 3ml/litre at 45 and 65 DAT against foliar and sucking; Release of *Trichogramma japonicum* @ 100,000/ha (6 releases to be made during season) at 10 days interval starting from 25 DAT for stem borer and leaf folder infestation). The silver shoot, dead heart, white ear head and leaf folder incidence in BIPM demonstrated plots were 2.40, 4.32, 3.20 and 4.18%, respectively as compared to 3.12, 3.90, 2.56 and 3.90% infestation in farmers practice (FP) with the use of chemical pesticides. Significantly higher silver shoot (4.84%), dead heart (9.76%), white ear heads (10.76%) and LF (10.84%) infestation was noticed in untreated control. Highest yield (40.84/ha) was recorded in FP. But the yield (39.48 q/ha) in BIPM package was at par with FP. Lowest yield (31.20 q/ha) was recorded in untreated control. The benefit cost ratio in BIPM treated plots was found (1.38) as against 1.40 and 1.09 in FP and untreated control, respectively

NIPHM, Hyderabad

Evaluation of NIPHM white media for production of *Nomuraea rileyi (=Metarhizium)* NIPHM MRF-1 strain for management of *Spodoptera frugiperda,* Growth of *M. rileyi* was good in 2% NIPHM white media. The growth and sporulation of the fungus was assessed in the 2% NIPHM white media. The sporulation was better than the normal media. The colony forming unit of *M. rileyi* was six times ($6x10^8$) higher than the standard media where it was ($1x10^8$). The laboratory bioassay of *M. rileyi* against *S. frugiperda* using second instar larva recorded 90% mortality.

AAU, Anand

The native isolate *Trichogramma chilonis* was documented from the castor and cotton ecosystem and native isolate of *Heterorhabditis indica* – AAU-R strain (Genbank accession no. MW418203) was documented from the soil collected from TalalaSasan Gir, Gujarat.

Survey and surveillance of invasive pest rugose spiraling whitefly was carried out in coconut orchards of Junagadh district, Gujarat. The RSW infestation to the tune of 60-70% was noticed in the villages BarulaGir and Kanek, taluka Maliya. Documented the new invasive thrips, *Thrips parvispinus* in chilli fields of village Bechri, Umreth Taluka, Dist. Anand in middle Gujarat. Infestation to the tune of 20-30% was noticed.

Successfully conducted large scale demonstration trials to validate the technologies of BIPM modules in okra, cabbage, mango and pigeonpea covering the area of 580 ha..

DrYSRHU, Tirupathi

Lecanicilium lecanii (NBAIR Vl8) @ 5g/L was found effective with least infestation by thrips on fruits (11.78%) followed by acephate 75SP @ with 12.64% as compared to *Beauveria bassiana* @ 5g/L (16.09%) and *Metarhizium anisopliae* @ 5g/L (16.72%) where the latter two treatments were on par with each other and maximum infestation was recorded in control with 24.83% fruits infested.

Beauveria bassiana (NBAIR Bb 5a @ 5g/L was found effective with lower infestation by rust mites?? on fruits (19.46%) while least infestation was recorded in propargite 57EC @ with 13.44% whereas with respect to green mites infestation on fruits, *Lecanicilium lecanii* @ 5g/L (15.49%) showed lowest damage followed by T2*(Metarhizium anisopliae* @ and maximum damage was noticed in control (31.59%).

YSPUHF, Solan

Trichogramma spp *viz., Trichogramma achaeae, Trichogramma pretiosum, T rchogramma chilonis, Trichogramma pieridis* and *Trichogramma embryophagum* were evaluated against apple fruit moth, *Argyresthia conjugella*. Maximum parasitisation was 16.6 % with *T. embryophagum.* The parasitism resulted by *T. achaeae, T. pretiosum* and *T. chilonis* was 5.6, 8.9 and 11.1 %, respectively, whereas, *T. pieridis* failed to parasitize the eggs of apple fruit moth.

Metarhizium anisopliae (10^8 conidia/g) was applied @ 30g/ tree basin mixed in well rotten farm yard manure during July- August i.e. at the time of egg hatching and emergence of new/young grubs. *Metarhizium anisopliae* treatment resulted 71.1 to 82.2 % mortality of the apple root borer grubs in different orchards, which was close to that resulted chlorpyriphos (0.06%) (77.4 - 86.6%).

Among different biocontrol agents evaluated **against leopard moth, *Zeuzera multistrigata* in apple**, *Heterorhabditis bacteriophora* (5000IJs/gallery) was the most effective resulting in 77.8% mortality followed by *Steinernemma feltiae* (5000IJs/gallery) and azadirachtin 1500ppm @ 2ml/L 10ml/gallery) (66.7% each). Whereas, chlorpyriphos 20 EC @ 0.04% resulted 100 % mortality.

The number of mines caused by *Tuta absoluta* in tomato was recorded which were statistically on par in both the plots (BIPM and Chemical) and varied from 0.33 to0.37 mines/leaf. The yield recorded in BIPM plots (31.3t/ha) was also statistically on par with

chemical treated plots (29.4.t/ha). The aphid population (*Macrosiphum euphorbiae)* recorded on top 10 cm length of the shoot during second week of September was 18.7 in BIPM and 23.2 numbers/plant in chemical plots.

Seed treatment with *T. asperellum* formulation @ 10g/kg seed+ soil application of *T. asperellum* formulation after mixing with FYM (10g/Kg FYM) @ 40g/m^2 provided significantly better control of *Fusarium* wilt of pea (10.67 %)as compared to already recommended chemical treatment.

NRRI

NBAIR isolates i.e., NBAIR-PEOWN (*Pseudomonas entomophila*), NBAIR-BATP (*Bacillus albus*), NBAIR-BtoYPS (*Lysinibacillus sphaericus*), NBAIR-PFDWD (*Pseudomonas fluorescens*) and NBAIR-TATP(*Trichoderma asperellum*) shown lesser dead heart and white ear-head damage caused by rice yellow stem borer, leaf damage caused by rice leaf folder but increased plant height and grain yield than the untreated control. Based on this lead result, NBAIR-BATP (*Bacillus albus*) which performed better was carried forward for the multi-location evaluation against rice insect pests under field conditions.

NBAIR-PFDWD (*Pseudomonas flourescens*) was the most effective isolate against rice diseases *viz.*, sheath blight, brown spot and blast with lesser Percent Disease Index (PDI) followed by NBAIR-TATP (*Trichoderma asperellum*) under field conditions. NBAIR-PFDWD treatment enhanced the plant growth of rice plants in terms of plant height, fresh shoot weight, fresh root weight, dry shoot weight, dry root weight and yield as compared with control plants. Based on this lead result, NBAIR-PFDWD (*Pseudomonas flourescens*) which performed better was carried forward for the multi-location evaluation against rice disease pests.

Bacillus thuringiensis NRRI Bt Biocb 7 was identified to be effective in managing leaf folder of rice, and BS-5 (*Bacillus amyloliquefaciens*), BS-6 (*Bacillus subtilis*), BS-39 (*Bacillus cereus*) effective against rice diseases. Apart from microbials, macrobials *viz.., Trichogramma* spp., and *Bracon* spp. etc. were also mass reared and supplied for farmers for effective management of rice yellow stem borer and leaf folder of rice.

KAU, Thrissur

Large scale validation of BIPM practices in rice at Palakkad District demonstrated the superiority of BIPM practices over farmers' practices. Adoption of BIPM practices have consistently led to reduction in cost of cultivation by an average of 6.0 % and an increase in yield by 23.0 %. The cost benefit ratio, at an average of 2.18 has been almost double for BIPM fields as compared to 1.40 for non BIPM fields.

Spraying with *Beauveria bassiana* was shown to be effective in managing pseudo stem weevil in banana. Plots treated with *B. bassiana* recorded 27.38 % infestation as against 35.5 % in case of untreated plots.

BIPM in brinjal resulted in significantly lower infestationby shoot and fruit borer as well as mealybug. BIPM plots also recorded significantly higher fruit yield compared to untreated plots. Adoption of BIPM practice could be a viable alternative for chemical insecticides.

The entomopathogenic fungus *Beauveria bassiana* registered lower pod damage??? in cowpea which is on par with the chemical check, malathion recommended??.

The anthocorid predator *Blaptostethes pallescens* released twice at 20/m row was as effective as spiromesifen formulation?? Concentration?? in managing ??? spider mites in cucumber under polyhouse conditions.

Surveys for prevalence of cassava mealybug revealed that that four mealybug species *viz.*, *Paracoccus marginatus* (36.72%), *Ferrisia virgata* (29.69 %), *Phenacoccus manihoti* (28.90 %) and *Pseudococcus jackbeardsleyi* (4.69 %) infested the cassava plants simultaneously, forming a complex. Predators like ape fly and green lacewings were encountered frequently in the cassava field. Entomopathogenic fungi, *viz.*, *Lecanicillium araneicola*, *Simplicillium* sp., *Pupueocillum lilacinum* and *Lecancillium psalliote* were isolated from the mummified cadavers of *Paracoccus marginatus.*

Incidence of invasive pests like wax scale on cassava, hard scale on mango, *Pseudococcus jackbeardsleyi* on glyricidia, *Rastrococcus iceryoides* on *Triumfetta rhomboidea* and mealybug *Pseudococcu slongispinus* on coconut were reported during the period.

IGKV

Parasitization of *Braconhebator* was recorded on DBM, *Plutella xylostella* on cabbage. Maximum parasitization (32 %) was recorded by *Cotesia flavipes* followed by *Bracon* spp. (20%) and *Bracon hebator* (10%).Release of *Bracon hebator* under caged condition was effective in managing the population of DBM in cabbage crop. Initially after 3 days of application it showed 3.33 number of dead larvae which increased to 5.33 and 7.66 after 7 and 14 days of treatment.

Maximum paddy grain yield/plot (31.56 kg) and per acre(1303.22) was obtained in BIPM treatment followed by farmer's practice (28.88kg)/plot and (1284.63Kg) and control (25.25 kg) and (1122.87kg) per plot and per acre respectively.

XXV. Priorities, programmes and research projects

CPCRI

a) Survey, monitoring and biodiversity of fauna

(i) Surveillance of exotic whiteflies and population assessment of natural enemies

Salient outcome

- Morphological identification of the four non-native whiteflies *viz.,* rugose spiralling whitefly (RSW) (*Aleurodicus rugioperculatus* Martin), Bondar's nesting whitefly (BNW) (*Paraleyrodes bondari* Peracchi), non-native nesting whitefly (*Paraleyrodes minei* laccarino) and the palm whitefly (*Aleurotrachelus atratus* Hempel) was established by using puparium (compound pore and lingula features) and adult features (male genitalia and cement gland) [Fig 1] as well as molecular characterization using the cytochrome c-oxidase subunit 1 (COI) gene was established with phylogenetic relationship and nucleotide sequences of all five exotic whiteflies are deposited in Gen Bank.

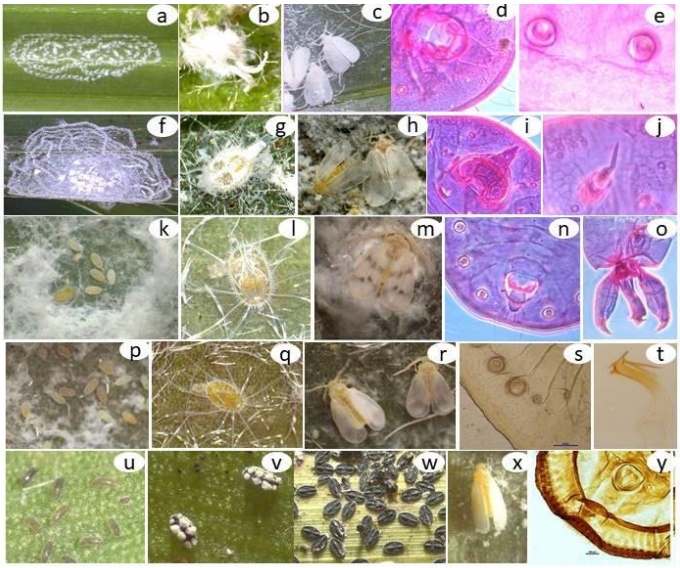

Fig. 1 ***Aleurodicus dispersus*** **Russell** a) colony b) puparia c) adults d) lingula e) compound pore ***Aleurodicus rugioperculatus*** **Martin** f) colony g) puparia h) adults i) lingula j) compound pore ***Paraleyrodes bondari*** **Peracchi** k) eggs l) puparia m) adult n) lingula o) male genitalia ***Paraleyrodes minei*** **Iaccarino** p) eggs q) puparia r) adults s) compound pore t) male genitalia ***Aleurotrachelus atratus*** **Hempel** u) eggs v) nymphs w) puparia x) adult y) lingula

- BNW, *Paraleyrodes bondari* was found to co-occur with solanum whitefly (*Aleurotrachelus trachoides*), areca whitefly (*Aleurocanthus arecae*), citrus blackfly (*Aleurocanthus woglumi*), guava woolly whitefly (*Aleurothrixus floccosus*) and rugose spiralling whitefly (*Aleurodicus rugioperculatus*). Under such co-occurrences, identification of different life stages of co-existing whiteflies would be confusing for which correct diagnosis is very important.
- Occurrence of the two non-native nesting whiteflies (*P. bondari* and *P. minei*) as well as the sooty mould scavenger beetle, *Leiochrinus nilgirianus* Kaszab (Tenebrionidae: Coleoptera) is reported in the country for the first time in 2018.
- The population of *A. rugioperculatus* which was as high as 4.5 live colonies per leaflet in 2019 got diminished to as low as 1.0 live colony per leaflet in 2022. Similarly, the population of *P. bondari* was found maximum (4.0 live colonies /leaflet) in 2019 got reduced to <1.0 live colony in 2022.
- Parasitism of *A. rugioperculatus* by the aphelinid parasitoid, *Encarsia guadeloupae* Viggiani ranged from 20%-70% subduing the flare up of the pest in Kerala.
- A wide array of natural predators such as *Apertochrysa* sp. (Chrysopidae: Neuroptera), *Jauraviapallidula* Motschulsky (Coccinellidae: Coleoptera), *Cybocephalus* sp. (Cybocephalidae: Coleoptera) were widely prevalent regulating the exotic whitefly complex on coconut to the tune of 5% to 7%.
- The population of RSW was found to be positively correlated with maximum temperature (r=0.89) and difference in temperature (r=0.71), whereas, negative correlation was observed with relative humidity (r=-0.69) and rainfall (r=-0.49). Thus, both weather factors and parasitic potential of the aphelinid parasitoid, *E. guadeloupae* play a critical role in the population dynamics of RSW.

- Chowghat Orange Dwarf (COD). Malayan Green Dwarf coconut varieties and the hybrid Kalpa Sankara (CGD x WCT) are found to be relatively susceptible, however, West Coast Tall (WCT) and East Coast Tall (ECT) are found to be relatively tolerant.
- In the surveillance programme, more than 1.3% of grubs of coconut rhinoceros beetle (*Oryctes rhinoceros*) collected from natural breeding zone has been virosed in the country with characteristic gut clearing and prolapse symptoms. Molecular characterization of *CO1* gene of coconut rhinoceros beetle collected from Kayamkulam, India had no A to G transition indicating the absence of CRB-Guam haplotype in the country.
- Some potential invasive pests *viz.*, Coconut leaf beetle, *Bronstispa longissima* Gestro (Chrysomelidae: Coleoptera) and false coconut scale *Aspidiotus rigidus* Reyne (Diaspididae: Hemiptera) ravaging South-East Asian coconut are at our doorsteps for possible entry at any time. So far, they are not reported in our surveillance surveys.

b) Biological suppression

(i) Biological control of rugose spiralling whitefly in coconut

Salient outcome

- Under good nutrition management, palms treated with neem oil (0.5%), water spray and *Isaria fumosorosea* (5g per litre) reduced the RSW (*A. rugioperculatus*) population significantly ranging from 0.78 to 1.08 from the initial population of 1.51 to 3.01. However, highest reduction of RSW population by 74% was recorded on neem oil treated palms.
- Parasitism by *E. guadeloupae* was not influenced by bioagents or botanicals and ranged from 38% to 58%.
- Conservation biological control (Fig 2) practices reduced the RSW population in the most efficient manner after four months by the natural build-up of defenders, pollinators and scavenger beetles for which pesticide holiday approach is crucial in the bio-suppression of exotic whitefly complex and it enhanced ecosystem vitality and delivered economic benefits to the tune of 1760cr rupees

Fig. 2 Conservation biological control of invasive whiteflies infesting coconut

a) Encarsia guadeloupae emerging from puparium of RSW b) *Encarsia guadeloupae* c) *Apertochrysa sp.* d) *Jauravia pallidula* e) *Cybocephalus sp.* f) *Menochilus sexmaculatus* g) *Scymnus nubilis* h) *Leiochrinus nilgirianus* i) *L. nilgirianus* feeding on sooty mould j & k) *Aschersonia* sp. l) Unidentified

c) Evaluation and efficacy of bioagents

(i) Stage specific parasitoids against black headed caterpillar

Rearing system, release norms and mass production of larval parasitoids *viz.*, *Goniozus nephantidis* and *Bracon brevicornis* (pre-pupal parasitoid, *Elasmus nephantidis* (and pupal parasitoid, *Brachymeria nosatoi* using factitious host, *Corcyra cephalonica* are well standardised and available for commercialization.

(ii) Microbials

Green Muscardine fungus

The green muscardine fungus, *Metarhizium majus* @ 5 $x10^{11}$ per cubic meter was found effective for application on the breeding grounds of coconut rhinoceros beetle, *Oryctes rhinoceros* especially in the farm yard manures pits, fallen logs *etc*. Cost-effective mass production technologies using semi-cooked rice and pressure cooker was standardised and popularized among the women farmers in different panchayats of the state. Area-wide delivery using dairy farmers are very important in pest reduction.

***Oryctes rhinoceros* nudivirus (OrNV)**

This unique pest-specific nudivirus (OrNV) was a potent bioagent used in the bio-suppression of coconut rhinoceros beetle (*Oryctes rhinoceros*) in Island system and successfully demonstrated in Lakshadweep and Bay Islands. Release of 12 virosed beetles per hectare reduced the pest damage significantly in the Islands through auto-transmission approach.

Entomopathogenic nematode capsules (EPN cadaver capsules)

A very potent and high efficacious entomopathogenic nematode *Steinernema* sp., mass multiplied on greater wax moth larvae, *Galleria mellonella* and the cadaver of which are made into capsules for the suppression of red palm weevil. Leaf axil filling of these capsules (one each in top most five axils) is being evaluated for area-wide application and validation. The emerging infective juveniles could invade the grubs of red palm weevil upon infestation and rescue the palm.

(iv) Botanical formulation Botanical cake and paste

ICAR-CPCRI has developed two eco-friendly botanical products *viz.*, a cake as well as a paste for the repulsion of coconut rhinoceros beetle. Methanolic and hexane extracts of botanicals (*Clerodendrum infortunatum* & *Aegera tum conyzoides*) admixed with neem oil was developed as a soap /cake for leaf axil filling. In addition, grease admixed with cashew nut shell liquid and neem oil was made as a paste for smearing on the pest landing zone of spear leaf. Both the products could be applied on juvenile palms in the spear leaf zone for the repulsion of coconut rhinoceros' beetle and shielding juvenile palms from pest attack for about two months.

d) Area-wide demonstration trials

i) Bio-suppression of exotic whitefly complex

Pesticide holiday approach, conservation biological control using the aphelinid parasitoid, *Encarsia guadeloupae*, the chrysopid, *Apertochrysa* sp. lady beetles and *in situ* habitat preservation of sooty mould scavenger beetle, *Leiochrinus nilgirianus* along with soil test-based nutrition management were found effective in the bio-suppression of invasive whitefly complex infesting palms. It was well demonstrated in South Kerala conditions.

Management of black headed caterpillar using *Goniozus nephantidis* and *Bracon brevicornis* is endemic areas of Kerala

Salient outcome

- Moderate incidence of the black headed caterpillar to the tune of 30.6% was observed in coconut gardens at Mogral Puttur, Kasaragod district during October 2019 and augmentative release of *Goniozus nephantidis* and *Bracon brevicornis* @ 20 parasitoids / palm could reduce pest incidence significantly to 11.4%, 3.0% and 1.1% in March 2020, August 2020 and March 2021, respectively. Palm health has also improved with good nut set in a period of 18 months.
- Laboratory maintenance of parasitoids *viz*., *Goniozus nephantidis* and *Bracon brevicornis* was continued and these parasitoids were supplied to State Parasite Breeding Stations and farmers as per demand.
- This is one of the classical success stories of augmentative biological control which could invariably reduce the pest incidence in most of the districts of Kerala ever since its commencement in 1950's by delivery of the bio-agents through boat laboratory.

(iii) Converging biological suppression approaches for area-wide management of coconut rhinoceros beetle

Salient outcome

- More than 400kg of green muscardine fungus, *Metarhizium majus* mass multiplied in semi-cooked rice was distributed to dairy farmers in Vallikunnam panchayat
- The application procedure of the entomopathogenic fungus on the breeding sites was demonstrated by ICAR-CPCRI Crop Protection Scientists through sensitization programmes covering all the wards in the village at a regular time period under the co-ordination of the Agricultural Officer/Dairy Society/Karshaka sangamam. The farmers were empowered on the technical know-how, famer-participatory technology dissemination as well as sustainable impact of the technology. The leaf and spear leaf damage were found as 19.8% and 38.6%, with reduction by 7.91% and 5.39% over the previous year, respectively.

e) Technologies developed and adopted

(i) Bio-suppression of leaf eating caterpillar using augmentative release of stage specific parasitoids.

(ii) Area-wide management of coconut rhinoceros beetle by delivery of green muscardine fungus, *Metarhizium majus* on to the breeding grounds (cow dung pits, wooden logs *etc*., of the pest.

NCIPM

Brief achievements:

a) Surveys, monitoring and Biodiversity of fauna :

- A survey was conducted in Bajra growing area of Agra, Firozabad and Etawah district of UP during 3-5 September 2020. During survey in Agra and Firozabad district, FAW incidence was recorded at low level.However, in few fields 10-20 per cent FAW infestation was observed in younger crop (30-40 days) in the village

Shankerpur, Jaraulikalan. During survey in the Etawah district severe FAW infestation in bajra field was recorded in the village Labedi, Harnarayanpura, Ababakkarpur, Himmatpura, Jaitpura, Birodhi, In younger crop of 30-45 days old, >50 % plant were found infested. Overall infestation ranged between 5-30 per cent.

- Farmers were spraying insecticides especially Cypermethrin + cholorpyriphos based upon the advice of pesticides dealer.

Population dynamics of whitefly, *Bemisia tabaci* (Gen) and its natural enemies in cotton: A study in farmers' field in North Zone

- Dynamics of whitefly during the cotton crop season was studied which indicated that the whitefly population (adults/ 3 leaves) remained below ETL in June and crossed ETL at few locations during July-August and thereafter remained below ETL in all locations. Whitefly (adults/3 leaves) was maximum in Fazilka (12.77) followed by Sirsa (6.79), Muktsar (3.86), Sriganganagar (3.03) and Hanumangarh (2.33).
- Average population (mean of the season) of Chrysopid (egg/larvae per plant) was maximum in Sirsa (2.21) followed by Fazilka (0.89), Sriganganagar (0.67) and Hanumangarh (0.47). Spider population (adults/spiderlings per plant) was maximum in Sriganganagar (0.83) followed by Fazilka (0.81), Muktsar (0.78), Sirsa (0.61) and Hanumangarah (0.17). The population of Chrysopid in the month of June was negligible which increased in mid of July and reached its peak in Aug and September. However, spiders were present in large numbers from the beginning of the season and continued throughout the season. Mean (average of the season) parasitization (percent) of whitefly nymphs by *Encarsia* spp or other parasitoids was recorded maximum in Fazilka (45.87, Range 28.74 – 60.90) followed by Muktsar (45.10 Range 23.08-55.94), Sirsa (43.66 range 26.00-54.25), Hanumangarah (34.10 range 22.27-45.49) and Sriganganagar (30.31; range 19.62-51.95). Maximum parasitization in the month of July and August and thereafter it declined with the reduction in whitefly population and pesticide applications.

Evaluation of Biointensive Integrated Pest Management against pod borer in chickpea in Bundelkhand region

- Evaluation of Biointensive Integrated Pest Management against pod borer in chickpea in Bundelkhand region' was carried out at farmer's field in village Chokari (25°35'15.4"N 79°13'00.5"E) of district Jhansi with the help of district KVK during *Rabi* 2020 and Rabi 2021 in five acres in farmers participatory mode. BIPM module consist of deep summer ploughing and field sanitation, sowing in the first fortnight of November, selection of tolerant/resistant variety (RVG202), seed treatment with *T. harzianum* (NCIPM-TH1) 10 g/kg seed, intercropping with mustard, installation of pheromone trap for monitoring @ 5/ha in November and 30/ha for mass trapping on 10 Feb 2022, erection of bird perches 20/ha, need based application of botanical neem azadirachtin 1500 ppm @ 5 ml/litre and biopesticides *Bacillus thuringiensis* krustaki (2×10^8cfu per ml). In farmers practice (FP) fields, farmers used insecticides without recommendations based up on the advice of pesticides dealers 1-2 spray against chickpea pod borer.

- Over all BIPM fields recorded a significant reduction in infestation of pod borer (70.52%) and disease incidence of collar rot (77.4%), *Fusarium* wilt (73.77%) and dry root rot (62.5%) over FP fields and remained below ETL. Economic analysis indicated that BIPM field recorded average yield of chickpea 18.60 q/ha with B: C ratio 3.87 whereas, 14.40 q/ha yield was recorded in FP fields with B: C ratio of 3.06. Implementation of BIPM strategy provided >29 per cent increase in seed yield and >42 per cent increase in net return in BIPM over FP consequently farmers earned >Rs 20000/ha extra net income over farmers practice.

UBKV, Pundibari

c) Evaluation and bio efficacy of Biopesticides:

Field evaluation of bio-pesticides against tea red spider mite, *Oligonychus coffeae*:

- Among the tested fungal bio-pesticides, *Lecanicilium lecani* (NBAIR strain) reduced the mite population better which is statistically at par with Azadirachtin 10000 ppm and *Beauveria bassiana* (NBAIR strain).

Evaluation of Fungal pathogens against chilli yellow mite, *Polyphagotarsonemus latus*:

- The treatment with Spiromesifen 240 SC ranked best in controlling the mite in both the spray. Among the tested fungal biopesticides, *Lecanicilium lecani* (NBAIR strain) significantly reduced the mite population.

Field evaluation of bio-pesticides against mustard aphid:

- Among the selected bio-pesticides, Azadirachtin 3000 ppm @ 2.5 ml/lit treated plots showed the lowest number of aphids per shoot followed by *Beauveria bassiana*.

Technologies developed and adopted during the review period:

1. Release of *Trichogramma chilonis*, *T. japonicum* @ 50000- 100000/ ha for 2-3 times against rice borer pests.
2. Fungal bio-pesticides, *Lecanicilium lecani* (NBAIR VI-8) (1×10^8spores/g) @ 5 gm/litre of water significantly reduced the mite population in tea.
3. *Lecanicillium lecani* (NBAIR VI-8) (1×10^8 spores/g) @ 5 gm/litre of water significantly reduced the whitefly in cucumber.

PAU, LUDHIANA

Brief achievements:

Surveys, monitoring and biodiversity of fauna:

Cotton: Natural enemy fauna comprising 10 insect species (8 predators and 2 parasitoids) under 5 families; 7 species of arachnids in 4 families constituting a total of 17 species were recorded from the cotton fields in Punjab including coccinellids, chrysopids, spiders and whitefly parasitoids. The population of *Chrysoperla* was maximum till end July, but declined thereafter. However, spider population was at peak during August month. Among parasitoids, *Encarsia lutea* (Masi) and *Encarsia Sophia* (Girault& Dodd) were the two parasitoids that emerged from whitefly pupae. The parasitization of whitefly by *Encarsia* spp. in different cotton growing areas of Punjab was 5 to 10 per cent. The parasitization was comparatively more in unsprayed plots as compared to sprayed plots.

Maize: Seventeen natural enemies including ten parasitoids (*Trichogramma chilonis*, *Chelonus formosanus*, *Chelonus blackburni*, *Campoletis flavicincta*, *Charops bicolor*,

Temelucha sp., *Cotesiarufricus*, *Microplitis* sp., *Campoletis* sp. and unidentified Braconid) and seven predators (*Eocanthecona furcellata*, *Cheilomenes sexmaculata*, *Paederus* sp., *Neoscona theisi*,*Oxyope s*sp., unidentified Carabid beetle and unidentified Coccinellid beetle) were recorded to be associated with fall armyworm on maize/fodder maize. Among parasitoids, egg-larval parasitoid, *Chelonus formosanus* was the predominant species (72.2 % abundance) under Punjab conditions.

Rice: Eleven spider species, from 7 families were recorded from rice growing areas of Punjab. Among these, *Neoscona theisi* (72.05 % abundance) was the predominant species in the central plain zone followed by *Tetragnatha javana* (14.29% abundance). However in the south western districts, *Tetragnatha javana* (45.64 %) was predominant by *T. maxillasa* (30.20%) and *Neoscona theisi* (18.21%). The spider diversity was comparatively more in central districts than south western districts of Punjab. The key parasitoids collected from rice fields were *Trichogramma chilonis*, *T. japonicum*, *Stenobracon* sp., *Bracon* sp. and *Xanthopimpla* sp.)

Sugarcane: *Fulgoraecia melanoleuca* (nymphal and adult parasitoid) was recorded to be key parasitoid infesting *Pyrilla perpusilla* on sugarcane crop. Among different agro-climatic zones of Punjab, the natural parasitism of pyrilla was more in central plain and sub-mountainous undulating zones as compared to Western zone of Punjab. The parasitoid remained active in overlapping stages during the months of April to November with peak activity in September month. It overwintered in cocoon stage from December to March months in sugarcane trash.

Wheat, oilseed and cole crops: Coccinellids (*Coccinella septempuntata* and *Cheilomenes sexmaculata*) and syrphids were recorded from wheat, oilseed and cole crops. *Cotesia glomerata* was recorded from *Pieris brassicae* on oilseed and cole crops.

Gram and tomato: Larval parasitoid**,** *Campoletis chloridae* was found to be parasitizing *Helicoverpa armigera* (5-10 % parasitism) in gram and tomato crop.

Polyhouse pests: The diversity of insect pests was recorded on brinjal, capsicum, cucumb
er and tomato crop grown under net house conditions. In brinjal, whitefly (*Bemisia tabac*i) and red spider mite (*Tetranychus urticae*) were recorded, out of which red spider mite was predominant during spring season crop. In capsicum, aphid (*Myzus persicae*), yellow spider mite and red spider mite were recorded during March, September-October and April-May, respectively. In cucumber, major pests recorded were red spider mite, leaf miner (*Liriomyza* sp.), *B. tabaci* and *M. persicae*. Amongst these, red spider mite and whitefly were pre-dominant species during spring and rainy season crops, respectively. The major insect pest in tomato was whitefly *B. tabaci*, the incidence of which was observed at peak during the months of April and May.

Isolation of microbials from various agro-ecological zones of Punjab

A total of 98 soil samples at root zone depth were collected from five different spots in polythene bags and brought to laboratory along with infected larval cadavers. The samples were processed for isolation of entomopathogens. Isolates of *Beauveria bassiana* (2), *Metarhizium anisopliae* (1), *Aspergillus flavus* (3), *Aspergillus terreus* (1) and *Lysinibacillus macroides* (1) were identified by molecular characterization. One SpltNPV was isolated from *Spodoptera litura* larvae collected from vegetable crop field.

a) Biological Suppression

1. **Habitat manipulation for the management of whitefly on Bt cotton :** BIPM practices involving cultivation of Bt cotton crop following recommended agronomic practices, growing sorghum as a barrier crop, installation of yellow sticky traps, augmentative releases of chrysopid and two applications each of neem (azadirachtin 10000 ppm) and *Lecanicillium lecanii* resulted in 38.3 per cent reduction in whitefly incidence as compared to 78.2 per cent in chemical control. The predator population was more in BIPM (1.02/ plant) as compared to chemical control (0.50/ plant) and untreated control (0.84/ plant). The yield increase in BIPM and chemical control was 6.36 and 11.82 per cent over untreated control, respectively.
2. **Management of plant hoppers through BIPM approach in organic *basmati* rice :** BIPM practices involving cultivation of recommended variety, optimum time of transplanting (1st fortnight of July) and proper spacing (20 x 15 cm), green manuring, alleyways of 30 cm after 2 m, water management (alternate wetting and drying), erection of straw bundles @ 20/ha, increasing floral diversity through flowers (marigold and balsam) on bunds and one spray each of neem (azadirachtin 50000 ppm @ 200 ml/ ha) and biopesticide (*Metarhizium anisopliae* @ 2.5 kg/ha) resulted in 33.29 per cent reduction in plant hoppers population over untreated control. The spider population was more in BIPM as compared to control plot. The yield increase in BIPM was 4.98 per cent over untreated control.
3. **Biointensive management of fall armyworm in maize :** Among different biocontrol agents, lowest plant damage and larval population of fall armyworm was recorded in *Tc* + NBAIR-Bt 25 followed by *Tc* + NBAIR-Ma 35 and *Tc* + NBAIR-Bb 45 as compared to untreated control. However, chemical control was significantly better in reducing the plant infestation and larval population as compared to all treatments and also recorded highest grain yield.
4. **BIPM module for management of *Helicoverpa armigera* on chickpea :** BIPM module 1 involving timely sowing, raising marigold as trap crop, erection of bird perches (8/acre) and two sprays of *Bacillus thuringiensis* (2 kg/ha) at 15 days interval starting from pod initiation stage was comparatively better in reducing the pod damage (2.90 %) in gram than BIPM module 2 (involving 2 sprays of HaNPV strain ($1.5x10^{12}$ POBs/ha) @ 500 ml/ha) (5.95 %) and untreated control (11.21 %). However, chemical control was the best treatment (1.03 % pod damage).
5. **Bio-intensive pest management of *Helicoverpa armigera, Tuta absoluta* and sucking pests of tomato :** BIPM practices involving Raising marigold as trap crop, pheromone traps @ 1 trap per plot, *Trichogramma pretiosum* @ 50,000 per release (6 releases) and spray of azadirachtin 1500 ppm @ 2 ml/liter water and spray of *Lecanicillium lecanii* (NBAIR) 1x 10^8 spores/ g @ 5g/lt for sucking pests recorded 28.92 per cent reduction in fruit damage over untreated control. The fruit yield in BIPM (27.74 q/ha) was at par with chemical control (31.88 q/ha).
6. **Evaluation of biocontrol agents for the control of sucking pests in capsicum under polyhouse :** Among various biocontrol agents, chrysopid releases @ 4 larvae/ plant (65.8% reduction over control) and *Lecanicillium lecanii* 1 x 10^8 spore/g @ 5 g/ litre of water (66.4% reduction over control) were significantly better as compared to other

biocontrol treatments. However highest reduction (83.5% reduction over control) was recorded in the chemical control.

7. **Management of sucking pests in tomato under polyhouse conditions :** Biointensive module involving chrysopid releases @ 4 larvae/ plant + yellow sticky traps @ 4 per 250 m^2 (6.91 aphids/plant & 2.15 whiteflies/plant) were significantly better as compared to Azadiractin 5% (2 ml/ litre of water) and *Lecanicillium lecanii* 1 x 10^8 spore/g (10 g/ litre of water) sprays and untreated control. However, lowest population (2.06 aphids/plant; 1.07 whiteflies/plant) was recorded in chemical control.
8. **Bio-intensive management of fruit borer, *Conopomorpha sinensis* in litchi :** BIPM practices involving ploughing in orchard during March-April, clean cultivation, regular collection and destruction of fallen infested fruits during May-June and releases of *T. embryophagum* @ 4000 parasitized eggs per tree 6 times at 7-10 days interval starting from flower initiation to colour break stage were significantly better in reducing the fruit borer damage (19.40 %) as compared to farmer's practice (26.80 %) and untreated control (60.60 %). The yield was also significantly more in BIPM (60.70 q/acre) as against farmer's practice (56.59 q/acre). However, lowest yield was recorded in untreated control (26.21 q/acre).
9. **Integration of botanical/microbials and insecticide spray schedule for the management of pod borer complex in mungbean :** Among various treatments, minimum pod damage (8.98%) was recorded in treatment with both sprays of spinosad 45 SC and it did not differ significantly from treatment with first spray of *Bt* formulation and second of spinosad 45 SC (9.52%) and treatment with both sprays of *Bt* formulation (10.23 %). However significantly higher pod damage (20.49 %) was recorded in untreated control.

c) Evaluation and bioefficacy of biopesticides:

1. **Field evaluation of biopesticides for the management of whitefly on Bt cotton:** Among biopesticides/botanicals, neem (azadirachtin 10000 ppm @ 1250 and 1500 ml/ha) and biopesticide (*Lecanicillium lecanii* @ 2500 and 3000 ml/ha) were comparatively better than other treatments (*Beauveria bassiana* and *Metarhizium anisopliae*) in reducing whitefly population on Bt cotton. However, significantly lower population was recorded in chemical treatments (spiromesifen 240 SC @ 500 ml/ha & diafenthiuron 50 WP @ 500g/ha).
2. **Evaluation of NBAIR Bt formulation against pod borer complex in pigeonpea:** NBAIR Bt formulation (NBAIR Bt G4 @ 2 %) resulted in 48.1 per cent reduction in pod damage over untreated control as compared to 67.5 per cent in chemical control (spinosad 45 SC @ 150 ml/ ha). The yield in chemical control (11.58 q/ha) and NBAIR Bt G4 (10.74 q/ha) was significantly better than untreated control (9.35 q/ha).
3. **Field evaluation of NBAIR entomopathogenic strains against stem borer in fodder maize :** Among the four NBAIR isolates (Bb-5a, Bb-23, Bb-45, Ma-35), Ma-35 isolate of *Metarhizium anisoplae* and Bb-5a isolate of *Beauveria bassiana* were significantly effective in reducing the incidence of leaf injury (4.74 and 4.69%) and dead hearts (3.05 and 2.59%) and recorded highest fodder yield of 146.62 and 148.59 q/ha, respectively. However chemical control (chlorantraniliprole 18.5 SC @ 100 ml/ha) was the best treatment.

4. **Evaluation of *Bt* formulations and bioagent against stem borer in *kharif* maize :** Commercial Bt formulations (Delfin WG and Dipel 8 L) resulted in 68.8 and 65.6 per cent reduction in dead heart incidence over control, respectively as compared to 87.1 percent in chemical control (chlorantraniliprole 18.5 SC @ 75 ml/ha) and 47.3 per cent in *Trichogramma* releases @ 1,00,000/ ha (10 and 17 days old crop). However, untreated control recorded significantly lower dead hearts (15.50 %) and yield (41.02 q/ha).
5. **Evaluation of *Pseudomonas* (Pantnagar Strain) against sheath blight in rice:** The disease incidence and severity was significantly less inPBAT-3 strain (*Pseudomonas fluorescence*) as compared to untreated control. However, chemical control (Tilt 25 EC @ 500ml/ha) was the best treatment and also recorded higher yield.
6. **Evaluation of microbial antagonists for the management of foot rot of *kinnow* caused by *Phytophthora* spp.:** Among microbial antagonists, NBAII-PWDWD *Pseudomonas fluorescence* was significantly better in the management of foot root disease in *kinnow* than other bio-formulations, *Pseudomonas fluorescence* (commercial talc formulation), *Trichoderma viride* (commercial talc formulation) and *Trichoderma harzianum* (commercial liquid formulation) and also recorded higher yield. However, chemical control (Curzate M-8 @ 25g/10 litre water/ tree) was the best treatment.
7. **Evaluation of microbial antagonists for the management of Ascochyta blight disease in pea:** Among microbial antagonists, the disease incidence (39.76 %) and severity (35.53 %) was lowest in *Pseudomonas flouresecence* (NBAIR-Pf DWD) and was significantly better than untreated control (54.32%). However, chemical control recorded 25.43 per cent disease incidence and 26.61 per cent disease severity.

d) Brief about each large scale demonstration trials:

1. **Large scale demonstrations of proven biocontrol technology against borers (early shoot borer, top borer and stalk borer) in sugarcane using Trichogrammids (tts)**
    - Biocontrol technology involving augmentative releases of egg parasitoids, *Trichogramma chilonis* and *T. japonicum* was demonstrated in sugarcane against borers on large scale at farmers' field in collaboration with Sugar mills, Krishi Vigyan Kendras (KVKs) and Farm Advisory Service Centres (FASCs) in various districts of Punjab over an area of 4493, 4806, 4823, 2004 and 2915 hectares during 2017, 2018, 2019, 2020 and 2021, respectively.
    - Against stalk borer, multiple releases of *T. chilonis* wasps were done at 10 days interval (50,000 wasps /ha / release x 10 releases) from July to October. For early shoot borer and top borer, augmentative biological control consisted of multiple releases of *T. chilonis* (50,000 wasps/ ha / release x 8 releases) and *T. japonicum* (50,000 wasps/ ha/ release x 8 releases), respectively at 10 days interval from mid-April to end-June.
    - Based on the pooled mean of 5 years, the dissemination of biocontrol technology in sugarcane resulted in reduction in incidence of early shoot borer (54.9 %), top borer (53.5 %) and stalk borer (57.4 %) over untreated control and gave higher yield with additional economic benefits of Rs. 16205 to 19774/- per ha during different years**.**

2. **Large scale demonstrations on bio-intensive pest management in organic *basmati* rice**
   - The proven BIPM technology involving seed bio-priming with *Trichoderma harzianum* @ 15g/ kg of seeds for foot rot disease, mechanical control by passing the 20-30 m long coir/jute rope 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 (DAT) for stem borers and leaf folder was demonstrated on large scale in collaboration with KVKs and FASCs at farmers' field in various districts of Punjab over an area of 81, 118, 131, 124 and 139 hectares during 2017, 2018, 2019, 2020 and 2021, respectively in organic *basmati* rice.
   - Based on the mean of 5 years, the mean reduction of dead heart and white ears incidence was 54.2 and 50.1 per cent, respectively in BIPM fields as compared to untreated control. Similarly, leaf folder damage was significantly lower in BIPM fields with an overall mean reduction of 57.8 per cent. The yield increase in BIPM fields gave additional monetary returns of Rs. 7070 to 8200/- per ha.
3. **Large scale demonstrations of proven biocontrol technology against maize stem borer*, Chilo partellus* using *Trichogramma chilonis* (tts)**
   - Large scale demonstrations on the biological control of maize stem borer, *C. partellus* using two releases of *T. chilonis* @ 1,00,000 parasitoids/ha on 10 and 17 days old crop were demonstrated in collaboration with KVKs and FASCs at farmers' field over an area of 162, 177, 179, 24 and 2 hectares during 2017, 2018, 2019, 2020 and 2021, respectively.
   - The reduction in maize stem borer incidence was 53.2 to 57.4 per cent in biocontrol fields as compared to untreated control. The higher yields in biocontrol fields as compared to untreated control resulted in additional benefit of Rs. 6160/- to 7218/- per ha in the biocontrol package during different years.

e) Technologies developed and adopted (included in University POP):

- Bioagent (*Trichogramma chilonis*)/ two releases (10 & 17 days old crop) @ 1,25,000/ha for management of stem borer in fodder maize (included in University POP)
- Integrated management of stalk borer, *Chilo auricilius* with pheromone traps and *Trichogramma chilonis* in sugarcane (included in University POP)
- Integrated management of early shoot borer, *Chilo infuscatellus* with pheromone traps and *Trichogramma chilonis* in sugarcane (included in University POP)
- Integrated management of top borer, *Scirpophaga excerptalis* with pheromone traps and *Trichogramma chilonis* in sugarcane (included in University POP)
- Biopesticide, *Bacillus thuringiensis kurstaki* 0.5 WP (DOR Bt-1) @ 800 g/acre for management of gram caterpillar on gram (included in University POP)
- Biopesticide, Helicop 2 % AS (HaNPV) @ 200 ml/ acre for the management of gram caterpillar, *Helicoverpa armigera* in gram (included in University POP)
- Neem based biopesticide, Ecotin (azadirachtin 50000 ppm) @ 80 ml/acre for the management of leafhopper in okra (included in University POP)

- Neem based biopesticide, Achook (azadirachtin 1500 ppm) @ 1000 ml/acre in *Basmati* rice under organic and normal cultivation conditions for the management of stem borers and leaf folder (included in University POP)
- Neem based biopesticide, Ecotin (azadirachtin 50000 ppm) @ 80 ml/ acre for the management of stem borers and leaffolder in rice/*basmati* rice under conventional and organic conditions (included in University POP)
- Biointensive management of fall armyworm using *Trichogramma* releases, NBAIR Bt 25 @ 2 % and Ma 35 @ 0.5 % in maize (recommended under AICRP)

SKUAST, Srinagar

Brief achievements:

Surveys, monitoring and Biodiversity of fauna

- A total of twenty-five natural enemies including parasitoids and predators were collected from fruit orchards in different districts of Kashmir and Laddakh during 2017-18. Majority of natural enemies were collected on apple. Among these, *Coccinella undecimpunctata*, *Prisci brumus uropygialis*, *Chilocorus infernalis*, *C. septempunctata*, *Scymnus* sp. *Chrysoperla zastrowi sillemi* dominated on apple associated with different pests. Among aphelinid parasitoids *Encarsia perniciosi* and *Aphytis proclia* together exhibited 16.0 to 20.0 per cent parasitism in unmanaged orchards against San Jose scale *Aphelinus mali* was found a promising parasitoid of Woolly apple aphid, *Eriosoma lanigerum* displaying a maximum of over 75.0% parasitism. *C. undecimpunctata* was first time recorded from Kargil on apricot. Three predators *C. septempunctata*, *Coccinella undecimpunctata* and *Chrysoperla zastrowi sillemi* were recorded first time on Pear psylla on pear in university campus, Shalimar.
- Many coccinellid species were found associated with a number of insect pests of fruits. Parasitism of Woolly aphid, *Eriosoma lanigerum* ranged 18.0- 60.0 per cent in apple orchards. Aphelinid parasitoids were observed associated with San Jose scale, *Quadraspidiotus perniciosus* in unmanaged orchards with 29.0 per cent parasitism.
- A total of nine natural enemies including two parasitoids and seven predator species were recorded on insect pests of fruit ecosystem in Kashmir and Ladakh. Per cent parasitism by *Aphelinus mali* ranged 20- 80.0 per cent in woolly apple aphid, in different parts of Kashmir. *Chilocorus infernalis* was found actively associated with San Jose scale on apple and *Parthenolecanium corni* on plum. *Psyllaephagus* sp. was recorded first time parasitizing *P. lecanii* in Kashmir. An average of 60.0 per cent parasitism was recorded by two hymenopterous parasitoids viz. *Psyllaephagus* sp. and *Metaphycus* sp.
- Total larval parasitism by *Cotesia glomerata*, unidentified ichneumonid and tachinid flies was 34.34 % in *Pieris brassicae* whereas in diamondback, moth, *Plutella xylostella* total parasitism by *Diadegma semiclausum* and *Cotesia vestalis* was 45.75 per cent. Cabbage aphid, *Brevicoryne brassicae* recorded 22.06 per cent parasitism by *Diaeretiella rapae* and 7.56 per cent hyper parasitism by *Pachyneuron aphidis*. Lepidopteran complex was found associated with maize in different parts of Kashmir with total of 48.83 per cent parasitism by *Cotesia flavipes* and unidentified tachinid in

Chilo partellus, ecto parasitism by *Euplectrus coimbatorensis* in *Helicoverpa armigera* and *Cotesia* sp. on *Mythimna* sp.

- A total of five coccinellid predators including *Adalia tetras polita*, *Calvia punctata*, *Chilocorus* sp., *Harmonia eucharis*, and *Oenopia conglobata* were found to be associated with different insect pests of apple, pear, nectarine and walnut. Association of *Calvia punctata*, *Oenopia conglobata* and *Chilocorus* sp. with pear psylla, *Cacopsylla pyricola* was recorded first time from Kashmir. Three variants of *Harmonia eucharis* were recorded on San Jose scale and green apple aphid on apple, and pear psylla on pear.

b) Biological Suppression

- An all-inclusive approach for codling moth caused 52.34 per cent reduction in fruit damage over control as compared to 22.8 per cent as in Farmer's practice. *Heterorhabditis pakistanensis* provided good result when used against overwintering larvae. Two releases of *B. pallescens* @200 bugs/plant caused 51.0 per cent reduction in population of two spotted spider mites *Tetranychus urticae* over control. Similar dose however caused only 23.8 per cent reduction in population of European red mite, *Panonychus ulmi* on apple. Per cent mortality caused to 4th larval instar of *Pieris brassicae* on cabbage was highest by *Heterorhabditis pakistanensis* (53.75) followed by *H. indica* (42.5) and *S. carpocapsae* (17.5).
- Average density of aphids / terminal shoot after three weekly treatments during June' 2021, was found considerably low (5.13) in case of Neem oil (Azadirachtin 10000 ppm @ 2.0 ml^{-l}) and was found statistically different from other bio pesticides used. All the treatments however were found statistically significant (F= 230.36**; D.F. (5, 24); p= ≤ 0.001) and superior over untreated control. Per cent reduction in aphid density over pretreatment was found identical in all the bio pesticides except Neem oil (Azadirachtin 10000 ppm), but all the treatments indicated statistically significant difference in % reduction over untreated control (F= 114.66**; D.F. (5, 20); p= ≤ 0.001).
- European red mite indicated their statistically identical susceptibility to Neem oil (Azadirachtin 10000 ppm) as well as NSKE (Azadirachtin 1500 ppm) + *Lecanicilium lecanii* Average population of ERM^{-leaf} by these bio pesticides was held at 3.8 and 4.46 (much below the economic threshold) respectively, which differed significantly from others. Per cent reduction in ERM population over control was found maximum (87.86) in case of Neem oil (Azadirachtin 10000 ppm) but statistically identical with NSKE (Azadirachtin 1500 ppm). All the treatments however displayed statistically significant difference in % reduction over pre treatment (F= 86.26**; D.F. (5,20); p= ≤ 0.001) as well as % reduction over control (F= 107.67**; D.F. (5,20); p= ≤ 0.001).

Organic management of wooly apple aphid, *Eriosoma lanigerum* infesting apple in traditional orchards

- Among bio pesticides used against wooly apple aphid, Neem oil (Azadirachtin 10000 ppm) @ 1.0 and 2.0 ml^{-l} proved superior in terms of restricting the WAA colony on apple twig and also controlling WAA density$^{-colony}$

- Three weekly sprays of Neem oil (Azadirachtin 10000 ppm) @ 2.0 ml^{-1} reduced aphid $colony^{-twig}$ from 14.13 (untreated check) to 1.86 and WAA $density^{-colony}$ from 144.86 to 17.73.
- Neem oil (Azadirachtin 10000 ppm) @ 2.0 ml^{-1} proved next best to chemical in terms of managing Wooly apple aphid.

Brief about each large-scale demonstration trials:

Codling moth management

- Release of *T. cacoeciae* @ 2.5 lakh/ha. (4 releases/ season) + Trunk banding + Pheromone trapping + disposal of infested fruits + spray of *Heterorhabditis pakistanensis*. An all-inclusive approach for the management of Codling moth, *Cydia pomonella* was found best in terms of reduction in pest in Kargil
- *Heterorhabditis pakistanensis* exhibited maximum larval mortality, both of *P. brassicae* (60.8) and *Plutella xylostella* (64.0) as compared to *H. indica* (42.4 and 53.6) and *S. carpocapsae* (24.8 and 36.8). Per cent larval mortality of *Pieris brassicae* by *H. pakistanensis* after 72 hrs. (49.6) was statistically different from *H. indica* (33.6) Total mortality caused by Chlorpyriphos 20 EC @ 1.0 ml/lit. of water (T4) however was 88.8 per cent as compared to 10.4 per cent in untreated control (T5). *H. pakistanensis* was found superior over *H. indica* and *S. carpocapsae* in terms of larval mortality of *Plutella xylostella*. Active Juvenile stage (IJS/ plant) after 24 hrs. on kale was found maximum in case of *H. pakistanensis* (7900.00) followed by *H. indica* (5100.00) and *S. carpocapsae* (3800.00).

Technologies developed and adopted during the review period:

- Mass production of *Corcyra cephalonica*
- Mass production of *Trichogramma* spp.
- Mass production of entomopathogens
- Trunk banding for trapping larvae of Codling moth, *Cydia pomonella* in Ladakh
- SS production technique of *Blaptostethus pallescens*
- Integrated pest management of codling moth, *Cydia pmonella* infesting apple in Ladakh

GBPUAT

Brief achievements

- **Field evaluation of promising *Trichoderma*/ *Pseudomonas* isolates for crop health management: Rice:** Of all the isolates, PBAT-3, Psf-2 and Th-14 were comparatively better than other bioagents in reducing diseases and in increasing yield. **Chickpea:** Of all the isolates BARC-Th (11.1%), followed by PBAT-3 (15.5.0%), Th-14 (16.4%) were better in reducing plant mortality and mature plant wilt and in increasing plant growth.
- **Isolation and evaluation of temperature tolerant *Trichoderma* isolates for crop health management during coldest/hottest climate:** The extensive collection of samples led to the generation of 20 isolates of *Trichoderma*, coded as Ta-1 to Ta-20. A temperature of 30ºC was significantly best for the growth of all the isolates of

Trichoderma. Isolate Ta 18 recorded maximum colony diameter at 10^{o}C and isolate Ta15 showed maximum colony diameter at 40^{o}C.

- **Evaluation of bio-agent consortium in field for crop health management in chickpea:** Mixed formulation (Th 14+Psf173) shown better performance over individual isolates with respect to its effect on seed germination and plant growth.
- **Plant stand and plant growth under field**: Minimum Number of mature plant wilt (3.7) at 120 DAS was observed with consortium Th17+Psf 173 (3.0), while maximum in control (5.7) after 120 days of sowing.
- **Field evaluation of promising *Trichoderma/ Pseudomonas* isolates for crop health management: Rice:** Of all the isolates, Psf-173, PBAT-3, Th14, TCMS 36 and NBAIR-2 were comparatively better than other bioagents in reducing diseases and in increasing yield.**Chickpea:** Of all the isolatesPBAT-3, BARC-Th and NBAIR1-Th were better in reducing plant wilt and in increasing plant growth.
- **Effect of delivery methods (foliar sprays) of PBAT-3 for crop health management in Rice:** Of all the delivery methods, PBAT-3 + Molasses + Cow urine + Vermiwash followed by PBAT-3 + Molasses + Cow urine + Vermiwash were better in reducing diseases and in increasing yield.
- **Evaluation of fungal and bacterial isolates for crop health management in rice: Efficacy consortium under glass house condition:** Mixed formulations PBAT-3, Th17+Psf-173, Th14+Psf-2, Th17+Psf2 and Th17+Th14 shown better performance over individual isolates with respect to its effect on seed germination and plant growth.
- **Efficacy of consortium against diseases in field:** Minimum Sheath blight (*Rhizoctonia solani*) disease severity was recorded with PBAT-3. Minimum percentage of Brown spot (*Drechslera oryzae*) infected panicle/hill was observed with Carbendazim which did not differ significantly with PBAT-3.
- **Efficacy of consortium for plant vigour and yield in field:** Mixed formulations Th17+Psf-173, PBAT-3, Th14+Psf-2, Th17+Psf2 and Th17+Th14 shown better performance over individual isolates with respect to its effect on plant vigour and yield.
- **Plant mortality and mature plant wilt in field**: Maximum percentage of seed germination and plant stand was observed with PBAT-3. Minimum Number of mature plant wilt (3.24) at 120 DAS was observed with consortium Th17+Psf 173, while maximum in control (6.10).
- **Effect of BIPM practices on the incidence of major diseases in rice:** In BIPM practices, Sheath blight disease reduction was found to be 53.28% while in farmer's practice it was 50.46%. In BIPM practices, Brown spot disease reduction was found to be 47.33% while in farmer's practice it was 24.26%.
- **Effect of BIPM practices on the incidence of major insect pests in rice:** The incidence of leaf folder, stem borer and BPH in BIPM practices was 6.31%, 7.94% and 1.39/m^2 which were significantly lower as compared in farmer's practice 9.08%, 9.12% and 1.70/m^2.

- **Effect of BIPM practices on the incidence of natural enemies in rice** Natural enemy population of spiders and coccinellids were substantially higher in BIPM practices as compared in farmer's practice. The percentage of eggs parasitized 59.55% by egg parasitoids on yellow stem borer was also found to be substantially higher in BIPM practices, than in farmer's practice 11.93%.
- **Effect of BIPM practices on seed germination and incidence of wilt disease in Chickpea:** Maximum seed germination with 82.66% was observed in BIPM practices as compared to farmer's practice, 73.33% and incidence of wilt disease in BIPM practice (24.67%) did not differ significantly with farmer's practice (28.06%). The maximum grain yield of chickpea was recorded from the BIPM practice (14.48q/ha) followed by farmer's practice (11.50 q/ha). Net return of chickpea in BIPM practice was Rs 70414.86/ ha and farmer's practice was Rs 51466.84/ ha with C:B ratio1:5.4 and 1:1.2 respectively.
- **Effect of BIPM practices on the incidence of major insect pests in chickpea:** Incidence of *Helicoverpa armigera* was significantly lower in BIPM practice (1.9 eggs/m2) as compared to farmer's practice (2.2 eggs/m2). In BIPM practices, the percent pod damage owing to pod borer differed significantly (26.7%) from farmer's practice (30.3%). In comparison to the farmer's practice, the results showed that the strategies used in the BIPM practice, such as border crops, flowering plants in combination with the spray of HaNPV (NBAIR strain), pheromone traps, and the use of botanicals, played a significant role in increasing the natural enemies population.
- **Large scale field demonstration of bio-control technologies: Rice:** Large scale field demonstrations of Pant Biocontrol agent (PBAT)-3 in rice 1544 nos., area 837ha; chickpea 310 nos., area 115 ha; lentil 230 nos., area 124 ha; Pea 140 nos., area 60 ha and Tomato 148 nos., area 59 ha and supplied 59 Q Pant Biocontrol agent (PBAT)-3 to the farmers. In rice an average yield of 68.0 q/ha was recorded by the farmers adopting bio-control technologies along with need based organic practices as compared to an yield of 52.0 q/ha by the farmers adopting conventional practices for the management of insect pests and diseases. The cost benefit ratio was in Biocontrol Practices 1: 2.40 in comparison to Conventional practices 1: 1.26. In Pea an average yield of 90.0 q/ha was recorded by the farmers adopting bio-control technologies along with need based organic practices as compared to an yield of 71.0 q/ha by the farmers adopting conventional practices for the management of insect pests and diseases. The cost benefit ratio was in Biocontrol Practices 1: 1.66 in comparison to Conventional practices 1: 1.44. Through the adoption of biocontrol technologies farmers were able to reduce their cost of production substantially and minimized losses due to pests and diseases resulting in increased cost-benefit ratio and a healthy crop.

IIRR (millets)

Brief achievements:

a) Surveys, monitoring and Biodiversity of fauna:

Management of Pink borer in Ragi with entomofungal pathogens:

- For the management of Pink borer (*Sesamia inferens*) in Finger millet, spray application of *Metarhizium anisopliae* ICAR-NBAIR (Ma 35) oil based formulation @ 10 ml/lit at 20 & 40 DAE of crop) and application of ICAR-NBAIR (Bb-45) oil based formulation @ 10 ml/lit at 20 & 40 DAE) were the best and were on par with soil application of Carbofuran 3G @ 20kg /ha twice at 20 and 40 DAE.
- Highest incremental yield (6.77 q/ha) over control was realized in application of carbofuran 3G granules @ 20 kg/ha which was on par with 5.62 q/ha yield gain realized in spray application of Ma 35 @10 ml /lit implying that there was 46.7% increase in grain yield over the control and 9.56% decrease in grain yield over the insecticide control.

Management of Fall army worm in sorghum with bioagents:

- Release of *Trichogramma chilonis* @ one card/acre twice at weekly intervals commencing at 7 DAE, 14 DAE of sorghum followed by spray of *Metarhizium anisopliae* (Ma 35) @ 0.5 % at 20, 35 DAE was found to decrease the egg patches, larvae numbers (42.0 %) and whorl damage (59.9%) caused by *Spodoptera frugiperda*, significantly.
- There was 11.1 and 15.4 % increase in the grain and fodder yield in comparison to control.

IIHR

Brief achievements:

a) Surveys, monitoring and Biodiversity of fauna :

Extensive surveys in the farmers' fields, (Kandali village, Hassan district, Karnataka; 76.03^{o} E 12.97^{o} N; cv. PKM-1, n = 500) and at the experimental fields of ICAR-Indian Institute of Horticultural Research, Bengaluru, Karnataka (12°58' N; 77°35' E; cv. PKM-1, n = 140) revealed severe damage by the tea mosquito bug on drumstick plants. Tea mosquito bug *Helopeltis antonii*, was observed to cause severe damage (74-100%) to drumstick, *Moringa oleifera* Lam.The feeding damage by adult as well as nymphal stages of *H. antonii* led to wilting of shoots and the typical damage symptoms on drumstick included the necrotic/silvery patches on the tender shoots/ fruits, leaf loss and dieback of tender shoots that led to complete drying of plants.

c) Evaluation and bio efficacy of Biopesticides:

The mean number of ash weevils per brinjal plant were significantly lower in treatments *Heterorhabditis indica* @ 2.5 10^{9} IJs $ha^{-1}$and *M. anisopliae* (NBAIR strain) followed by *B. bassiana* (NBAIR strain) and *B. bassiana* AAU strains. They were significantly different form the control check, but not superior over chemical control. Similarly, the leaf damage scoring by ash weevil in different treatments were recorded. The *B. bassiana* (NBAIR strain) and *M. anispoliae* AAU strains were showing significantly lower leaf damage scoring compared to other treatments.

IIRR

Brief achievements:

a) Surveys, monitoring and Biodiversity of fauna :

- Survey and monitoring of natural enemy biodiversity in rice was taken across the country. 40 species of odonata have been recorded from rice fields. Similarly, 40 species of spiders from 14 families have also been recorded from rice fields during various stages of crop growth. *Telenomus* sp from egg masses of stem borers have been collected from 13 locations.

b) Biological Suppression

- Biocontrol potential of temperture tolerant strains of *Trichogramma* developed at NBAIR have been evaluated. Studies on parasitic efficiency of both the strains of *Trichogramma japonicum* against three lepidopteran pests exhibited an order of preference *i.e., Sesamia inferens* > *Scirpophaga incertulas* > *Chilo polychrysus* by thermo-tolerant *T. japonicum.* Highest female progeny emergence of 68.13±8.14 per cent was recorded from parasitized eggs of thermo-tolerant *T. japonicum* on *S. incertulas* than 32.22±11.38 per cent by normal *T. japonicum* on the same host.
- Similarly, the *Amphiareus constrictus* (Stal.)an anthocorid predatorwas evaluated for management of rice hoppers.Under no choice test, percentage prey offered was in order BPH eggs (48.00%) >WBPH eggs (40.00%) >GLH eggs (20.00%). Mini cage experiments with varying densities of predator and prey also indicated a suitability of this predator for reducing numbers of early intars of Brown planthopper.
- Bioagents *Trichoderma asperellum Strain* TAIK1, *Bacillus cabrialesii* BIK3 and *Pseudomonas fluorescens* Strain PIK1 isolated from rice soils were found to reduce diseases such as blast and false smut significantly.

c) Evaluation and bio efficacy of Biopesticides:

- Evaluation of entomopathogenic fungi isolated from KAU and NBAIR was taken up against ear head bug *Leptocorisa* spp was taken up in two locations for two years. *L saksanae* spray was on par (9.50/ 10 hills) with insecticide treatment at Navsari, Gujarat.

Brief about each large scale demonstration trials:

- Bio intensive pest management demonstrations were taken up at two locations – Telangana and Odisha in 2018 and 19 and in Telangana state in 2020 and 2021 for four years
- Indigenous bioagents from rice ecosystem such as *Trichoderma asperellum* Strain TAIK1, *Bacillus cabrialesii* BIK3 and *Pseudomonas fluorescens* Strain PIK1based BIPM packages along with interventions such as bund cropping, application of Phosphorous Solubilising Bacteria, alleyways, organic manuring, owl perches for rodent management were found to reduce insecticide use and manage pests were demonstrated in BIPM trials with a benefit cost of 1.95 – 2.59 as compared to 1.77-2.46 in farmers' practices of chemical dependence.
- The brown plant hoppers was lowest in the BIPM plots (25/ 10 hills) with a single application of insecticide while in farmers practice the numbers increased to 150/ 10

hills in spite of spraying four times. This was mainly due to timing of application and sole dependence of insecticides for insect management.

- Field days were conducted at Kalahandi and Koraput Odisha and at Ibrahimpatnam and Nalgonda districts of Telangana

Technologies developed and adopted during the review period:

- Adopted BIPM modules with various interventions
- Tested efficient entomopathogens developed through AICRP Biocontrol in the rice AICRIP system

IIVR

Brief achievements:

a) Surveys, monitoring and Biodiversity of fauna :

Extensive surveys were conducted in and around Varanasi to identify the occurrence of American pin worm, *Tuta absoluta* on tomato. Occurrence of pin worm on leaf and fruit were first recorded during last week of February (9 SMW) and maximum *T. absoluta* adults catch was recorded during 13 SMW (23.33 aduts /trap). During the survey, one polyphagous predator *viz*., *Nesidiocoris tenuis* (Miridae: Hemiptera) was observed in tomato. Maximum 5.7 bugs/apical twigs were recorded. Critical observation revealed that apart from early instars larvae, it also feed up on soft-bodied insects like whiteflies and jassids infesting tomato.

b) Biological Suppression :

Bio-intensive pest management of *Helicoverpa armigera*, *Tuta absoluta* and sucking pests of tomato

Bio-intensive pest management module (BIPM) comprising seed treatment with *Trichoderma harzianum* @ 10g/kg of seeds; raising marigold as trap crop; use of NBAIR pheromone traps @ 1 trap per plot; inoculative six-release of *Trichogramma pretiosum* @ 50,000 / release and spraying of Azadirachtin 1500 ppm @ 2 ml/lit; and *Lecanicillium lecanii* (NBAIR starin) $1x10^8$ spores/ g @ 5g/lit for sucking pests was compared with chemical control (Chlorantraniliprole18.5% SC for *Tuta* and Indoxacarb 14.5 SC for other pests at their recommended doses) and untreated control against insect pests complex of tomato. The lowest whitefly (0.31), aphid (0.20), jassid (0.28) and leaf miner (0.90) populations per leaf were recorded in the BIPM module followed by chemical module with 0.51, 0.46, 1.30 and 1.41 pest population per leaf, respectively. In contrast, untreated control plots harboured maximum whitefly (1.47), aphid (1.22), jassid (2.52) and leaf miner (1.59) population per leaf. However, lowest fruit damage by its borer complex was recorded in chemical control module (1.51%) followed by BIPM module (4.19%) where maximum fruit damage (15.52%) was recorded in untreated control. Similarly, occurrence of predatory mirid bug (*Nesidiocoris tenius*) was recorded maximum in untreated control plots (2.65 bugs/leaf) followed by BIPM module (2.21) treated plots and lowest predator population (0.39) was in plots treated with chemical insecticides.

c) Evaluation and bio efficacy of Biopesticides:

Field evaluation of ICAR-NBAIR entomopathogenic strains against cabbage aphid (*Myzus persicae*) and *Plutella xylostella* (DBM)

Effect of different biopesticides on major insect pests of cabbage was studied during the rabi season of 2018-21 at the experimental farm of ICAR-IIVR, Varanasi. It is evident that among the biopesticides tested, *Metarhizium anisopliae* (Ma-4 strain) was most promising with 48.95 per cent reduction over control (PROC) against diamond back moth (*Plutella xylostella*) followed by *Lecanicillium lecanii* (Vl-8 strain). In case of aphid (*Myzus persicae*), maximum reduction (42.56 PROC) was recorded with *Lecanicillium lecanii* (Vl-8 strain). However, amongst the all treatments, the chemical insecticide Indoxacarb 14.5 SC at its recommended dose @ 0.75 ml/lit was superior both in reducing DBM and Aphids in cabbage. In case of two polyphagous predators *viz.*, spider and lady bird beetle (*Menochilus sexmaculatus*) populations were lowest in Indoxacarb treated plots (0.11 and 0.29 per plant, respectively), and were relatively higher in untreated control and entomopathogens treated plots.

KAU, Vellayani

Brief achievements:

a) Surveys, monitoring and Biodiversity of fauna :

- Field visits conducted during the period 2018-22 reported the occurrence of the Rugose spiralling whitefly, cassava mealybug, fall armyworm in maize (less occurrence). Coffee locust *Aularches miliaris,* oriental fruitfly, melon fruitfly, coconut eriophyid mite, pseudostem weevil, redpalm weevil, rhinoceros beetle, mango hoppers in the southern districts of Kerala

b) Biological Suppression

- The invasive pest RSW is being supressed naturally by *Encarsia guadelopeae*, parasitisation ranging from 55 to 75 % during the summer and winter season of the year, with a negligible population during monsoon season.

c) Evaluation and bio efficacy of Biopesticides:

- Experiments on management using biocontrol agents proved the efficacy of water jet, NBAIR starin of *Isaria fumosorosea* and Neem oil emulsion with sticker
- Experiments on of oil/talc formulations of *Lecanicillium saksenae* proved its efficacy in managing rice bug, pod bugs in pulses.
- NBAIR Ma 4 was more effective to rice bug than NBAIR Bb 5 Capsule formulation of NBAIR Bb 5 and KAU Bb 6063 wee effective for leaf webbers in amaranthus.
- BIPM in rice comprising seed priming with NBAIR Bb 5 + foliar spray at vegetative phase + Trichocards from 30 DAP + foliar spray of *L. saksenae* during panicle initiation and milkystage was effective against rice bugs.
- BIPM in rice comprising seed priming with NBAIR Bb 5 + foliar spray at vegetative phase + Trichocards from 30 DAP + foliar spray of *L. saksenae* during panicle initiation and milkystage was effective against rice bugs.

Technologies developed and adopted during the review period:

- Chitin enriched oil formulation of *L.saksenae*
- Capsule formulations of entomppatogenic fungi

KAU, Kumarakom

Brief achievements:

a) Surveys, monitoring and Biodiversity of fauna:

- Survey conducted in polyhouses of Kottayam district revealed the incidence of serpentine leaf miner, *Liriyomyza trifolii* and Tetranychid mite *Tetranychus truncates* Ehara.
- Survey on infestation by rugose spiraling whitefly revealed 53 to 73 percent infestation at Kumarakom (Kottayam district), 37 to 51 percent at Moncompu (Alapuzha district) and 44 to 57 per cent at Vyttila (Ernakulam district). Parasitism by *Encarsia guadalopae* was observed in all the places surveyed.
- Survey on infestation by Bondar's Nesting whitefly revealed 45-80 per cent infestation at Kumarakom (Kottayam district), 42-67 per cent infestation at Moncompu (Alappuzha district) and 39-77 per cent infestation at Vyttila (Ernakulam district). Parasitism by *Encarsia guadeloupae* on nesting whitefly was not noticed in any of the places surveyed.

b) Biological suppression

The fungal isolate *Hanseniaspora uvarum* (Y-73), *Trichoderma harzianum* (Th-3), *T. viride* (KAU strain) and *Pseudomonas fluorescens* (KAU strain) applied as seed treatment followed by foliar spray provided effective control of anthracnose disease of vegetable cowpea. Foliar spray with Vl-8 isolate of *Lecanicillium lecanii* was found to be the best in reducing chilli mite. *Isaria fumosorosea* Pfu-5 followed by neem oil spray could bring about reduction in live colonies and nymphs of Bondar's nesting whitefly.

CAU, Pasighat

Brief achievements:

a) Surveys, monitoring and Biodiversity of fauna: Collected various pests and natural enemies like parasitoid, coccinellids and spiders from different agro-ecological zones during surveys from remote places for the first time (Nafra-West Kameng, Mechukha-ShiYomi, Riga-Siang). Reported Rugose Spiralling Whitefly on Coconut from Arunachal Pradesh region during 2020. Recorded the leaf and fruit scarring beetles on banana crop. Reported paddy white backed plant hopper outbreak during 2020-21. First record of *Anisopteromalus calandrae* (Howard) from Arunachal Pradesh (NEH)-a parasitoid on Bruchids in Green gram.

b) Biological Suppression:

- Demonstrated BIPM techniques for biological suppression of insect pests in Cabbage, Tomato, Mustard and Maize covering 05 farmers for each crop

c) Evaluation and bio efficacy of Bio-pesticides:

- Among the different bio-pesticides evaluated, Vl-8 isolate (NBAIR isolate) of *Lecanicillium lecanii* was found promising in getting higher cabbage yield (22.19 t/ha) due to lower pest incidence (2.96 aphids/plant and 2.15 DBM larvae/plant) in Cabbage.
- Among different biocontrol agents tested, significantly lowest number of *Spodoptera frugiperda* was recorded in the treatment *Trichogramma chilonis* @ 1 card/acre + NBAIR Bt @ 2% in Maize (1.85 larvae/10 plants and 15.19 % plant damage).

Brief about each large scale demonstration trials:

1. BIPM in Tomato: Used ICAR-NBAIR and IIHR, Bengaluru based BIPM technology for demonstration in farmer fields during 2020-21 and 2021-22. In each year demonstration was carried out in 01 ha area covering 05 farmers from Jampani and Tulap, East Siang. The BIPM module recorded the significantly lowest pest population of *H. armigera* (1.54 larvae/plant) and sucking pests (whiteflies and leaf hoppers) (7.70/plant) than chemical module. It has documented the higher yield (22.80 t/ha) as compared to chemical module (20.43 q/ha).

2. BIPM in Cabbage: Used ICAR-NBAIR Bengaluru and ICAR-IIVR, Varanasi based BIPM technology for demonstration in farmer fields during 2020-21 and 2021-22. In each year demonstration was carried out in 02 ha area covering 05 farmers from Jampani and Tulap, East Siang. Although, the chemical module documented the lowest population of DBM (3.24 larvae/plant) and aphid (24.46/ plant), it was found statistically at par with the pest population recorded in BIPM module (DBM – 3.24/plant, aphid – 19.92/ plant). With regard to the population of natural enemies, BIPM module documented with highest coccinellids and syrphids (3.91/ plant) which were significantly higher than the population observed in chemical module (0.92/plant).

3. BIPM in Mustard: Used ICAR-NBAIR Bengaluru based BIPM technology for demonstration in farmer fields of Yagrung village (05 farmers 01 ha each) during 2020-21 and Taki Lalung village (05 farmers 01 ha each) during 2021-22. The farmers' module documented the highest population of aphid (41.92/plant), compared to BIPM module (25.12 aphids/plant). Although, the farmers practice recorded the higher number of natural enemies (coccinellid beetles and syrphid flies) i.e. 5.47 per plant, it was found statistically at par with those recorded in BIPM module (4.11/plant). Due to higher pest incidence in farmers practice and no externally added agro-inputs, it was recorded with the lowest yield (6.44 q/ha) significantly lower than that of BIPM module (9.36 q/ha).

4. BIPM in Maize: Field demonstrations were carried out to create awareness and management of invasive pest Fall armyworm on Maize.Used ICAR-NBAIR Bengaluru based BIPM technology for demonstration in farmer fields of Berung village (05 farmers 01 ha each) during 2020-21 and Tulap and Jampani village (05 farmers 01 ha each) during 2021-22. Though chemical module recorded the significantly lower FAW population (1.41 larvae/plant) and plant damage (7.41 %) than BIPM module (1.64 FAW larvae/plant and 9.04% plant damage). The BIPM module (3.40/plant) documented the significantly higher natural enemies (coccinellids, lacewing flies and spiders) than chemical module (0.98/plant). In spite of higher FAW incidence, the BIPM module recorded the grain yield of 36.15 q per ha which was statistically at par with farmers practice (35.45 q/ha).

Technologies developed and adopted during the review period:

- BIPM technologies in Cabbage, Tomato, Maize, and Paddy adopted from ICAR-NBAIR, Bengaluru
- Talc based microbial pesticides are in progress using native isolates of *Beauveria bassiana* and *Metarhizium rileyi*

MPKV

Brief achievements:

a) Surveys, monitoring and Biodiversity of fauna :

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

- The natural enemies inclusive of coccinellids, *Dipha aphidivora* Meyrick, *Micromus igorotus* Bank. and syrphids *Eupoderes confractor* and parasitoid, *Encarsia flavoscuttellum* on Woolly aphids in sugarcane, *Coccinella transversalis* F., *M. sexmaculata, Brumoides suturalis* (F.), *Scymnus coccivora* Ayyar, *Triomata coccidivora* and *B. suturalis*in mealybug colonies on custard apple, *Acerophagus papaya* N& S, *Mallada boninensis* Okam. and *Spalgisepius* on papaya mealybugs were recorded. However, the Chrysopid, *Chrysoperla zastrowi sillemi* Esben. were observed in aphid colonies on cotton, maize, bean, jawar, okra and brinjal crops.
- The entomopathogens, *Metarhizium rileyi* (Farlow) (*N. rileyi*) diseased cadavers of *S. litura* were collected and isolated from soybean and cabbage crops, while diseased cadavers of *Spodoptera frugiperda* (Smith) infected with *Metarhizium rileyi* (Farlow) (*N. rileyi*) were collected from Maize fields. The cadavers of NPV infected larvae of *S. frugiperda* were also collected from maize. *H. armigera* larvae, mango hoppers and white grubs infected with *M. anisopliae* were collected and isolated from pigeon pea crops.

Surveillance for pest outbreak and alien invasive pests (CPOR)

- Amongst the targeted invasive pests, the mealybug species *Pseudococcus jackbeardsleyi* and *Paracoccus marginatus* were recorded on custard apple and papaya respectively, in Pune region. *Tut aabsoluta* was recorded in Junnar Tahasils of Pune district during April to May 2017 on tomato crop.
- The Fall armyworm (FAW), *Spodoptera frugiperda* (Smith) was recorded for first time in Kolhapur district on maize crop in July, 2018. The pest extended its host range on sorghum in Satara, Pune, Solapur, Jalgaon districts and also recorded in fields of sugarcane in PalusTahasil of Sangli district and KagalTahasil of Kolhapur district, respectively. FAW is reported for the first time on Cotton crop at Susare Village of Pathardi Tahasil in Ahmednagar district during 2019-20.
- The new alien pest, rugose spiralling whitefly was observed first time on coconut palms in Western Maharashtra during the year 2021-22. Parasitoid, *Encarsia* sp. and predator, *Apertochrysa* Sp. sere seen in the colonies of rugose spiralling whitefly (*Aleurodicus rugioperculatus*) on coconut in Pune, Ahmednagar and Satara districts. *Encarsia*sp. and a predator, *Chrysoperla* sp. were also seen in the colonies of rugose spiralling whitefly on guava.

b) Biological Suppression of Crop Pests.

Chickpea: Biological suppression of pod borer, *Helicoverpa armigera* infesting chickpea on farm

- In efficacy studies of bioagent, *Bacillus thuriengiensis* @ 1 Kg/ha (2g/L of water) effectively suppressed the gram pod borer infestation in chickpea and recorded the

larval population of 0.68 larvae / Sq. m., pod damage of 5.33 % and grain yield of 15.97 q/ha with B: C ratio 2.20 as against in chemical check spinosad 45 SC @ 150 ml/ha (0.3 ml/L of water) with 0.37 larvae / Sq. m., pod damage of 4.27 % and grain yield of 16.28 q/ha with B: C ratio 2.27. Bt was at par in reducing larval population of *H. armigera* with 4.88% pod damage and recorded grain yield of 16.03 q/ha as against in standard insecticidal check of spinosad 40 SC @ 150 ml/ha with larval population of 0.34 larvae/m. 3.55% pot damage and grain yield of 17.83 q/ha (2021-22).

Pigeon pea: Evaluation of NBAIR *Bt* formulation on pigeon pea against pod borer complex (Pooled results of 2017-18 to 2018-19)

- The pooled data indicated that three sprays of chlorantraniliprole 18.5% SC at fortnightly interval was significantly superior over other treatments in suppressing the larval population of *Maruca testulalis* (av. 4.66 larvae/plant), *Exelastis atomosa* (av. 1.62 larvae/plant) and *H. armigera* (av. 1.11 larvae/plant) and recorded minimum pod (7.22 %) and grain (5.44%) damage with maximum yield (16.76 q/ha) and BC ratio 1:1.21. However, it was at par with NBAII-*Bt* G4 @ 2% in respect of *M. testulalis* (av. 5.46 larvae/plant), *E. atomosa* (av. 2.01 larvae/plant) and *H. armigera* with average 1.65 larvae/plant, pod damage (8.89%), grain damage (6.17%) and yield (15.52 q/ha) on pigeon pea with BC ratio 1:1.12.

Cowpea: Field evaluation of ICAR-NBAIR entomopathogenic strains against cowpea aphids (*Aphis craccivora*) (2021-22)

- Two sprays of ICAR-NBAIR entomopathogenic strains and insecticides against cowpea aphids showed that the treatment with Imidacloprid 17.8 SL has significantly controlled the population of cowpea aphids (118.80 mean aphid population/3 leaves) over rest of the treatments. The treatment Vl-8 isolate of *Lecanicillium lecanii* @ 1×10^8cfu/ml @ 5.00 gm/liter was next best with 29.84 aphids/3 leaves. The significant highest yield was recorded from the treatment Imidacloprid 17.8 SL @ 0.40 ml/litre of water (13.76 qt/ha) which was followed by 12.58 qt/ha in the treatment Vl-8 isolate of *Lecanicillium lecanii* @ 1×10^8cfu/ml @ 5.00 gm per litre of water.

Cotton: Evaluation of entomofungal agents and botanicals for the management of sucking pests in cotton

- Pooled means for two years (2017-18 and 2018-19) indicated that amongst the biopesticides, *Lecanicillum lecanii* (1 x 10^8conidia/g) @ 5 g/litre recorded lowest population of sucking pests *viz.,* aphids (5.74), jassids (2.69), thrips (2.61), and white flies (1.77) on 3 leaves per plant. The *Lecanicillum lecanii* (1 x 10^8 conidia/g) @ 5 g/litre recorded seed cotton yield of 18.32 q/ha which was at par with dimethoate 0.05 per cent (19.02 q/ha) with B:C ratio (1.25) and 1.32, respectively.

Tomato: Bio-intensive management of *Helicoverpaarmigera, Tuta absoluta* and sucking pests on tomato

- BIPM treatment, fruit on number basis (15.75%) and on weight basis (14.05 %) was at par with chemical treatment (20.58 %) and (17.15 %), respectively. Regarding sucking pest population, the BIPM treatment recorded minimum number of thrips

(3.42 thrips/plant) and whiteflies (2.04 flies/plant). The highest marketable fruit yield (21.72 t/ha) was recorded in BIPM treated plots with B:C ratio (1.60) as against yield in chemical treatment (20.24 t/ha) with B:C ratio (1.53).

Okra: Efficacy of biocontrol agents for management of fruit borer *Earias vittella*on okra

- Three sprays of *Bacillus thuringiensis* var. *Galleriae* (*Bt*) @ 1 kg/ha starting from 45 days after sowing at 15 days interval is recommended for the effective control of shoot and fruit borer, *Earias vittella* on okra.

Cabbage: **Field evaluation of ICAR-NBAIR entomopathogenic strains against cabbage aphid (*Brevicoryne brassicae*) and diamond back moth *Plutella xylostella* (L)**

- The two years pooled data revealed that out of biopesticides, the VI-8 isolates of *Lecanicillium leccanii* @ 5.00 g/liter of water was superior in controlling aphid population with 28.45 number of aphids/3 leaves/head followed by Bb-5a isolate of *Beauveria bassiana* @ 5.00 gm/liter of water Highest yield (149.98 q/ha) was recorded in the treatment Cynantraniliprol 10.26% OD while 129.59, 129.09 and 125.89 q/ha were recorded in VI-8 isolates of *Lecanicillium leccanii*, Bb-5a isolate of *Beauveria bassiana* and Bb-45 isolate of *Beauveria bassiana*, respectively.

Sugarcane: Field efficacy of EPN strains against white grubs in sugarcane

- The three years pooled data (2019-20, 2020-21 and 2021-22) on efficacy of different EPN strains against white grubs in sugarcane revealed that the significant difference among treatments were recorded in clump mortality due to application of EPN. The treatment Fipronil 40% + imidacloprid 40 WG @ 0.4 g/l was found significantly superior over rest of the treatment with 6.22 per cent clump mortality.
- The treatment *Heterorhabditis indica* 10 kg/ha (NBAIR WP formulation) @ 10 kg/ha was second best treatment in clump mortality due to white grub (8.03%) and was at par with the treatment *Heterorhabditis bacteriophora* @ 10 kg/ha (NBAIR WP formulation) with (9.04 %) clump mortality as aginst 19.67 % .
- Highest white grub reduction was recorded in chemical control (68.38%) followed by *H. indica* @ 10 kg/ha (59.18 %), *H. bacteriophora* @ 10kg/ha, S. *carpocapsae* @ 10kg/ha and *S. abbasi* @ 10kg/ha which recorded 54.04, 49.56 and 45.55 per cent, reduction, respectively.
- Grapevine powdery mildew, *Uncinula necator* disease of grape was effectively managed with three spraying of *Trichoderma harzianum* @ 5 ml /L + *Ampelomyces quisqualis* @ 5 ml /L and recorded minimum 6.33 – 6.77 Per cent Disease Index (PDI) and maximum fruit yield 18.667- 19.567 Mt./ha followed by *Bacillus subtilis* @ 1 g /L + *Ampelomyces quisqualis* @5 ml /L which recorded 7.00- 8.23 PDI with fruit yield of 18.517 - 19.453 Mt./ha as against in chemical check (sulphur 2g/litre of water) recording 8.67 PDI- 10.00 PDI and fruit yield 17.467 -19.033 Mt./ha (2020-21 and 2021-22)

Brief about each large scale demonstration trials:

Large scale demonstration on biological suppression of *Spodoptera litura* with *Nomuraea rileyi* in soybean

- The large scale demonstration was conducted on the Kuran farm of College of Agriculture, Pune .The pooled result of trials conducted during 2017 and 2018 *Kharif* seasons indicated that two sprays of *Metarhizium rileyi* (Farlow) (*N. rileyi)* 2.0 x 10^8cfu/g were significantly superior in suppressing the larval population of *S. litura* (2.46 larvae/m row) due to fungal infection with maximum soybean yield of 16.43 q/ha with BC ratio 1.62.

Large scale demonstration of *Trichogramma* sp against sugarcane bore

- The large scale demonstration on biological suppression of borer complex in sugarcane was carried out.
- The pooled results of three years trial conducted during 2017-18, 2018-19 and 2019-20 revealed that eight releases of *T. chilonis* TTS @ 50,000 parasitoids/ha at weekly interval starting from 40 days after emergence of shoots found significantly superior to untreated control in reducing the ESB infestation (from 22.16 to 6.41 % dead hearts) and recorded maximum cane yield (139.64 Mt/ha) with B: C ratio 1: 2.31.

Technologies developed and adopted during the review period:

- Mass production of *Metarhizium anisopliae* was carried out on PDA media and mass multiplied on talc powder was demonstrated over 20 ha on research farm of College as well as farmers' fields against white grub on sugarcane. The strain of *M. anisopliae* found infectious to white grub on sugarcane, which resulted in 52 to 60 per cent decline in pest population.
- Three sprays of *Bacillus thuringiensis* var. *Galleriae* (BTG 4) @ 20 ml per 10 lit. water **at 15 days interval** starting **from 45 days after sowing is** recommended for the control of shoot and fruit borer on okra. (Joint Agresco Meeting, MPKV, Rahuri 28-30th May, 2019) (State Level).
- Three sprays of *Sl*NPV @ 250 LE/ha (1.5 x 10^{12} POBs/ha) or *Nomuraea rileyi* @ 2.5 kg/ha (1 x 10^{13} conidia) at 15 days interval starting from appearance of the pest is recommended for the control of *Spodoptera litura* in soybean.
- Demonstrated use of *Apertochrysa astur* for the control rugose spiraling white fly (*Aleurodicus rugiperculatus* Martin) in coconut orchards from College Of Agriculture, Pune and Khed, Daund and Haveli Tahashil of Pune district in western Maharashtra.

MPUAT, Udaipur

a) Survey, monitoring and biodiversity of fauna

- During *Kharif* and *Rabi,* the diversity of natural enemies of major insect pests of maize, gram and tomato crops from different villages of Southern Rajasthan were recorded. The natural enemies recoded were *Cheilomenes sexmaculata* Fab. *Coccinella septempuctata* L in, *Chrysoperla zastrowi sillemi, Brumoides suturalis* (Fabricius), Rove beetles (Staphylinidae), Predatory pentatomid bug, *Cotesia flavipes* (Cameron) and Spiders

(ii) Survey and surveillance of Fall Army Worm, *Spodoptera frugiperda* (Smith) on maize:

- Surveys were conducted to record the incidence of fall armyworm, *S. frugiperda*from June, 2018 to March, 2022. The survey indicated that the incidence of fall armyworm was noticed to be low to moderate in different districts of Southern Rajasthan with an average incidence range of 10-40 per cent.

b) Biological suppression

i) Biological Control of Maize Stem Borer, *Chilo partellus* using *Trichogramma chilonis*:

- The dead heart formation recorded in fields with the releases of *T. chilonis* was 8.50-13.50 per cent and in chemical control, it was 6.50-10.20 per cent on an average during the period from 2018-2022. The reduction in incidence over control was 44-50 per cent and 56-62 per cent, respectively for *T. chilonis* and Spinosad. The yield in *T. chilonis* (T_1) fields were 28.50-32 q/ha and 31-35 q/ha in Spinosad, which was significantly more than in untreated control.

(ii) Biological Suppression of Pod Borer, *Helicoverpa armigera* (Hubner) Infesting Chickpea.

- The maximum larval population reduction was recorded in quinalphos 25 EC @ 250g a.i/ha treatment and the minimum reduction was observed in *B. bassiana* @ $1x10^8$ conidia /gm @ 5 gm/l at 7 days interval, 2 sprays at pod initiation stage, whereas, the untreated control recorded least reduction in larval population at ten days after spray. Minimum per cent pod damage was recorded in treatment of quinalphos 25 EC @ 250g a.i/ha and maximum was in *B. bassiana* @ $1x10^8$ conidia /gm @ 5 gm/l.

d.) Technologies developed and adopted

- Release of *Trichogramma chilonis* @ 100000/ha for 3 times against Maize Stem Borer**,** *Chilo partellus.*
- Fungal bio-pesticides, *Beauveria bassiana* @ $1x10^8$ conidia /gm @ 5 gm/l at 7 days interval, 2 sprays at pod initiation stage significantly reduced the Pod Borer, *Helicoverpa armigera* (Hubner) infesting chickpea.
- *Bacillus thuriengiensis* @1 kg/ha significantly reduced the Pod Borer, *Helicoverpa armigera* (Hubner) infesting chickpea.

TNAU

a) Surveys, monitoring and Biodiversity of fauna :

- Surveys were conducted to assess the status of invasive pests. The occurrence of *A. rugioperculatus* was recorded in all the coconut growing areas in Tamil Nadu. The parasitization by *Encarsia guadeloupae* ranged between 10.00 and 100.00 per cent in coconut gardens. A diverse array of predators *viz*., *Aprtochysa astur*, *Chilocorus nigrita*, *Coccinella transversalis*, *Malladades jardinsi*, *Cheilomenes sexmaculatus*, *Propylea dissecta*, *Scymnus nubilis*, *Scymnus saciformis*, *Chrysoperla zastrowi sillemi* are present in the coconut gardens. In sugarcane, *Dipha aphidivora* and *Micromus igorotus* were observed in Coimbatore and Erode Districts. Cassava mealybug *Phenacoccus manihoti* caused 30-40 % damage in cassava fields in Erode, Namakkal and Salem Districts during May, 2020. *Hyperaspis maindroni* was found to be the predominant coccinellid predator of the mealybug. Besides *H. maindroni*, *Mallada* sp.

and *Prochiloneurus aegyptiacus*, *Tetrastichus* sp. were also observed. Among the parasitoid species, *Homalotylus turkmenicus* emerged from the coccinellid predator, *H. maindroni* grubs. Encyrtid parasitoid, *Copidosomyia ambiguous* (Subba Rao) Hymenoptera: Chalcidoidea: Encyrtidae) has been found on *Malladades jardinsi* (Navas) eggs.

b) Biological Suppression

Tomato

- In the BIPM field, the leaf damage caused by *Tuta absoluta* (6.70 %) was significantly lesser than in farmers practice and control plot on 60 Days After Transplanting (DAT). At 105 DAT, the fruit damage caused by *T. aboluta* (10.90 %) was significantly lesser in BIPM plots when compared to chemical treatment (13.20%) and control (18.90 %). Moreover, the fruit damage caused by *H. armigera* (11.30 %) was significantly lesser in BIPM when compared to chemical treatment (16.10 %) and control (25.30%). The fruit yield (24t/ha) was significantly higher in BIPM plot as compared to insecticide treated plot (21.5t/ha) and control plot (18.25/ha).

Brinjal

- The incidence of *Epilachna* beetle noted in brinjal with coriander as inter crop and cowpea as border crop was minimum 0.2 Nos./ plant as against the 1.57 Nos./ plant in the sole crop. The natural enemies like coccinellids was high in mixed crops (2.68 Nos./plant) as against sole crop of brinjal which showed 0.6 Nos. / plant. The nematode population (Root knot and reniform nematodes) was significantly lower in Brinjal crop intercropped with radish (192.6 nos./250 gm soil) and coriander (201.6 nos./250 gm soil) whereas cowpea (458 nos. /250 gm soil) as intercrop housed more numbers of nematodes which was on par with the control plot (491 nos. /250 gm soil).
- The fruit damage in brinjal due to *Leucinodes orbonalis* was significantly low (17.82%) in plots sprayed with pesticides followed by 21.80 per cent fruit damage in BIPM plots (Azadirachtin 1500 ppm @ 2ml/lit (one round of spray) + *Lecanicium lecanii* (one round of spray) + *Trichogramma pretiosum* (8 releases) + Pheromone traps @20/ha + Cowpea as bund crop). The cost benefit ratio realized in BIPM was 1:3.90 as against 1:4.83 in insecticides treated plots

Cabbage

- BIPM practices was significantly superior in reducing the population of diamond back moth by recording 0.46 larvae/plant after three rounds of spray while it was 1.62 and 7.66 larvae /plant in chemical treatment and control plot respectively. Inundative release of *Trichogramma* worked out effectively and parasitoids were recovered from cabbage plants A highest yield of 44.25 t/ha was recorded in BIPM plot which was on a par with chemical treatment (43.2 t/ha). Yield from control plot was 38.7 t/ha. The CB ratio was 3.53 in BIPM plot while it was 2.84 in chemical treatment.

Jasmine

- Application of *Beauveria bassiana* (NBAIR formulation) at 5g/ litre of water along with 6 releases of *Trichogramma chilonis* and *Chrysoperla* at 7 days interval from bud initiation stage was superior in checking the bud borer with minimum bud

damage of 21.70 per cent followed by Azadirachtin @ 1500 ppm @ 2ml/L (25.42%). The flower yield ranged between 1650 and 1945 Kg/ha in the treatments while it was 1450Kg/ha in control.

Chickpea

- BIPM module with Bt application (Nos.) was statistically on par with insecticide treatment with 2.33 and 1.33Nos. of larvae /meter row respectively on 3rd Day After First Spraying (DAFS),. Similar trend was observed on 7 DAFS also. Pod damage was less in insecticide treatment (8.38%) when compared to the BIPM module with HaNPV (13.41%) and BIPM module with Bt (14.17%). There was 43.82 per cent increase in the yield in insecticide treatment followed by BIPM module with HaNPV (21.91%) and BIPM module with Bt (25.00%).

***Bt* cotton**

- Rosette flowers due to pink boll worm was 1.22 per cent in BIPM plots while it was 2.87 per cent in the control plot on 110 Days After Sowing (DAS). There was 17.52 per cent reduction in the bad open bolls in BIPM module whereas 30.65 per cent reduction in bad open bolls was observed in insecticides treated plots. The yield was maximum in insecticide sprayed plots (2215Kg/ha) followed by 1890Kg/ha and 1598Kg/ha in BIPM and control plots respectively. CB ratio was higher in insecticide treated plots (1:2.57) than in BIPM plot (1:2.52).

Coconut

- The population of Rugose Spiralling Whitefly **(**RSW) nymphs was minimum (12.25Nos.) in the coconut trees sprayed with neem oil 0.5% followed by 13.33 numbers of nymphs in foliar application of *Isaria fumosorosea* (pfu-5) @ $1x10^8$cfu/ml, Foliar water spray (15.25Nos.) and *Encarsia guadeloupae* (natural conservation) (18.13Nos.) on 15th day after 2nd spraying. Parasitised nymphs were significantly more in *Encarsia guadeloupae* (natural conservation) (37.09%) than in foliar application of *Isaria fumosorosea* (pfu-5) @ $1x10^8$cfu/ml (26.24%), foliar application of neem oil 0.5% (24.84%) and Foliar water spray (30.22%) on 15th day after 2nd spraying.

c) Evaluation and bio efficacy of Biopesticides:

Pigeonpea

- NBAII-BTG4 @ 2% spray was effective in reducing the larval population of *Helicoverpa armigera* and *Maruca vitrata* in all stages of pigeon pea. Pod damage in NBAII BtG4 and insecticide treated plots was statistically on par with each other. Both the Bt formulation and the chemical sprays gave higher grain yield of 625 and 590 Kg/ha respectively than control (415 Kg/ha). The CB ratio was maximum (2.13) in NBAII BtG4 treatment.

Bhendi

- Among the biocontrol treatments, maximum reduction in fruit damage (83.43%) due to *Earias vitella* was registered in *Trichogramma chilonis* @50,000 parasitoids/ha, 6 releases at weekly interval followed by *Bacillus thuringiensis* @ 1 kg/ha (70.82%) while in insecticide sprayed plots there was 87.27 per cent reduction in the fruit damage. The fruit yield was also significantly high (9978Kg/ha) in *Trichogramma*

chilonis @ 50,000 parasitoids/ha, 6 releases at weekly interval while in control, the fruit yield was 8266Kg/ha.

Maize

- Among the biocontrol agents, lowest plant damage of 39.67 per cent was observed in *Trichogramma chilonis* + NBAIR Bt 2% followed by *Trichogramma chilonis* + *Metarhizium anisopliae* Ma-35 (41.52%), *Trichogramma chilonis* + *Beauveria bassiana* NBAIR -Bb 45 (43.27%), *Trichogramma chilonis* + Spfr NPV(NBAIR1) (43.31%) and *Trichogramma chilonis*+ EPN *H. Indica* NBAIR H38 (47.59%) on 7th day after first spraying of entomopahogens and insecticide, while in insecticide treated plots 38.62 per cent damage was observed. Similar trend was observed on 15th day after first spraying also. A maximum of 35.48 per cent egg parasitisation by *Telenomus* sp was observed in *Trichogramma chilonis* + NBAIR Bt 2%. Yield was maximum (3563Kg/ha) in *Trichogramma chilonis* + NBAIR Bt 2 % plots followed by *T. chilonis*+ *Metarhizium anisopliae* Ma35 (3420Kg/ha) and these two treatments statistically onpar with each other while in the insecticide treated plots the yield was 3883Kg/ha.

Rice

- Soil application (2.5kg/ha) + Seed treatment *Bacillus subtilis* (10g/kg) + Seedling dip *Bacillus subtilis* (2.5kg/ha) + Foliar spray *Bacillus subtilis* (20g/lit)) was found to be the best in reducing the incidence of blast, brown spot, bacterial leaf blight, false smut to a considerable level. Yield was 3585Kg/ha in *Bacillus subtilis* treated plots and it was higher than the yield in Azoxystrobin (1ml/lit) (3295Kg/ha).

d) Large scale demonstration trials:

1. **Large scale biointensive management of pink bollworm on *Bt* cotton - 10acres**
   In BIPM module pink bollworm incidence bad open boll was 22.00 per cent while it was 32.00 per cent in control. The yield increase in BIPM plots was 20.00 per cent over control plots.
2. **Large scale biological suppression of rugose spiralling whitefly in coconut – 25acres**
   BIPM module *ie., Encarsia guadeloupae* natural conservation + Release of *Apertochyrsa astur* eggs @1000/ha + Yellow sticky traps @ 20/ha was demonstrated in Chinnappampalayam, Anaimalai Block, Coimbatore Dt. In BIPM field, there was 80.00 per cent reduction in the population of Rugose spiralling whiteflies (RSW) while in control plot there was 60.00 per cent reduction in RSW population. Similar trend was observed in the population of Bondars Nesting Whiteflies also.

d) Technologies developed and adopted during the review period:

1. Biointensive management of pink bollworm on *Bt* cotton
2. Biological suppression of rugose spiralling whitefly in coconut
3. Bio-intensive insect management in brinjal
4. Card board boxes for transport and release of Chrysopids eggs
5. Labour saving method for collection of *Corcyra cephalonica* moths

SKUAST-Jammu

Brief Achievements:

a) Surveys, monitoring and biodiversity of fauna

- Surveys were conducted in different districts of Jammu and Kashmir and occurrence of fall armyworm, scales and mealy bug from aonla, guava and Alstonia, beetles form Til and guava, strawberry caterpillar, Alstonia galls and linseed pod bugs and predatory coccinellid beetles were recorded and identified
- Monitored the suspected invasion by *Tuta absoluta*, seeing the symptoms on tomato fruit. The pheromone traps for *T. absoluta* were installed in the suspected areas but no incidence of pest was found.
- Fruit fly incidence in mango and guava orchards was monitored through pheromone traps.

b) Biological Suppression

- Bio-ecological engineering for the management of major insect pests of maize was evaluated and the percent plant damage by *Chilo partellus* on maize was lowest and maize equivalent yield was significantly higher in maize + cowpea (intercrop) + sorghum (border crop). The natural enemies present in the ecosystem were coccinellids andspiders were more active in okra, mash and cowpea intercrops.
- Habitat manipulation for the management of *Helicoverpa armigera* in chickpea was evaluated.Significantly lower incidence of *H. armigera* larvae and consequent pod damage was recorded in chickpea + linseed (intercrop) + Napier / Mustard (border crop). Percent parasitization by *C. chloridae* was highest in coriander, followed by linseed and fenugreek. Grain yield and C:B ratio was also accordingly the highest.

c) Evaluation and bio-efficacy of biopesticides

- Biological control of scale insects, *Icerya purchasi* using entomopathogens in guava and aonla was evaluated. Significantly higher percent reduction in guava scale, *Icerya purchase* population was recorded in treatment *Lecanicillium lecanii* and was at par with *B. bassiana* and azadirachtin spray at 7 DAS.
- Biological control of mealy bug was evaluated using entomopathogenic *M. anisopliae.*Significantly highest percent reduction in mealybug population was recorded in *M. anisopliae* and azadirachtin spray followed by *B. bassiana* spray at 7 DAS.

d. Evaluation and bio-efficacy of biopesticides against plant diseases

- Biopesticide NBAIR-TATP strain *Trichoderma asperellum* (liquid formulation or its talc formulation) was found effective to manage Maize Turcicum leaf blight (*Exserohilum turcicum*). Percent disease index in carbendazim spray was comparable to that of *T. asperellum* (liquid formulation). Grain yield was significantly highest accordingly in both the treatments. The growth and yield attributes (plant height, length of cob, breadth of cob, no. of rows/cob, no. of grains/row and biomass) also corresponded respectively with the grain yield.
- NBAIR-TATP strain *Trichoderma asperellum* (Liquid formulation) and its talc formulation was found effective in the management of chickpea *Fusarium* wilt

(*Fusarium oxysporum f. sp. ciceris*). Percent wilt incidence in carbendazim spray was comparable with NBAIR-TATP strain *T. asperellum*.

- NBAIR-PFDWD strain *Psuedomonas fluorescens* (talc formulation) or its liquid formulation effectively managed pea rust (*Uromyces viciae-fabae*). Percent disease index in Mancozeb spray was comparable to that of *P. fluorescens* (NBAIR-PFDWD strain – talc formulation), and significantly higher seed yield was obtained.
- NBAIR-PFDWD strain *Pseudomonas fluorescens* (talc formulation) or its liquid formulation effectively managedMustard white rust (*Albugo candida*). Percent disease index in Ridomil spray was comparable to that of *P. fluorescens* (NBAIR - PFDWD strain – talc formulation), and significantly higher seed yield was obtained.

OUAT, Bhubaneswar

Brief achievements:

a) Surveys, monitoring and Biodiversity of fauna:

- Survey on the exotic pest rugosespiralling whitefly, *Aleurodicus rugioperculatus* and its natural enemies in the coconut plantations of Puri, Odisha indicated its presence in Odisha during 2020 and its incidence also observed in Konark and Pipili areas of Odisha.
- During survey, ten species of spiders belonging to six genera were recorded in rice (var. swarna) at Bhubaneswar during *kharif* season and spider species *Tetragnatha mandibulata* was the most dominating in rice ecosystem.
- Surveys were conducted to know the status of invasive fall armyworm in Odisha during 2018 along with PPO (Quarantine), DDA (PP), Bhubaneswar and PPO, CIPMC, Odisha. Recommendations were given for managing the pest populations accordingly.
- Surveys were conducted in rice growing areas of in Odisha to know the status of rice hispa (*Dicladispa armigera*) during September 2018 and pest status wwas near ETL level.

b) Biological Suppression

- Sugarcaneearly shoot borer *Chilo infuscatellus* and *Scirpophaga excerptalis* were controlled by the weekly release of *Trichogramma* spp.in the farmers field under BIPM programmes.
- Rice leaf folder population was reduced by releases of *Trichogramma* spp. in rice under BIPM programmes.

c) Evaluation and bio-efficacy of biopesticides

- Neem biopesticides (azadirachtin) was found effectivein managing foliar and sucking pests in rice in BIPM practice.
- Bio-efficacy of biopesticides and botanicals were evaluated and *L. lecanii* was superior in its performance and found comparable to azadirachtin 1500 ppm. Significantly highest yield (8.66 q/ha) was recorded in imidacloprid treated plots 17.8 SL (3ml/10L) followed by azadirachtin 1500 ppm (2ml/L) treated plots (7.47q/ha). The yield in *L. lecanii* treated plots remained at par with azadirachtin (7.45 and 7.40 q/ha).

d) Brief about each large scale demonstration trials

- Large scale bio-intensive pest management in rice pests was carried out during 2017-18 to 2021-22. Results revealed that the pest infestation in BIPM was at par with chemical. The damage incidence of silver shoot, dead heart, white ear head and leaf folder incidence were similar as in chemical treated fields. The average yield obtained in BIPM (52.65 q/ha) was next to chemical control (54.79 q/ha) and was significantly higher than untreated control (42.42 q/ha). The benefit cost ratio in BIPM treated plots was found highest (1.55) as against 1.44 and 1.21 in farmer practice and untreated control, respectively.
- Large scale demonstration of *Trichogramma* spp.*viz. Trichogramma chilonis and T. japonicum* for the management of sugarcane borer was carried out during 2017-18 to 2021-22. The incidence of early shoot borer, internode borer and top shoot borer was comparable to the chemical applied treatment and higher incidence was recorded in untreated control fields. The average yield in BIPM was 76.99 t/ha was comparable to chemical treated (73.2 t/ha) was and significantly higher than untreated control (59.34t/ha).
- Field trial against fall armyworm in *Rabi* maize was carried out during 2018-19. Various bio-modules were tested to manage the fall armyworm incidence in *Rabi* maize from 2018-19 to 2020-21. Among the tested modules, tricho-card releases + Bt sprays expressed highest average yield (14.86t/ha) and lowest pest damage and wasat par with emamectin benzoate check (16.42t/ha) and closely followed by tricho-card releases + *Pseudomona*s sprays. The obtained yield in untreated control field was (8.15t/ha).

NIPHM, Hyderabad

Brief achievements:

a) Surveys, monitoring and biodiversity of fauna:

- Recorded the predators fauna *viz*., *Chrysoperla carnea,* coccinellids *viz*.,*Cheilomenes sexmaculata, Coccinella transversalis, Coccinella septempuctata*, Big eyed bug Geocoris sp., preying mantis, dragon fly, damselfly, Pentotomid bug, *Eocanthecona furcellata*, reduviid bug, *Rhynocoris fuscipes*, robber fly, long legged fly, carabid beetle, ear wig, hover fly, Rove beetle, Long horned grasshopper, spiders and wasp.
- Recorded parasitoids*Cotesia* sp., *Bracon*sp.and*Trichogramma*sp. from various host insects.

c) Evaluation and bio efficacy of biopesticides

- After the pot culture studies the *Nomuraea rileyi (=Metarhizium rileyi)* NIPHM MRF-1 strain will be evaluated for its efficacy in different agro-climatic zones under AICRP (BC).

ANGRAU

Brief achievements:

Surveys, monitoring and biodiversity of fauna:

- Outbreak of BPH, WBPH and sheath blight in paddy during *kharif* season and severe incidence of early shoot borer and inter node borer in rainfed sugarcane was recorded.

- Severe outbreak of white grub and yellow leaf disease in sugarcane was recorded in in endemic areas 2017-18.
- Severe outbreak of new invasive pest, fall armyworm *Spodoptera frugiperda* in maize during 2018 and later it was spread to ragi, bajra, sorghum and sugarcane during 2019.
- Incidence of invasive rugose spiralling whitefly (RSW) was recorded in coconut in the north coastal districts of Andhra Pradesh during February, 2019. Noticed severe outbreak of RSW in coconut, banana, papaya, sapota and guava during 2019.
- Severe outbreak of looper, *Perixera illepidaria* in mango was recorded.
- Natural occurrence of entomopathogenic fungus, *Nomuraea rileyi* on fall armyworm was recorded during 2019.
- Incidence of grasshopper, *Poekilocerus pictus* on *Calotropis* was recorded in Vzianagaram and Srikakulam Districts in May and June, 2020 in Andhra Pradesh.
- Spotted grasshopper *Aularches miliaris* incidence was recorded on *Wrightia tinctoria* and cashew in Vizianagaram and Visakhapatnam districts in May-June 2020.
- Mixed borer complex in maize *i.e.,* stem borer, *Chilo partellus*, pink borer, *Sesamia inferen s*and *S. frugiperda* was recorded as dominant species.
- Naturally infected rice skipper larva with *Fusarium verticilloides* was collected and reported.
- Parasitism of *Telenomus remus* and *Trichogramma chilonis* on fall armyworm eggs was recorded in maize and sugarcane.
- Parasitism of *Encarsia guadeloupa*e on coconut rugose whitefly was recorded during the year 2020-21.
- Root grub adult populations were collected from sugarcane growing areas of Visakhapatnam, Krishna, Chittore districts of Andhra Pradesh during July-September,2021 and *Schizonycha fuscescens* was identified as dominant root grub species and other species were *Maladera rufocuprea* and *Adoretuslasio pygus*, *Apogonia* sp. prevailing in sugarcane ecosystem.
- Natural infection of maize fall armyworm showing NPV infection was noticed.
- New invasive pest, flower thrips/ black thrips in chilli was identified as *Thrips parvispinus* and the incidence was severe (55-70%) in chilli.

Biological Suppression

- Management of fall armyworm in maize using biocontrol agent and biopesticides in *Rabi* maize was carried out in 2018-2020. Field release of *Trichogramma pretiosum* (20,000/acre; 2 releases) + *Bacillus thuringiensis* (NBAIR Bt 25 @ 2ml/L; 3 spray) was highly effective followed by field release of *T. pretiosum* + *Metarhizium anisopliae* (NBAIR-Ma 35@ 5 g/L; 3 spray) with high cob yield and was on par insecticide check. The number of dead larvae was higher in *T. pretiosum* + *M. anisopliae* (42.9) followed by *T. pretiosum* + NBAIR Bt (41.9) and was on par with insecticide check. Cob yield recorded high in insecticidal check (42.1 q/ha) and was on par with *T. pretiosum* + NBAIR Bt (39.9 q/ha), *T. pretiosum* release + *M. anisopliae* (39.38 q/ha).

Evaluation and bio-efficacy of biopesticides:

- Management of rice stem borer and leaf folder using entomopathogenic nematodes and entomopathogenic fungi was evaluated during 2017 to 2019. The percentreduction in leaf folder damage (54.77%) and stem borer (43.18%) was highin *Bacillus thuringiensis* (NBAIR strain) @ 2ml/L, followed by *Metarhizium anisopliae* (NBAIR strain) and *Beauveria bassiana* (NBAIR strain). Highest grain yield recorded in *B.thuringiensis* (NBAIR strain) (4.15 t/ha), *B. bassiana* (NBAIR strain) (4.21 t/ha) which was on par with flubendiamide 40SC @ 0. 1ml/L (4.02 t/ha).
- Management of plant hoppers through BIPM approach was evaluated in rice during 2017-2019. Hopper population was significantly lower in BIPM plot (4.91 hoppers/hill) compared to farmers practice plot (6.31 hoppers/hill) and high in control plot (7.74 hoppers/hill). Grain yield recorded significantly high in BIPM practice i.e., *Beauveria bassiana* @ 5g/L, *Metarhizium anisopliae* @ 5 g/Lafter two sprayings (4.14 t/ha) as compared to farmer's practice i.e., monocrotophos @1.6 ml/L and acephate @ 1.5 g/L as two sprayings (3.74 t/ha) and low in untreated control (3.47 t/ha).
- Evaluation of Bacillus thuringiensis (NBAIR Bt G4) on pigeon pea against pod borer complex was carried out during 2017-2019. Spraying *Bacillus thuringiensis* (NBAIR Bt G4) @ 2 ml/L at pre-flowering, flowering and pod formation stages in pigeon pea against pod borer complex in comparison with chemical sprays (chlorpyriphos @ 2.5 ml/L at pre-flowering acephate @ 1.5 g/L at flowering, Chlorantraniliprole @ 0.3ml/L at pod formation. Foliar spray with ICAR-NBAIR *B. thuringiensis* Bt G4 effectively reduced *Maruca* leaf webber with 37.9% reduction in leaf webbing; 22.88 % reduction in pod damage and higher pod yield (676.7 kg/ha) with 48.62% yield increase over untreated control. Chemical sprays gave reduction in leaf webbing damage (37.8%) and pod damage (10.7%) with pod yield of 639.82 kg/ha and 40.8% yield increase compared to untreated control.
- Field evaluation of ICAR NBAIR endophytic entomopathogenic strains against shoot borers (*Chilo infuscatellus* and *Chilo sacchariphagus indicus*) was carriedout in sugarcane during 2020-2022. Sugarcane early shoot borer cumulative incidence upto 120 days after planting recorded low in sett treatment and foliar spray two times with *Metarhizium anisopliae* NBAIR Ma-35 @ 5 g/L (6.65% deadheart, *Beauveria bassiana* NBAIR Bb-23 @ 5 g/L (7.65% deadheart) and *B. bassiana* NBAIR Bb-45 (7.99% deadheart) which are below ETL next to cholorantraniliprole (4.63 % dead heart) and was high in untreated control (27.75% dead heart). Internode borer incidence and intensitywas significantly low in cholorantraniliprole sprays (40 % and 2.73%) and on par with *B. bassiana* NBAIR Bb-45 (41.25% and 3.1 5) and *M. anisopliae* NBAIR Ma-35 (46.25% and 2.95%). Cane yield recorded high in cholorantraniliprole treatment 76.2 t/ha) and was on par with NBAIR Bb45 (75.73 t/ha) and NBAIR Ma35 (72.52t/ha).
- Integration of botanicals, microbials and insecticide spray schedule for the management of pod borer complex in greengram was carried out during 2020-2022. Green gram pod borer, *Maruca virtata* damage was significantly low in spinosad and

was on par with *Bacillus thuringiensis* (NBAIR Bt G4). Green gram yield recorded high *B. thuringiensis* two sprays (7.39q/ha) next to chemical insecticide, spinosad two sprays (7.77q/ha); spinosad in one spray (7.59 q/ha) compared to azadiractin two sprays (5.4q/ha) and control (3.42 q/ha.).

- Laboratory bioassay of *Metarhizium (=Nomuraea) rileyi* (Anakapalle strain AKP-Nr-1) against maize fall armyworm, *Spodoptera frugiperda* during 2020-2022. High larval mortality of maize fall armyworm with *M.rileyi* (AKP-Nr-1) 1×10^9 spores / ml followed by *M. rileyi* (AKP-Nr-1) 1×10^8 spores / ml in leaf dip method (93.75%) and larval treatment method (92.8%). *M. rileyi* (AKP-Nr-1) showed LC_{50} of (1.1×10^8 spores/ml) and LT_{50} at (1×10^8 spores/ml) was 85.1 hours against maize fall armyworm.
- Field efficacy of *Metarhizium (=Nomuraea)rileyi* isolate (Anakapalle strain AKP-Nr-1; UAS, Raichur) against fall armyworm in maize was evaluated during 2020-2022. Maize fall armyworm damage was low at concentration 1×10^8 spores/ml of *M. rileyi*Anakapalle strain and *M. rileyi*, UAS Raichur and on par with other higher concentrations. Percent reduction in fall armyworm incidence after two sprays of *M. rileyi* was high in *M. rileyi* (Anakapalle strain) 1×10^8 spores / ml (60.69%) and *M. rileyi* (UAS Raichur strain)1×10^8 spores/ml (59.13 %). Cob yield recorded high in *M. rileyi* (Anakapalle strain)1×10^8 spores/ml (61.67q/ha) and *M.rileyi* (UAS,Raichur) 1×10^8 spores / ml (60.49 q/ha) and low yield in control (32.69 q/ha).
- Management of coconut rugose spiralling whitefly (RSW) using entomopathogenic fungi, *Isaria fumosorosea* NBAIR Pfu5 was carried out during 2018-2020: High reduction in RSW intensity in *Isaria fumosorosea* NBAIR Pfu5 @ 5 g/L(2 sprays) + *Encarsia guadeloupae* release (63.47%) was recorded followed by *I. fumosorosea* NBAIR Pfu5 (2 spray) + *Dichocrysa* predator release (60.11%). Neem formulation 10000 ppm @ 1ml/L, two sprays results in low reduction in white fly intensity (18.79%).
- Ecofriendly management of stem rot, *Macrophomina phaseolina* in sesame using biocontrol agents was evaluated. NBAIR *Pseudomonas fluorescence* seed treatment @ 10 g/kg + *Trichoderma asperillum* soil drenching @ 5 g/L at 30, 60 days after sesame sowing was effective in managing stem rot, *M. phaseolina* in sesame (4.29%) with high grain yield (376 kg/ha), followed by *T. asperillum* as seed treatment @ 10 g/kg + *P. fluorescence* soil drenching @ 5 g/L (6.52%) with grain yield (353 kg/ha) and on par with chemical, carbendazim seed treatment @ 1 g/kg + soil drenching @ 5 g/L (stem rot 11.13% and yield 258 kg/ha) during 2020-2022.

d) Brief about each large scale demonstration trials:

- Large scale demonstrations of proven biocontrol technologies against sugarcane borers: Field Release of *Trichogramma chilonis* @ 50,000/ha at weekly interval, 8 times from 30 days after planting/ ratooning for early shoot borer and 4 times at node formation against internode borer reduced pest incidence. Early shoot borer and Internode borer incidence reduction was 66.6% and 27.9% in biocontrol compared to chemical control. Cane yield increase in biocontrol (66.19t/ha) over chemical control (57.54t/ha) was 14.8% (8.6 t/ha) additional yield resulted in additional returns of Rs.

24,220/- per ha. Saving in Cost of plant protection was 77% (Rs. 5000/- per ha) in biocontrol. Incremental benefit cost ratio was high Biocontrol (56.77) compared to Chemical control (10.29).This technology was included in University crop package of practices for the integrated pest management of sugarcane pests and also fits in organic farming.

- Efficacy of entomopathogenic nematode, *Heterorhabditis indica* (ICAR-NBAII H38) for the management of sugarcane white grub (2017-18 to 2019-20): Large scale demonstrations and promotion of *H. indica* (NBAIR-H38) effectively reduced the white grub, *H. consanguinea* in sugarcane and increased cane yield in white grub endemic of Andhra Pradesh. Reduction in white grub damage was 85.5% in biocontrol compared to untreated control. Cane yield increase in biocontrol (79.4 t/ha) over untreated control (32.0t/ha) was 59.7% with 47.4 t/ha additional yield. Monitory Benefit with biocontrol compared to untreated control was Rs. 1, 20, 326 /- per ha with low cost on adoption of biocontrol (Rs. 4800/- per ha). Cost benefit ratio was high in biocontrol (1.51) compared to untreated control (0.88). This technology was included in University crop package of practices for the integrated pest management of sugarcane pests and also fits in organic farming.
- Evaluation of entomopathogenic fungi, *Metarhizium anisopliae* (ICAR-NBAIR Ma4) for the management of sugarcane white grub:Soil application of *M. anisopliae* (NBAIR Ma 4) @ 2.5 kg/ ha enriched in 250 kg FYM per hectare, two times at monthly interval or at onset of monsooneffectively reduced the grub population (85-86%) and plant damage (91-92%) resulted in increased cane yield (62.3%) with 56.5t/ha additional yield in biocontrol (90.7 t/ha) over untreated control (34.2t/ha). Additional returns with biocontrol was Rs.1, 38, 425/- per ha with low cost of adoption of biocontrol (Rs. 2600/- per ha). Cost benefit ratio was high in biocontrol (2.02) as compared tountreated control (0.78). This technology was included in University crop package of practices for the integrated pest management of sugarcane pests and also fits in organic farming.
- Bio suppression of *Chilo partellus, Sesamia inferens* with *Trichogramma chilonis* on *Rabi* maize during 2017-18. Field release of *T.chilonis* @1,00,000 per ha from 15 days after seedling emergence three times at weekly interval resulted in 92.6% reduction in *C. partellus*, 49.52% reduction in *S. inferens* andresulted in higher cob yield (27.17 q/ha) with 19.96% yield increase compared to farmers practice i.e., spraying monocrotophos @ 1.6 ml/L. Incremental benefit cost ratio of biocontrol was high (60.86) compared to farmers practice (8.8).
- Large scale demonstration for the management of fall armyworm in maize using biocontrol agents and biopesticides was carried out during year 2019-20 to 202-22. Field releases of *T. pretiosum* @ 50,000/ha or *T. chilonis* @ 1,00,000/ha from 7 days after seedling emergence (2 times) and spraying *Bacillus thuringiensis* (NBAIR Bt 25) @ 2 ml/L or *M.anisopliae* (NBAIR Ma 35) @ 5 g/Lfrom 20 days after seedling emergence (3 times at 10 day interval) was found effective in controlling fall armyworm in comparison with insecticidal check (Azadirachtin + chlorantraniliprole + emamectin benzoate sprayings). Cobyield recorded in biocontrol treatments egg

parasitoid + Bt was 39.97q/ha followed by egg parasitoid + *M. anisopliae* (39.38 q/ha) and was on par with chemical check (40.18 q/ha). Benefit cost ratio was high in egg parasitoid + *M. anisopliae* (18.98) followed byinsecticidal check (16.54) and egg parasitoid + Bt(13.04).

- Bio-intensive pest management in Rice (2017-2019): BIPM practices includes *Pseudomonas flourescens* @ 10 g/kg seed treatment ; spraying *P. flourescens* @ 5 g/L two times from 30-40 days after transplanting against foliar diseases (blast, sheath blight), three release of *T.chilonis* @ 1,00,000/ha for leaf folder and *T. japonicum* @ 1,00,000 /ha/ releasefor stem borer from 25 days after rice transplanting in rice after monitoring the adults in comparison with farmers practice (application of carbofuran granules 3G @ 10 kg/ha, at 30 DAP, two sprayings with chlorpyriphos @ 2.5 ml/L, acephate @ 1.5 g/L and two sprays with propiconazole @ 1ml/L). BIPM technology in rice gave reduction in pest damage i.e., leaf folder damage by 77.04%; stem borer damage by 84.13% and sheath blight incidence by 42.16 % resulted in 12.81% yield increase in BIPM (5.74 t/ha) compared to farmers practice (5.09 t/ha) with net returns of Rs. 17,928 /- per ha and high incremental benefit cost ratio in BIPM (2.36) compared to chemical control (1.57).
- Management of coconut rugose spiralling whitefly using entomopathogenic fungus, *Isaria fumosorosea* NBAIR Pfu-5 (2020-2022): Two spray of *I. fumosorosea* NBAIR Pfu-5 @ 5 g/L + sticker @ 10 ml/Lat 15 day interval and release of *Encarsia guadeloupae* parasitoid gave 70-75% reduction of rugose spiralling whitefly in coconut compared to neem formulation (Azadirachtin 10000ppm) (19-22% pest reduction). Noticed conservation of parasite *E. guadeloupae* and multiplication of *I. fumosorosea* NBAIR Pfu5 in demonstrated coconut orchards and farmers are redistributing *Encarsia* parasite for RSW management.

e) Technologies developed and adopted during the review period:

- Field release of temperature tolerant strain *Trichogramma chilonis* @ 50,000/ha at weekly interval, 8 times from 30 days after planting/ ratooning for early shoot borer and 4 times at node formation against internode borer.
- Bio-efficacy of entomopathogenic fungi, *Metarhizium anisopliae* (NBAIR Ma4) @ 2.5 kg/ ha mixed with 250 kg FYM at planting or onset of monsoon rains two times at monthly interval for white grub management.
- Bio-efficacy of entomopathogenic nematodes NBAII H38 @ 20 kg/ha in 150 kg mixed with moist sand or entomopathogenic fungi, *Metarhizium anisopliae* (NBAIR Ma4) @ 2.5 kg/ ha mixed with 250 kg FYM at planting or onset of monsoon rains two times at monthly interval white grub management.
- Foliar spray with ICAR-NBAIR *Bacillus thuringiensis* (Bt G4 @2 ml/L), 3 times at pre-flowering, flowering and pod formation stages in pigeon pea effectively reduced *Maruca* leaf webber.
- Bio-intensive pest management in rice i.e., seed treatment with *Pseudomonas flourescens* @ 10 g/L; spraying *P. flourescens* @ 5 g/L two times from 30 - 40 days after transplanting against foliar diseases (blast, sheath blight); Field release ofbiocontrol agent, egg parasitoid, *Trichogramma chilonis* @ 50,000/ha, 3 times for

leaf folder and *Trichogramma japonicum* @ 50,000/ha/ release, 3 times for stem borer from 25 days after rice transplanting in rice after monitoring the adults.

- Management of fall armyworm in maize using biocontrol agents and biopesticides i.e., release of *Trichogramma pretiosum* @ 50,000/ha or *T.chilonis* @ 1,00,000/ha from 7 days after seedling emergence, 2 spray of *Bacillus thuringiensis* (NBAIR Bt 25 @ 2 ml/L) or *Metarhizium anisopliae* (NBAIR Ma 35 @ 5 g/L) from 20 days after seedling emergence, 3 times at 10 day interval for the management fall armyworm in maize compared to insecticidal check (Azadirachtin + chlorantraniliprole + emamectin benzoate sprayings).
- Management of coconut rugose spiralling whitefly using *Isaria fumosorosea* and *Encarsia guadeloupae* parasotoid as spraying *I. fumosorosea* (NBAIR- Pfu5) @ 5 g/L with sticker @ 10 ml/L as two sprays + release of parasite, *E. guadeloupae* at 15 days after *I. fumosorosea* first spraying was adapted.

AAU, Anand

Brief achievements:

Surveys, monitoring and biodiversity of fauna

- The activity of biocontrol agents' *viz*., *Trichogramma* spp., *Chrysoperla zastrowi sillemi, Cryptolaemus montrouzieri, Cheilomenes sexmaculatus,* spiders, antagonistic bacteria-Bt, entomopathogenic nematodes (EPN) was recorded in kharif and rabi crops.
- *Trichogramma chilonis* from cotton and castor and *Trichogrammatoidea bactrae* was recorded from cotton fields.
- Total 149 spider were collected from rice ecosystem and represented five families namely Araneidae, Thomisidae, Oxyopidae, Tetragnathidae and Salticidae. *Neoscona theisi* was found dominant followed by *Agriope* sp. in rice.
- Twelve soil samples were found positive for *Beauveria* spp.
- Four new native insect pathogenic isolates have been identified (*Providencia vermicola* AAUBC-Pv1, AAUBC-Pv2, AAUBC-Pv2, *Paenalcaligenes* spp. AAUBC-Pa1)
- Eight soil samples were found positive for EPN. Out of 8 isolates, 7 turned out to be *Steinernema pakistanense* (GenBank accession No. MK491792, MK491793, MK491794, MK491795, MK491796, MK491797, MK491798).
- Six soil samples found positive for EPN and *Metarhizium* spp.
- During the survey of invasive pest *Spodoptera frugiperda* NPV infected larvae were collected. NPV occlusion bodies (OBs) were isolated and pathogenicity of the virus was confirmed.
- The native isolate of *Heterorhabditis indica* – AAU-R strain (Genbank accession no. MW418203) was documented from the soil collected from Talala, SasanGir, Gujarat.
- The egg parasitoids of fall armyworm *viz., Chelonus formosanus* and *Telenomus remus* was documented with Genbank accession No. OM422609 and OM424280, respectively.

- The predator *Mallada* sp. was collected in the coconut orchards infested with invasive rugose spiralling whitefly.
- The nuclear polyhedrosis virus (NPV) infected insect pests were recorded in various crops. The NPV infecting spotted pod borer, *Maruca vitrata* was recorded in cowpea fields of AAU, Anand.
- The intensity of papaya mealybug infestation was very low to medium and the parasitoid *Acerophagus papayae* was noticed parasitizing mealy bug.
- Natural enemy *Nesidiocoris tenuis* was observed predating *Tuta absoluta* in tomato under North Gujarat conditions.
- In the year 2020-21, rugose spiralling whitefly infestation to the tune of 60-70% was noticed in Junagadh, Gujarat.
- The incidence of fall armyworm in maize fields (20-25%, during June, July and August 2021) and invasive thrips, *Thrips parvispinus* in chilli fields (20-30%, January 2022) of Anand district was recorded.

Evaluation and bio-efficacy of biopesticides:

- Biological suppression of mustard aphid, *Lipaphis erysimi* was studied and among the various biocontrol treatments *Beauveria bassiana* + *Lecanicillium lecanii* recorded the low aphid index (1.51) with highest seed yield (4.77q/ha).
- Efficacy of biocontrol agents for management of fruit borer, *Earias vittella* on okra was evaluated. Lowest number of *E. vittella* larvae/plant was recorded in the treatment *Bacillus thuringiensis* @ 5 g/Lamong different biological control agents. The efficacy of biopesticide *B. thuringiensis* was nearly equal to that of chemical insecticide used.
- Biological suppression of fall armyworm in maize was evaluated during 2019-20 and 2020-21. Among the different biocontrol agents tested, significantly lowest number of *S. frugiperda* larvae/ 10 plants was recorded in the treatment *Trichogramma pretiosum* + *Bacillus thuringiensis*-NBAIR BTG1-1% WP and was at par with *T. pretiosum* + *Metarhizium anisopliae* NBAIR Ma35-1% WP and *T. pretiosum* + *Pseudomonas fluorescens* NBAIR P*f* DWD-1% WP.
- Biointensive pest management (BIPM) module for the management of shoot and fruit borer, *Leucinodes orbonalis* in brinjal was developed. The significantly lowest shoot damage was recorded in BIPM module (2.27%) followed by chemical module (3.31%). With regard to the data on fruit damage recorded on number and weight basis depicts the significantly lowest fruit damage in BIPM module (2.50% on number basis, 3.24 % on weight basis) than the fruit damage recorded in chemical module (3.84% on number basis, 4.81% on weight basis). The BIPM module recorded the highest fruit yield of 374.31 q/ha and it was statistically at par with the yield recorded in chemical module (346.78 q/ha). The lowest fruit yield was recorded in untreated control module (85.23 q/ha). Hence, it can be concluded that the BIPM module is effective in reducing the shoot and fruit borer damage with higher fruit yield.
- Influence of habitat manipulation on incidence and severity of pest damage in cabbage was evaluated during 2020-21 and 2021-22. Cabbage intercropped with

mustard and cowpea recorded the lowest aphid population (8.14/ plant). Lower larval population of DBM (1.27/ plant) was recorded in cabbage intercropped with cowpea and oats as border crop. The influence of intercrops in reducing the pest incidence was reflected in yield of the crop. The highest yield of 25.75 q/ha was recorded in the treatment in cabbage intercropped with cowpea and oats as border crop. Hence, intercropping of cabbage with cowpea and oats as border crop helps in reducing the pest incidence with higher yield.

- Efficacy of different biocontrol agents was evaluated against onion thrips, *Thrips tabaci*. Among the different biopesticides evaluated, *Metarhizium anisopliae* AAU strain Ma1 (3.70 thrips/plant) was effective with lowest number of thrips/plant and untreated control treatment recorded the highest thrips population of 15.02 thrips/ plant. The efficacy of biopesticide treatments in reducing the thrips population was depicted in bulb yield of onion. The treatment *M. anisopliae* AAU strain Ma1was found promising in getting higher bulb yield (113.67 q/ha). The untreated control treatment recorded the lowest bulb yield of 45.33 q/ha.
- Bio-efficacy of different bio-agents *Trichoderma harzianum* and *Pseudomonas fluorescens* was tested against the early blight of tomato.The treatment Th+ Pf (SA + RD) + Azoxystrobin 23% SC (FS) found effective in reducing the early blight disease intensity (9.26%). Among the treatments, foliar spray of biopesticides were evaluated as foliar spray i.e Th + Pf (SA + RD + FS) recorded the lowest disease intensity (16.50%). The untreated control treatment recorded the disease intensity of 39.83%.
- Bio-efficacy of different bio-agents *Trichoderma harzianum*a and *Pseudomonas fluorescens* was tested against the early blight of potato. The treatment Th+ Pf (SA +ST) + Kresoxim-methyl 44.3% SC (FS) found effective in reducing the early blight disease intensity (8.52%). Among the treatments where the biopesticides were evaluated as foliar spray, the treatment Th + Pf (SA + ST + FS) recorded the lowest disease intensity (17.17%). The untreated control treatment recorded the disease intensity of 40.60 %.

Brief about each large scale demonstration trials:

- Large scale bio-intensive pest management on rice was taken during 2017-18 to 2019-20. Lowest pest damage was recorded in BIPM package as compared to farmers' practice. With regard to the yield, the two treatments found at par with each other. The use of BIPM strategies resulted in lower incidence of rice leaf folder and higher grain yield. In BIPM package block these corresponding figures were 7.75, 10.62 and 12.62 per cent. Significant grain yield (39.10 q/ha) was recorded in BIPM package as compared to farmers practice (36.43 q/ha). It can be concluded that use of BIPM strategies resulted in lower incidence of rice leaf folder and higher grain yield.
- Bio-intensive pest management in Bt cotton during 2017-18 to 2019 was demonstrated.The number of PBW damaged bolls were 28.88% in BIPM package and 26.23% infested bolls in farmers practice treatment. In case of sucking pests, there was an incidence of thrips and aphid only. Farmers practice package recorded less number of aphid (4.88/leaf) compared to BIPM package (5.86 /leaf). BIPM package

recorded 22.03 q/ha cotton seed which was on par with the yield recorded in farmers practice (23.12 q/ha). With regard to thrips population BIPM package found equally effective as compared to farmers practice.

- Bio-intensive pest management of *Helicoverpa armigera*, *Tuta absoluta* and sucking pestsof tomato was demonstrated during 2017-18 to 2019-20. BIPM package found equally effective as chemical control against *H. armigera*. Similarly, with regard to fruit yield recorded in chemical control module (16.43-16.87 t/ha) was at par with the yield recorded in BIPM package (16.05-16.25 t/ha). It can be concluded that BIPM package is promising in minimizing the pest damage with higher yield.
- Large scale demonstration of bioagents based IPM module for whitegrub in groundnut was demonstrated 2017-18 to 2019-20. Lower incidence of whitegrub was noticed in IPM module (0.39 larva/meter length row) module compared to farmers' practice (1.42 larva/meter length row) and similarly the higher yield in IPM module. It can be concluded that adoption of bioagents based IPM module will be useful for the effective management of whitegrub menace in groundnut crop.
- Large scale demonstration on bio-intensive pest management in okra was demonstrated during 2020-21 to 2021-22. Between the two modules demonstrated for bio-intensive pest management in okra, the lowest larval population was recorded in chemical module (*H. armigera* - 0.86/ plant, *E. vittella* - 2.88/plant) and it was found at par with the population documented in BIPM module (*H. armigera* – 1.21 larvae / plant, *E. vittella* – 3.82/plant). Whereas, the fruit damage was significantly lower in BIPM module (3.08 % - number basis, 3.51 %– weight basis) as compared to chemical module (4.94% - number basis, 4.88 %– weight basis). Sucking pest incidence such as whitefly and jassid was less in BIPM module. The BIPM module recorded the significantly higher yield (136.36 q/ha) as compared to chemical module (111.21 q/ha). The BIPM module has witnessed significantly the highest population of coccinellids (2.60/ plant). This result demonstrates the successful bio-intensive module, which helps in reducing the pest incidence and damage in okra crop with higher fruit yield.
- Large scale demonstration on bio-intensive pest management in cabbage was demonstrated during 2020-21 to 2021-22. Between the two modules demonstrated for bio-intensive pest management in cabbage, the lowest larval population of diamond back moth was recorded in BIPM module (2.09/plant) as compared to chemical module (3.03/plant). With regard to aphid population, the BIPM module recorded significantly lowest population (13.64/plant) than chemical module (17.65/plant). With respect to the population of natural enemies, BIPM module witnessed highest coccinellids population (2.53/ plant) which was significantly higher than the population observed in chemical module (0.69/plant). Further, BIPM module recorded the significantly lowest fruit damage (3.09%) as compared to chemical module (4.41%). Due to significant low fruit damage in BIPM module, highest yield (29.63 t/ha) was recorded and it was statistically at par with the yield documented in chemical module (23.50 t/ha).

- Large scale demonstration on bio-intensive management of mango hopper was demonstrated during 2020-21 to 2021-22. The large-scale demonstration of BIPM module for mango hopper was comprising sole component, microbial biopesticide *Metarhizium anisopliae* was found highly effective in reducing the hopper population. This demonstrate the successful biointensive management of mango hopper with microbial biopesticide *Metarhizium anisopliae* (NBAIR Ma-4) 1% WP.

e) Technologies developed and adopted during the review period:

- The farmers of middle Gujarat (Agro-climatic Zone III) growing okra are advised to spray *Bacillus thuringiensis* (1% WP) @ 50g /10L of wateror NSKE 5% (500g/ 10L water) at fifteen days interval for three times or six releases of *Trichogramma chilonis* @ 50,000/ha at weekly interval starting from the initiation of shoot and fruit borer, *Earias vittella* for the effective biological control (Year: 2019-20)
- Application of *Bacillus thuringiensis* NBAIR strain-BtG4 (1% WP - 2×10^8cfu/g) @ 50g/10 L water or *Bacillus thuringiensis* AAU strain-AAUBt1 (1% WP - 2×10^8cfu/g) @ 50g/10 L for three times at ten days interval with the initiation of the pest found effective for the management of fall armyworm in maize (Year: 2020-21).
- Three releases of *Trichogramma pretiosum* @ 20000/acre at weekly interval followed by the spray of *Bacillus thuringiensis* NBAIR BtG4 1% WP @ 50 g/ 10 Lfor three times at ten days interval with the initiation of pest found effective for the management of fall armyworm in maize (Year: 2021-22)

AAU, Jorhat

Brief achievements:

a) Surveys, monitoring and biodiversity of fauna:

- Total 16 species of spiders were recorded from 8 different families' *viz*. Tetragnathidae, Lycosidae, Araneae, Oxyopidae, Araneidae, Salticidae, Attidae and Linyphidae. Collected species of spiders were *Tetragnatha javana*, *Tetragnatha bengalensis*, *Tetragnatha maxillosa, Lycosa pseudoannulata*, *Pardosa sumatra*, *Oxyopes shweata*, *Oxyopes javanus*, *Cyclosa insulate*, *Argiope pulchella*, *Argiope catenulate, Araneus* sp., *Neoscona bengalensis, Phidippus indicus, Plexippus* sp, *Atypena (=calitricha) formosan*) collected from different rice fields of Jorhat, Golaghat and Sivasagar districts.
- Among which *Lycosa pseudoannulata*, *Oxopes javanus* and *Tetragnatha* spp. were most dominant.
- The dominance of egg parasitoids were *Trichogramm*a sp. and *Telenomous* sp (9.9% parasitism) and *Cotesia* sp. with 15.8% parasitization in leaf folder larvae was recorded.
- Nine species of predator viz., *Spalgius epius*, Chysopids, *Coccinella septempunctata*, *C. transversalis*, *Serangium parcesetosum*, *Harmonia dimidiata*, *Cheilomenes sexmaculat*, *Brumoides saturalis* and *Cryptolaemus* sp. were recorded from different vegetables.

- Parasitoids *viz.*, *Cotesia glomerata* parasitizing larvae of *Piresis barassicae*, *Campoletis chlorideae* (larval), *Trichogramma chilonis*, *Bracon* spp. Parasitizing *Helicoverpa armigera*.
- *Diaeretiella* sp. from aphid, *Encarsia* sp.from whitefly and *Phanerotoma* sp. as a larval parasitoid from brinjal pest were also recorded.

b) Biological suppression

- Seasonal abundance of spiders in rice ecosystem was evaluated. Total 650 spiders were collected using visual, sweep net and pitfall traps. In total of 16 species collected from rice ecosystem. Relative abundance of *Oxyopes* spp. was 35.76% and was the most predominant species followed by *Lycosa pseudoannulata* (28.45%) and *Tetragnatha* spp. (22.76%), respectively.
- Biological suppression of rugosespiraling whitefly (RSW), *Aleurodicus rugioperculatus* in coconut was evaluated during 2020-22. The parasitism of *Encarsia* sp. on whitefly was ranged between 14 to 27%. The live colonies of whitefly was varied from 1.20 to 4.22 and 1.00 to 3.23 per leaflets, respectively at HRS, Guwahati and AAU, Jorhat) of study. In addition, the activity of predators such as spider, coccinalids and lacewing were also recoded.
- Bio-intensive insect management in brinjalwas carried out andduring 2017-18 to 2019-20. Based on 3 years experiment, MLT and OFT results the technology was included in AAU PoP as application of azadirachtin 1500 ppm @ 2 ml/L of water, *Lecanicillium lecanii* @ 1×10^8 spores/ml (5g/L of water) with eight releases of *Trichogramma chilonis* (MITs) @ 1,00,000 adults/ ha at weekly interval starting from initiation of flowering was found effective in controlling pests of brinjal.
- Role of habitat manipulation for insect pests, nematodes and natural enemies in brinjal was evaluated during 2017-18 to 2019-20. The incidence of sucking pest (aphids/ leaf) and *Leucinodes orbonalis* was significantly lower in brinjal intercropped with carrot and cowpea as border crop with least population of aphid (0.86/leaf) and per cent shoot (9.19) and fruit (12.94) infestation and maximum yield of 201.87 q/ha as compared to brinjal as sole crop, brinjal intercropped with cowpea and coriander as border crop and brinjal intercropped with coriander and carrot as border crop. Significantly, higher number of coccinellids predator population of 2.92 / plant was also recorded in brinjal intercropped with carrot and cowpea as border crop.
- The biointensive IPM module was evaluated against key pest so okra (2020-21 to 2021-22). The pooled data revealed that the six chemical sprays at intervals contributed maximum protection from infestation with lower larval infestation (1.65) and fruit damage (7.30%) as against 2.00 and 8.10%, respectively, in BIPM practice. However, highest marketable fruit yield of 76.12 q/ha was recorded in BIPM practice, whereas in chemical control yield was 68.92 q/ha. The percent parasitism on *Corcyra* sentinel cards by *Trichogramma* spp. in BIPM plot was 8.4% as against 2.25% in chemical control plot.
- BIPM module was evaluated against fruit flies *Bactrocera dorsalis* in cucumber during 2020-21 to 2021-22. From the pool data of 2 years, it was found that BIPM package revealed minimum percent damaged fruits (16.27%) and was lower than

chemical control (27.67%) at 65 days after sowing (DAS). The marketable fruit yield was 85.67 q/ha in BIPM package in comparison to conventional package (58.87 q/ha). The maximum percent damaged fruits (34.74 %) was recorded in untreated control plot with minimum yield of 45.51 q/ha.

Evaluation and bioefficacy of biopesticides

- Bio-efficacy of entomopathogenic fungus was evaluated against mustard aphid during 2017-18 and 2019-20. Three spraying of entomopathogenic fungus, *Beauveria bassiana* (AAU-J culture) @ 5g/L was the most effective treatment against mustard aphid (8.72% per 10 cm apical shoot) with 66.13% population reduction after 3rd spray and produce yield 7.85 q/ha and was at par with *Lecanicillium lecanii* (AAU-J culture) @ 5g/L in their efficacy. The mean population ofaphid in *L. lecanii* was 10.05% per 10 cm of apical shootwith 58.38% population reduction and yield 7.83 q/ha in comparison to *Metarhizium anisopliae* (AAU-J Culture)10^8 @ 5g/L and azadirachtin 1500 ppm @ 2 ml/L.
- Bio-efficacy of entomopathogens against banana fruit and leaf scaring beetles, *Nodostoma subcostatum*. Four time filling of leaf axil with *Beauveria bassiana* (AAU Culture) @ 10^8 spore /5 ml at 15 days interval showed maximum reduction (47.24%) over control.
- Field evaluation of ICAR-NBAIR entomopathogenic strains was carried against cabbage aphid, *Myzus persicae* and dimond back moth, *Plutella xylostella* (DBM) during 2019-20 to 2021-22. The pool data of 3 years found that four alternate spraying of chemical insecticide at 15 days interval could significantly reduce the mean population of *B. brassicae* and *P. xylostella* in cabbage in comparison to different biopesticides and gave a maximum yield of 206.50 q/ha. Among the different EPF, V1-8 isolate of *L. lecanii* @ 5 ml/L was the best treatment in reducing the mean population of aphid (3.17/plant) and DBM(4.74/plant), with highest yield of 205.25q/ha.
- Evaluation of entomopathogenic biopesticide was carried against *Aphis craccivora* in cowpea (*Vigna unguiculata*) during 2020-21 to 2021-22.The minimum number of *A. craccivora* was recorded in the field treated with *Verticilium lecanii* 1×10^8 cfu/ml @ 5gm/L which was at par with spinosad 45 SC @ 0.3 ml/L with maximum yield.
- Evaluation of microbial antagonist was carried out for the management of ginger rot disease. The highest per cent germination (84.25) and highest number of tillers per plant (20.33) were recorded in seed treatment with *Pseudomonas fluorescens* + spraying of *Trichoderma harzianum* (commercial formulation). The percent disease infested plants was 14.67% with yield of 18.00 t/ha. However, it was observed that all the biopesticides were equally effective in rhizome germination and producing tillers per plant compared to untreated control, where the germination per cent was only 61.67 with 11.33 nos. tillers/plant.

Large-scale demonstration trials

- Large scale demonstration trials for proven bio control technologies was adapted in 10 ha area during 2017-18 to 2021-22. The large scale demonstration included biocontrol technologies like seedling root dip treatment with *Pseudomonus fluorescens* (2%

solution), two sprays of azadirachtin 1500 ppm (3 ml/litre), erection of bird perches (15 no. /ha), spray of *P. fluorescens* (1.5 kg/ha) against foliar diseases and six release of *T. japonicum* @ 1,00,000 /ha at ten days interval starting from 30 DAT against *Scirpophaga* spp. and *Cnaphalocrocis* spp in comparison to chemical control (farmer practice) four alternate spray with chlorpyrifos @ (2.5ml/L) and quinalphos (2.5ml/L). Result revealed the large scale BIPM is equally effective as chemical control in terms of yield and benefit cost ratio. Adoption of BIPM increased the population of spider, coccinellids as compared tochemical control.

- Validation of BIPM practices against pest complex of organic Black rice was carried in *kharif* 2020 in an area of 1 ha at Jorhat. The BIPM practices included seedlings root dip with *Pseudomonas fluorescens* (2% solution), application of organic manure MUKTA 2t/ha, *B. bassiana* (10^{13}spores/ha) against sucking pests and release of six release of *T. japonicum* (100000 adults/ha) and bird perch (10/ha) for borer pests and need based application of NSKE (5%) (5 ml/L). Farmer practice included two rounds of Chlorantraniliprole 18.5 SC were sprayed against insect pests of rice. Results revealed that the incidence of dead heart and white ear head and leaf folder were lower in both BIPM and farmers practice field. However the grain yield was more in BIPM (3.13 ton/ha) than in farmers practice plots (2.88 ton/ha).
- Demonstration of BIPM module was carried out against fall armyworm, *Spodoptera furgiperda* on *Rabi* maize. Results revealed the larval count of *S. frugiperda* was 1.42 larvae/plant as compared to chemical sprayed farmer practice (1.58 larvae/plant). In BIPM plot plant damage was significantly lower (15.93%) after application of treatment as against farmers practice plot (23.84%) and highest yield of 42.95 q/ha was recorded in BIPM which was significantly higher than farmers practice with 35.12 q/ha.

Technologies developed and adopted during the review period:

- Three spraying of entomopathogenic fungus, *Beauveria bassiana* (AAU-J culture) @ 5g/L was the most effective treatment against mustard aphid which was statistically at par with *Lecanicillium lecanii* (AAU-J culture) @ 5g/L in their efficacy in respect of mean population ofaphid and yield in comparison to *Metarhizium anisopliae* (AAU-J Culture) 10^8 @ 5g/L and Azadirachtin 1500 ppm @ 2 ml/L.
- The incidence of sucking pest (aphids/ leaf) and *Leucinodes orbonalis* was significantly lower in brinjal intercropped with Carrot and Cowpea as border crop and gave maximum yield compared to brinjal as sole crop, brinjal intercropped with Cowpea and Coriander asborder crop and brinjal intercropped with Coriander and Carrot as border crop. Significantly, higher number of coccinellids predator population was also recorded in brinjal intercropped with Carrot and Cowpea as border crop.
- **BIPM on rice:** Six release of egg parasitoids *Trichogramma* spp. @ 50,000/ha (six releases) on observing the moths of yellow stem borer and application of *Beauveria bassiana* impregnated Rice Husk Saw Dust Rice Bran (RHSDRB) medium @ 3kg/ha in 600 litres of water (10^7 spores/ml) included in package of practices for *Kharif* Crops of Assam, 2019.

- Management of papaya mealybug (*Paracoccus marginatus*) was developed and included in PoP of Horticultural crop, 2021, AAU, Jorhat). Removal of weeds/ alternate hosts like *Hibiscus* sp. and application ofsticky bands or alkathene sheet on main stem of the plant to prevent up ward movement of crawlers. Prevention of the movement of ants with destruction of already existing ant colonies in the vicinity, conservation of natural enemies like *Coccinella septumpunctata, Coccinella transversalis, Cheilomenes sexmaculata* and *Spalgisepius*, release of *Acerophagous papaya* (Hymenoptera: Encyrtidae) @ 500-1,000/ha for three times at weekly interval.Chemical: spot spraying of neemoil (1 to 2%) 500 ppm @ 5ml/L, or 1000ppm @ 3ml/L or 1500ppm @ 1ml/L, NSKE (5%), profenophos 50EC(2 ml/L),thiamethoxam 25 WG (26g ai/ha) andimidacloprid 17.8SL(1ml/3L).
- Biointensive IPM against shoot and fruit borer of brinjal was developed using inputs of azadirachtin1500 ppm@ 2 ml/L, *Lecanicillium lecanii* @ 1×10^8 spores/ml (5 g/L) and eight releases of *Trichogramma chilonis* (MITs) @ 100000 ha at weekly interval starting from initiation of flowering and this input included in PoP Horticultural crop, 2021, AAU, Jorhat.
- Organic plant protection techniques in okra: Use of pheromone traps for *Helicoverpa armigera* (Heli lure), *Spodoptera litura* (*Spodo* lure) and *E. earias* (*Earias* lure) @ 5/ha, Use of yellow sticky traps for whitefly and thrips @ 10 traps/ha. Six releases of *T. chilonis* or *T. priteosum* @ 100000 adults/ ha against *H. armigera* at weekly interval need based application of neem oil 500 ppm @ 5 ml /L as an alternative to chemical insecticides at an interval of 15 days. Seed treatment with Org-Pochojal (aliquid bioformulation of *Pochonia chlamydosporia*, AAU product) @ 5 ml/L enriched compost @ 2 t/ha for root knot nematode. Seed treatment with *Bacillus megaterium* @ 5 ml/L + soil application of 2 ton of vermicompost enriched with 5 liter of *B. megatorium/*ha also reduces the infestation of root knotnematode. This PoP practices included in organic agriculture, 2021, AAU, Jorhat.
- Plant protection techniques in organic cabbage:Use of pheromone trap with lures are for pests liked *Plutella xylostella*; *Pieris* spp.; *Helicoverpa armigera* (Heli lure); *Spodoptera litura* (Spodolure) etc (8 traps/ha) with luresfor each pest, keep the distance of 1200 square meters between the traps (ETL for *H. armigera*is 8 to10 moths perday/trap), bird perches @ 50/ha, yellow sticky tarps for thrips and whitefly (10 traps/ha), mustard as a trap crop after 25 cabbage rows 15 days prior to sowing, six release of *T.chilonis, T. pretiosum* at 1,00,000/ha with weekly interval for controlling DBM and other lepidopteran pests. Need based application of neem based insecticides/neem oil 500 ppm @ 5 ml /L as an alternative to chemical insecticides at an interval of 15 days.Treatment of the seeds with *Trichoderma harzianum* based bioformulation like Org-Trichojal@ 5 g/L + CMC @ 0.02% for 1 hour followed by shade dry for 2 hour prior to sowing can reduce the soil borne disease like damping off.

YSPUHF, Solan

Brief achievements:

Surveys, monitoring and biodiversity of fauna:

- A total of 25 coccinellid beetles *viz. Coccinella septempunctata, Hippodamia varigieta, Adaliate traspilota, Cheilomenes sexmaculata, Propylealutiop ustulata, Chilocorus infernalis, Prisci brumus uropygialis, Platynaspis saundersii, Harmonia eucharis, Oenopea sauzetii, Oenopia conglobata, Oenopia kirbyi, Oenopia sexareata, Oenopia billieti, Halyzia sanscrita, Illeis* sp nr *confusa, Scymnus nubilus, Scymnus posticalis, Coelophora Bissell auta, Harmonia dimidiata, Harmonia eucharis, Megalocaria dilatata* and *Oenopia souzeti* have been recorded from different agro-ecological zones of Himachal Pradesh.
- Among these, *Oenopia billieti,* and *Halyzia sanscrita* were the new additions to the previously reported list of coccinellids in Himachal Pradesh.
- A total of eight syrphid flies viz. *Episyrphus balteatus, Eupeodes frequens, Melanostoma univitatum, Betasyrphus serarius, Sphaerophoria indiana, Ischiodon scutellaris, Metasyrphus corollae* and *Scaeva pyrastri* were collected from different flowering plants in the state.
- *Chrysoperla zastrowi sillemi* was recorded preying on aphids and whiteflies on apple, peach, okra and cucumber at different locations of the state.
- *Dinocalpus coccinellae* and *Pediobius foveolatus* were collected as parasitoids of *Coccinella septempunctata* and *Megalocaria dilatata* at Nauni.
- *Diadegma semiclausum* and *Diadromus collaris* were recorded as larval and pupal parasitoids of *Plutella xylostella,* infesting cauliflower and cabbage.
- *Orius* sp. and *Anthocoris* sp. were collected from peaches infested with leaf curl aphid and thrips.
- A mirid predatory bug, *Nesidiocoris tenuis* was recorded preying on eggs and early instars of the leaf miner, *Tuta absoluta*.

b) Biological suppression

- Evaluation of *Trichogramma* spp. against apple fruit moth, *Argyresthia conjugella* was carried out in under laboratory conditions during 2017 to 2019. *Trichogramma embryophagum* resulted maximum parasitism (26.6%) followed by *T. chilonis* (17.7%), *T. pretiosum* (12.2%) and *T. achaeae* (11.1%) in after second year of study. Adult emergence from the parasitized host eggs was 90.9, 72.7, 87.5 and 85% for *T. achaeae, T. pretiosum, T. chilonis* and *T. embryophagum*, respectively, of which 50, 100, 56.3 and 65% per cent were the females.
- Bio-intensive management of *Helicoverpa armigera, Tuta absoluta* and sucking pests of tomato were evaluated during 2017-18 to 2019-20. The obtained yield in BIPM were for three years were 28.5t/ha, 22t/ha and 26.1t/ha and was at par with chemical treatment (31t/ha, 21. 3t/ha and 24.9t/ha).
- Biocontrol agents for the control of sucking pests in capsicum under polyhouse was evaluated from 2017-18 to 2019-20. Among biocontrol agents, *Chrysoperla zastrowi sillemi* (4 larvae / plant) resulted highest (80.6%) reduction in the aphid population which was on par with azadirachtin (2ml/L of 1500ppm) and imidacloprid (0.5ml/L)

(90.3%) in all the three years of study. Bioagents like *Lecanicillium lecanii* (5g/l of 10^8 conidia/ g) (73%) and azadirachtin (2ml/L of 1500ppm) (68%) were also on par with *Chrysoperla zastrowi sillemi* (4 larvae / plant), but could not match imidacloprid (0.5ml/L) in their efficacy against the pest. Other biocontrol agents resulted 54.3 to 58 per cent reduction in the aphid population over control, 10 days after the second spray/ release.

- Management of phytophagous mites on cucumber using *Blaptostethus pallescens* and *Neoseiulus longispinosus* under polyhouse condition was evaluated during 2020-21 and 2021-22. The highest yield (6.8kg/plant) was recorded in plants treated with spiromesifen (100g a.i./ha) followed by *N. longispinosus* (1:20), *N. longispinosus* (1:30), *B. pallescens* (20nymphs/m row) and *B. pallescens* (10nymphs/m row) as compared to untreated control (2 kg/plant)

c) Evaluation and bio efficacy of biopesticides:

- Efficacy of biocontrol agents were evaluated against leopard moth, *Zeuzera multistrigata* in apple during 2019-20 to 2021-22. Among different biocontrol agents, *Heterorhabditis bacteriophora* (5000IJs/gallery) was the most effective resulting (60.0-77.8%) mortality followed by *Steinernemma feltiae* (5000IJs/gallery) and azadirachtin (2ml/L of 1500ppm; 10ml/gallery).
- Efficacy of biocontrol formulations were evaluated for the management of *Fusarium* wilt/ root rot of pea through biological control agents. Seed treatment with *T. asperellum* formulation @ 10g/kg seed + soil application of *T. asperellum* formulation after mixing with FYM (10g/kg FYM) @40g/m^2 could be an ecofriendly option for the management of *Fusarium* wilt/ root rot of pea.

d) Brief about each large scale demonstration trials:

- Large scale demonstration for the management of apple root borer using *Metarhizium anisopliae* was conducted during 2017-18 to 2020-21. *Metarhizium anisopliae* (10^8 conidia/g) applied @ 30g/ tree basin mixed in well rotten farm yard manure (FYM) and resulted 62.1 to 82.2% mortality of the apple root borer grubs, while chlorpyriphos applied @ 0.06% resulted mortality between 76.4-88.6% of apple root borer grubs during field trials.
- Demonstration on bio-intensive management of insect pests of tomato was carried during 2020-21 to 2021-22. The number of mines caused by *Tuta absoluta* were statistically on par with chemical plots and varied from 0.24 to0.37 mines/leaf. The fruit infestation in the two plots remained almost same throughout the season and varied from 2.33 to 3.67% in BIPM plots and 1.67 to 4.0% in chemical plots. The yield recorded in BIPM plots (31.3-33.8t/ha) was also statistically on par with that recorded in chemical treated plots (29.4-31.9.t/ha).

e) Technologies developed and adopted during the review period:

- Application of *Metarhizium anisopliae* (10^8 conidia/g) @ 30g/ tree basin mixed in well rotten farm yard manure (FYM) was found effective for the management of apple root borer, *Dorysthenes hugelii*.
- Bio-intensive Integrated Pest Management (BIPM) module comprised of pheromone trap (PCI) along with marigold as trap crop, six releases of *Trichogramma achaeae*

@ 50000/ha, two sprays of azadirachtin 1500ppm @ 2ml/L and one spray of *Lecanicillium lecanii* (5g/L of 10^8 conidia/g) was found effective for the management of insect-pests of tomato.

- Two releases of *Chrysoperla zastrowi sillemi* (4 larvae / plant) was found effective for the management of sucking insect-pests of capsicum under poly house conditions.
- Release of predatory mite, *Neoseiulus longispinosus* @ (1:20) (predator: prey) was found effective for the management of phytophagous mite, *Tetranychus urticae* infesting cucumber under polyhouse conditions.
- Application of *Heterorhabditis bacteriophora* @ 5000 IJs/gallery was found most effective for the management of leopard moth, *Zeuzera multistrigata* infesting apple.
- Seed treatment with *Trichoderma asperellum* formulation @ 10g/kg seed+ soil application of *T. asperellum* formulation after mixing with FYM (10g/Kg FYM) @ 40g/m^2 provided significantly better control of *Fusarium* wilt of pea.

NRRI, Cuttack

Brief achievements:

a) Biological Suppression

- Potential of beetle, *Altica* sp. nr. *caerulea* (olivier) (Chrysomelidae: Galerucinae) for bio-supression of *Ludwigia adscendens* (Onagraceae) was tested.

b) Evaluation and bio efficacy of Biopesticides:

- Field evaluation of ICAR-NBAIR entomopathogenic strains against rice stem borer *Scirpophaga incertulas*, leaf folder, *Cnaphalocrocis medinalis*, brown planthopper (*Nilaparvata lugens*) was carried out.
- Field evaluation of ICAR-NBAIR strains against rice blast (*Magnaporthe oryzae*), brown spot (*Bipolaris oryzae*) and sheath blight (*Rhizoctonia solani*) was carried out.
- Three bioagents *viz*., BS-5 (*Bacillus amyloliquefaciens*), BS-6 (*Bacillus subtilis*), BS-39 (*Bacillus cereus*) were identified effective against rice diseases.

c) Technologies developed and adopted during the review period:

- Insecticide induced hormesis for improved parasitoids
- Externally funded project by RKVY-Odisha entitled "Bio-Bank: Production and promotion of biocontrol agents and entrepreneurship development in aspirational districts of Odisha" was run in the institute.

KAU, Thrissur

a) Brief achievements

Surveys, monitoring and biodiversity of fauna

- A total of 1003 spiders' specimens were collected rice field during the period from 2017-2020 using pit fall traps and sweep nets. Two species of spiders *viz*., *Pardosa pseudoannulata* and *P. irriensis* were collected consistently the former accounted for nearly 99% of the catch.
- Rugose spirallng whitefly on coconut was parasitized by the hymenoptean parasitoid, *Encarsia guadeloupe* and caused up to 90% natural parasitism.

- Surveyed for prevalence of cassava mealybug in > 150 locations at Thrissur and Palakkad districts from 2020-2022. Four mealybug species *viz.*, *Paracoccus marginatus* (36.72%), *Ferrisia virgata* (29.69%), *Phenacoccus manihoti* (28.90%) and *Pseudococcus jackbeardsleyi* (4.69 %) infested the cassava plants simultaneously, forming a complex.
- Entomopathogenic fungi, *viz*., *Lecanicillium araneicola, Simplicillium* sp., *Lecancillium psalliote* and *Purpureocillium lilacinum* were isolated from the mummified cadavers of mealybug.
- Theoutbreak reported was that of the giant African snail (*Achatina fulica*) was observed in Thrissur during 2017-18.
- Localised incidences of brown plant hopper infestation in rice were reported from Palghat district in late stages of the crop during 2017-18.
- Co-existence of bondar's nesting whitefly, *Paraleurodes bondari* with rugose whitefly was reported from coconut in Thrissur.
- Invasive pests like wax scale (*Ceroplastes cirripediformis*), hard scale (*C. ceriferus*), *Pseudococcus jackbeardsleyi* on glyicidia and *Rastrococcus iceryoides* on *Triumfetta rhomboidea* were reported from Thrissur. T
- Two species of mealybugs were noticed in coconut and one of them was identified as *Pseudococcus longispinus.*

Biological Suppression

- Both *spiromesifen* and release of *B. pallescens* @ 20 m/ row plots were effective in causing a consistent reduction in the mite population indicating the potential of the predator to be a safer alternative to synthetic acaricides in managing spider mites in cucumber under polyhouse conditions. *B. pallescens* released @ 20 /m row recorded the highest mean yield of 2.73 kg per plant, followed by acaricide treated plot at 2.70 kg/plant, both being on par with each other.

Evaluation and bio efficacy of biopesticides:

- Management of rice stem borer and leaf-folder using entomopathogens was evaluated. Among the bioagents evaluated, *Bacillus thuringiensis Beauveria bassiana* and, *H. indica* respectively, with 1.5, 1.83 and 3.17 dead hearts/m^2 were on par with the insecticide flubendiamide (2.67 dead hearts/m^2)14 days after third spray and could be viable alternatives to flubendiamide for the management of stem borer in rice. The nematode *Steinernema carpocapse* as well as the EPF *Metarrhizum anisopliae* recorded mean values of 1.33 and 1.63 rolled leaves/m^2 28 days after third spray and were on par with the insecticide (0.83 rolled leaves/m^2).
- Evaluation of entomopathogenic fungi against pod bug *Riptortus pedestris* on cowpea was carried out and *Beauveria bassiana* registered significantly lower mean pod damage of 26.75% as against 36.33% in untreated control and was on par with the insecticide malathion, recording men pod damage of 27.14%.

Brief about each large scale demonstration trials:

- Large scale validation of BIPM in rice was carried out over an area of 840 ha in Palakkad and Thrissur districts during the period. Adoption of BIPM practices led to substantial reduction in infestation by major pests. The mean infestation by stem borer

and leaf folder in BIPM plots was 65 and 38% as compared to non BIPM plots. The rice bug population was 46% lower in BIPM plots. Similarly, incidence of bacterial leaf blight was mild in BIPM plots. The population of natural enemies was higher in BIPM plots. The yield obtained from IPM plots was 23% more than that obtained from non IPM plots. The cost of cultivation was 6% lower in the former. The increased yield as well as reduced cost resulted in an increase in profit by Rs.46705/ha. The cost benefit ratio, at 2.18 was almost double for IPM fields as compared to 1.40 for non IPM fields.

- The effectiveness of BIPM against brinjal shoot and fruit borer and mealybug was investigated in comparison with farmers' practice and untreated check. Fruit infestation by borer was lower in plots where insecticides were applied (31.51%), followed by BIPM plots (40.05 %). The economic yield was recorded as 57.0 and 42.73 q/ha, respectively for BIPM and chemical plots, which were on par. Significant reduction in yield was recorded in untreated plots, where the mean economic yield was 20.99 q/ha. Cumulative values for mealybug infestation was low in chemical treated plot (2.76 no.) as well as BIPM plots (8.77 no.), as compared to untreated control (20.60 no.). The cost: benefit ratio of BIPM module (1:1.96) was more than that of farmers' practice (1:1.25). The studies indicated that the BIPM package could be a viable alternative to chemical methods against insect pests in brinjal.

Technologies developed and adopted during the review period:

- A local isolate of the entomopthogenic fungus *Beauveria bassiana* from rice bug was isolated. The characterisation and evaluation for efficacy (lab, pot and field studies) against rice bug, *Leptocorisa* spp. was carried out. GenBank accession number was obtained for the isolate (MN062722). Aqueous and oil based formulations were developed and shelf life studies completed. Registration with CIBRC is in progress. The EPF is being distributed to farmers in Thrissur and Palakkad districts for application against rice bug.
- Entomopathogenic fungi, *viz., Lecanicillium araneicola, Simplicillium* sp., *Purpueocillium lilacinum* and *Lecanicillium psalliote* were isolated from the mummified cadavers of mealybugs on cassava. Characterisation and bioefficacy studies of these isolates are in the progress.

IGKV, Raipur

Brief Achievements:

a) Surveys, monitoring and biodiversity of fauna

- Four species of Coccinellid beetles *viz. Henosepilachna vigintiotopunctata, Menochilus sexmaculatus, Coccinella transversalis* and *Illeiscincta* was recorded in different crops during the year 2019 – 20.
- Four species of reduviid bugs viz., *Rhynocoris fuscipes, Coranus* sp., *Scadra* sp. and *Acanthaspis siva* was recorded from Raipur during 2019 – 20.
- Production and mass rearing of biocontrol agents namely *viz., Trichogramma, Bracon,* Reduviid bug, *Zygogramma* beetle and coccinellid beetle.

Biological Suppression

- Testing of two BIPM modules for management of *Helicoverpa armigera* on chickpea, during the year 2021 – 22

Brief about each large scale demonstration trials:

- Large scale testing of BIPM trial on paddy with control trail was conducted during the year (2020-21). Maximum grain yield was observed on BIPM felled by farmer's practice and contract.

Technologies developed and adopted during the review period:

- Tricho-cards production techniques.
- Braco-cards production techniques.
- Production of Coccinellid beetle and *Zygogramma* beetle.

UAHS, Shimoga

Brief achievements:

Evaluation and bio efficacy of biopesticides

- Two releases of *Encarsia guadeloupae* @ 600 adults per acre at 15 days interval found to be effective in management of Rugose Spiraling Whitefly in coconut.
- The consortia application of *P. lilacinum* + *P. fluorescens* + *T. harzianum* @ 1×10^8 Cfu/g- 10g each/plant multiplied in 3kg of FYM three times per year helps in maximum reduction of root knot nematode population in guava so it can be effectively used for the management of PPN in guava.
- Among the different botanicals tested neem seed karnal extract (NSKE) showed significant decrease in brinjal fruit borer compare to other treatments in organic pest management of brinjal.
- Biocontrol agents were evaluated against pod borers in red gram and found significantly lowest number of *H.* armigera larvae/plant in the treatment *Bacillus thuringiensis* (NBAIR BtG4 2%) @ 10ml/L.The efficacy of biopesticide *B. thuringiensis* was nearly equal to that of chemical insecticide (Chlorantraniliprole 18.5% SC@ 0.4 ml/L).

b) Brief about each large scale demonstration trials:

- Large scale demonstrations using EPN *Heterorhabditis indica* (NBAIR culture) and *Metarihizium anisopliae* was used for the management of root grubs in Arecanut. Lowest number of root grubs was recorded in the *H. indica* treated plants and was on par with the *M. anisopliae* treated plants and chemical treatment.
- Large scale demonstrations of *Trichoderma harzianum, Bacillus subtilis,* and *Pseudomonas fluorescens* for the management of soft rot of ginger was conducted in 50 acres of farmer fields of malnad and region of Karnataka. The consortia application of *T. harzianum, B. subtilis* and *P. fluorescens* @ 4 kg/ha each recorded lower disease incidence in ginger.

XXVI. Human resource development efforts

S. No	Centres	Training programme and name of the officer	Organised/ Conducted by	Duration	Training outcome
1.	**Dr.YSRHU-HRS**	Agriculture Skill Council of India (ASCI) and Dr. NBV Chalapathi Rao	Agriculture Skill Council of India (ASCI)	27-12-2020 1 day	Job roles and Master Trainers for Training of Master Trainers
		ICAR sponsored winter school training – Smt. B. Neeraja	ICAR-NBAIR, Bengaluru	03-12-2019 to 23-12-2019 21 days	Learnt techniques in mass multiplication of biocontrol agents, field evaluation and molecular techniques
		Executive development programme on leadership development	ICAR – NAARM, Hyderabad	27-11-2021 to 02-12-2021 (5 days)	Methods of teaching skills, writing projects on Research
		ICAR – NAARM Training Programme (FDP) – Smt. B. Neeraja	ICAR – NAARM, Hyderabad	15-03-2022 to 19-03-2022 (5 days)	Methods of teaching skills, writing projects on Research
		ICAR-IISR, Kozhikode, Kerala sponsored short course on Phytophthora- Smt. B. Neeraja	ICAR-IISR, Kozhikode	02-03-2022 to 11-03-2022 (10days)	*Phytophthora* from isolation to functional geneomics methods
		AgMOOCS- Statistical techniques for Agriculturists - Smt. B. Neeraja	IIT- Kanpur	26-07-2022 6 weeks	Learnt about the various statistical techniques used in Research
2.	**GBPUA&T**	Coordinated Certificate Course on the topic: Mass Production of Important Bio-control Agents.	National Agriculture Higher Education Project(NAHEP) GBPUA&T, Pantnagar	03 months	Training is imparted every year for entrepreneurship development
		Innovative Approaches in	Center of Advance	02 days	Strengthen the

		delivery of microbial antagonists for bio control of plant diseases.	faculty training (CAFT) GBPUA&T Pantnagar		knowledge of scientist
		Methods of Isolation, Quantification and Screening Techniques for Selection of Effective *Trichoderma* Isolates.	Center of Advance faculty training (CAFT) GBPUA&T Pantnagar	02 day	Strengthen the knowledge of scientist
		Mass Production of Bio-control agents and their Applications.	Center of Advance faculty training (CAFT) GBPUA & T Pantnagar	01 day	Strengthen the knowledge of scientist
		Advanced technology in delivery of microbial antagonists for bio control of plant diseases	Center of Advance faculty training (CAFT)GBPUA & T Pantnagar	03 day	Strengthen the knowledge of scientist
		Mass Production of *Trichoderma* and *Pseudomonas*.	Center of Advance faculty training (CAFT)GBPUA & T Pantnagar	03 day	Strengthen the knowledge of scientist
		Isolation and Characterization of *Trichoderma*: A Biocontrol Agent.		03 day	Strengthen the knowledge of scientist
		Mass production, Formulations and Quality assessment of *Trichoderma* spp. and *Pseudomonas fluorescens*.	Center of Advance faculty training (CAFT) GBPUA&T Pantnagar	03 day	Strengthen the knowledge of scientist
		Methods of Screening of Biocontrol Agents against Fungal Pathogens	Center of Advance faculty training (CAFT) GBPUA & T Pantnagar	03 day	Strengthen the knowledge of scientist
		Mass Production of Biocontrol Agents.	Center of Advance faculty training	02 day	Strengthen the knowledge of

			(CAFT)GBPUA & T Pantnagar		scientist
		Methods of Screening of Biocontrol Agents against Fungal Pathogens.	Center of Advance faculty training (CAFT)GBPUA & T Pantnagar	02 day	Strengthen the knowledge of scientist
		Participated in 70th Annual Meeting & National Symposium on Plant Health Management: Embracing Eco-Sustainable Paradigm. Organized by Indian Phytopathological Society, New Delhi.	Assam Agriculture University, Jorhat.	03 day	Presented research paper
		Participated workshop/training on "Nematode problems of Horticultural Crops and their Management". Organized by ICAR-IARI, New Delhi and GBPUA&T, Pantnagar.	GBPUA&T, Pantnagar	01 day	Strengthen the knowledge in the field of Nematology
		Participated in International Conference on Biological Control: Approaches and Applications. ICAR-NBAIR, Society of Biological Advancement.	Bengaluru, India.	03 day	Presented research paper and received award
		Participated in the International Conference on "Innovative Horticulture and Value Chain Management",	GBPUA&T, Pantnagar	04 day	Presented research paper and received award
		Participated in 28th AICRP Bio-control workshop.	AAU, Anand Gujarat	03day	Presented progress report of AICRP Biological control and formulated technical

					programme for next year.
		Attended workshop cum training programme on Suraksha Sankalp- Protect Farmers from Fall armyworm.	GBPUA&T, Pantnagar	01 day	Updated Knowledge
		Attended workshop on "Vrikshayurveda and Traditional Practices in Uttarakhand State: Present Status and Future Potential".	GBPUA&T, Pantnagar	02 day	Updated Knowledge
		Attended National Seminar on "Agriculture growth in 21st century viv-a-vis Ecological and social protection".	GBPUA&T, Pantnagar	02 day	Updated Knowledge
		Participated in 29th Annual National Workshop-Webinar of AICRP on Biological Control organized by ICAR-NBAIR.	GBPUA&T, Pantnagar	02 day	Presented progress report of AICRP Biological control and formulated technical programme for next year.
		Attended Webinar on "Paradigm Shift in Plant Disease Management" organized by ICAR-NBAIR.	GBPUA&T, Pantnagar	01 day	Updated Knowledge
		Participated in Review meeting-Webinar of AICRP on Biological Control organized by ICAR-NBAIR.	GBPUA&T, Pantnagar	01 day	Presented progress report of AICRP Biological control
		Attended Webinar on "International Online/Virtual Conference on Role of Basic and Applied Sciences in Human Well Being".	GBPUA&T, Pantnagar	02 day	Updated Knowledge

		Participated in National Conference on Biological Control: Approaches for Green India. ICAR-NBAIR, Society of Biological Advancement.	Bengaluru, India.	03 day	Presented research paper and received award
		Participated in 30th Annual Group Meet Online Webinar of AICRP on Biological Control organized by ICAR-NBAIR.	GBPUA&T, Pantnagar	01 day	Presented progress report of AICRP Biological control and formulated technical programme for next year.
		Attended Online Webinar on "New Paradigms in Biological Control of Insect Pest and Diseases". ICAR-IISR. Lucknow.	GBPUA&T, Pantnagar	01 day	Updated Knowledge
		Attended Online Webinar on "Trichoderma: A Superstar of Bio-pesticide Industry". ICAR-NRCIPM. New Delhi.	GBPUA&T, Pantnagar	01 day	Updated Knowledge
		Participated in National Conference on 8th International Conference, Plant Pathology: Retrospect and Prospect. Indian Phytopathological Society.	SKNAU, Jobner,Jaipur	04 day	Updated Knowledge
		Attended National Symposium on Multidisciplinary Approaches for Plant Health Management. Indian Society of Plant Pathologist (INSOPP) PAU.	GBPUA&T, Pantnagar	02 day	Updated Knowledge
		Participated in 31th Annual Group Meet of AICRP on Biological Control organized by	Bengaluru	02 day	Presented progress report of AICRP Biological control and formulated

		ICAR-NBAIR.			technical programme for next year.
3.	**PAU, LUDHIANA**	Training of Master Trainers/ Dr Sudhendu Sharma	Agricultural Skill Council of India	3 days (February 19-21, 2018)	Knowledge up gradation regarding good agricultural practices
		Plant Quarantine Procedures for Import and Export/ Dr Sudhendu Sharma	NIPHM, Hyderabad (Virtual)	5 days (November 9-13, 2020)	Knowledge up gradation regarding quarantine laws
		On-Farm and Mass Production Protocols of Bioagents and Microbial Agents for FAW Management for NWPZ/ Dr P.S. Shera	ICAR-IIMR, Hyderabad (Virtual)	3 days (October 25-27, 2021)	Knowledge up gradation regarding production protocols of bioagents
4.	**SKUAST, Srinagar**	On spot trainings on Biological Control on fruit crops	Directorate of Extension/ KVKS	02	Use of Biological Control
		On spot trainings on Biological Control on vegetables	Directorate of Extension/KVKS	02	Use of Biological Control agents
		On spot trainings on Biological Control on cole crops	Directorate of Extension/KVKS	01	Use of Biological Control
		On spot trainings on Biological Control on codling moth	Directorate of Extension/KVKS	01	Role of biopesticides
		On spot trainings on BIPM	Directorate of Extension/KVKS	01	Biological Control
		Biological control an important component of IPM	Directorate of Extension/ pesticide dealers	10 days	Reduction of pesticides
		Regular training on the biological control techniques	AICRP-BC	01	Skill training
		Installation and demonstration of pheromone baited traps	AICRP-BC	02	Skill training
		Demonstration of	AICRP-BC	02	Skill training

		biopesticides against mites			
		Validation technologies on apple	AICRP-BC	02	Skill training
5.	**PJTSAU**	Imparted training on "Biological Control as viable component of Pest Management" to First & Second batch MAOs	Govt. of Telangana	One day	Trainees gain info. On various aspects of Integrated Pest management
		Imparted training on "Biological Control as viable component of Pest Management" to First & Second batch MAOs under Govt. Telangana programme	Govt. of Telangana	One day	Trainees gain info. On various aspects of Integrated Pest management
		Imparted training on "Biological Control as viable component of Pest Management" to First & Second batch MAOs under Govt. Telangana programme	Govt. of Telangana	One day	Trainees gain info. On various aspects of Integrated Pest management
		Imparted training on "Prtocols& Methodologies in Mass Production of *Metarhizium anisopliae*" on 20.5.2019 to all the staff of State Bio Agent Production Units/Labs under Govt. Telangana	Govt. of Telangana	One day	Trainees gain info. On various aspects of Integrated Pest management
		Imparted training on "Biological Control as viable component of Pest Management" to First & Second batch MAOs under Govt. Telangana programme, "Agro Technologies for Productive & Profitable Agriculture in Telangana State"	Govt. of Telangana	One day	Trainees gain info. On various aspects of Integrated Pest management
		Imparted training on	Govt. of Telangana	One	Trainees gain info.

		"Strengthening of mass production of Bio Agents & Bio Pesticides" to all the staff of State Bio Agent Production Units/Labs under Govt. Telangana		day	On various aspects of Integrated Pest management
		Imparted training on "Biological Control in IPM" to Trainees under GOI programmeorganized by CIPMC, Hyderabad on 11.12.2019	Govt. of India	One day	Trainees gain info. On various aspects of Integrated Pest management
		Imparted training on "Strengthening of mass production of Bio Agents & Bio Pesticides" to all the staff of State Bio Agent Production Units/Labs under Govt. Telangana	Govt. of Telangana	One day	Trainees gain info. On various aspects of Integrated Pest management
		Imparted training on "Urban Pest Management" to Industry participants on 16.12.2019 organized by NIPHM, Hyderabad	Govt. of India	One day	Trainees gain info. On various aspects of Integrated Pest management
		Pest mngt. Basics and concepts to Agril Graduates	NGO.	One day	Trainees gain info. On various aspects of Integrated Pest management
		"Use of bioagents and biopesticides in pest management" on 5 February, 2021 in the village	PJTSAU VA Team	One day	Trainees gain info. On various aspects of Integrated Pest management
		Role of Biopesticides for pest management in various crops organized by Govt. of India on 26 November	Govt. of India	One day	Trainees gain info. On various aspects of Integrated Pest management
		Role of Biological	Maize Res. Centre,	One	Trainees gain info.

		alternatives in management of Maize pests for farmers under TSP on 22 March, 2022 organized by maize Research Centre, Rajendranagar.	PJTSAU	day	On various aspects of Integrated Pest management
		Role of Biological alternatives in management of Maize pests for farmers under TSP on 25 December, 2021 organized by maize Research Centre, Rajendranagar.	Maize Res. Centre, PJTSAU	One day	Trainees gain info. On various aspects of Integrated Pest management
6.	**CAU, Pasighat**	Regional workshop on Biocontrol of Invasive Crop Pests and Utilization of Insects as Food in North-eastern region of India (Dr. Ajaykumara K. M.)	CAU-Pasighat and ICAR-NBAIR, Bengaluru	08 to 09th Feb 2021	Gained knowledge on farm level production, conservation and application of biocontrol agents of crop pests
		6th National Conference on Biological Control (Dr. Ajaykumara K. M.)	SBA and ICAR-NBAIR, Bengaluru	March 3 to 5th, 2021.	Poster presentation on compatibility studies between *Metarhizium* sp and Chemical insecticides
		Annual Workshop cum Technical Interaction on AICRP-Biocontrol (Dr. Ajaykumara K.M.)	ICAR-NBAIR, Bengaluru	29th June to 03rd July 2022	Finalized TP for 2022-23 Submitted insect fauna belongs to different groups collected during field surveys
		Indian Phyotopathological Society's NEZ Symposium and National Conference on Reframing Futuristic Plant Health Safeguards (Dr. Ajaykumara K.M.)	AAU Jorhat	24-25th Nov 2022	Oral presentation on Evaluation of organic approaches for the management of Ginger rhizome rot
		7th National Conference	SBA and ICAR-	March	Oral presentation

		on Biological Control (Dr. Ajaykumara K.M.)	NBAIR, Bengaluru	3 to 5th, 2021.	on role of habitat manipulation for pest management in Tomato
7.	**TNAU**	Mass Production of biocontrol agents	TNAU	29.06.17	B.Sc. (Ag) Students PSMO College, Mallapura, Kerala
		Mass Production of biocontrol agents	TNAU	10.07.17	B.Sc. (Ag) Students College of Horticulture, Bangalore
		Mass Production of biocontrol agents (paid training)	TNAU	12.10.17	10 Entrepreneurs
		Mass Production of biocontrol agents	TNAU	21.11.17	Farmers, Mallapore
		Mass Production of biocontrol agents	TNAU	08.12.17	B.Sc. (Ag) Students STISAT, Vedasanthur
		Mass Production of biocontrol agents	TNAU	01.03.18	NPRC, Vamban
		Mass Production of biocontrol agents	TNAU	**02.03.18**	PG students, **AC&RI, Killikulam**
		Mass Production of biocontrol agents	TNAU	29.06.17	One year Diploma in DAESI programme , ICAR- MYRDA KVK
		Mass Production of biocontrol agents	TNAU	14.11.18	Department Officials Kerala state Department of Agriculture, Chawara
		Mass Production of biocontrol agents	TNAU	19.11.18	Department Officials Kerala state Department of Agriculture Kotayam
		Mass Production of biocontrol agents	TNAU	27.12.18	B.Sc. (Ag) Students APHC, Kalavai

		Mass Production of biocontrol agents	TNAU	10.01.19	B.Sc. (Ag) Students AC&RI, Coimbatore
		Mass Production of biocontrol agents	TNAU	07.02.19	B.Sc. (Ag) Students AC&RI, Coimbatore
		Mass Production of biocontrol agents	TNAU	4.7.19 and 5.7.19	B.Sc. (Asthetic Crop Science) students - 2Nos. Sultan QaboosUniversiy, Muscat
		Mass Production of biocontrol agents	TNAU	4.7.19	Diploma Agri. Students -40 Nos., Institute of agriculture
		Mass Production of biocontrol agents	TNAU	5.7.19	B.Sc. (Seri) students – 46Nos.FC&RI, Mettupalayam
		Mass Production of biocontrol agents	TNAU	8.7.19	B.Sc. (Ag.) students - 44Nos. SethubaskaraAgricultural College, Sivagangai
		Mass Production of biocontrol agents	TNAU	18.09.19	Farmers – 40 Nos. KVK, Kottayam, Kerala
		Mass Production of biocontrol agents	TNAU	14.10.19	Agricultural Officers - 6Nos.Govt. of Maldives
		Mass Production of biocontrol agents	TNAU	28.11.19	Laboratory assistants 15+6TNAU, Coimbatore
		Mass Production of biocontrol agents	TNAU	4.12.19	Students 64 Nos. PRIST deemed to be University, Tanjore
		Mass Production of biocontrol agents	TNAU	10.12.19	Farmers – 40Nos. MYRADA KVK, Gopi

		Mass Production of biocontrol agents	TNAU	07.01.20	Farmers - 35 Nos. KVK, Needamanagalam, Thiruvarur
		Mass Production of biocontrol agents	TNAU	20.01.20	Students - 9 Nos. SNGS College, Pattambi, Kerala
		Mass Production of biocontrol agents	TNAU	24.01.20	Students - 43 Nos. SRMV-IARD, PN Palayam
		Mass Production of biocontrol agents	TNAU	30.01.20	Students - 29 Nos. Govt. Boys Hr.Sec. School, Kavindapadi
		Mass Production of biocontrol agents - Paid training –	TNAU	12.02.20	Farmers, Entrepreneurs - 18 Nos. 17+1 Venture Capital scheme
		Mass Production of biocontrol agents	TNAU	12.02.20	Farmers - 24 Nos. ATMA, Wadakeva, Kozhikode
		Mass Production of biocontrol agents	TNAU	26.02.20	Agricultural Officers -26 Nos. 12+14 Department of Agriculture, TamilNadu
		Mass Production of bio-control agents	TNAU	04.05.20	Officials from Dept. Biocontrol Unit, Salem -2Nos.
		Mass Production of bio-control agents	TNAU	07.01.21	Entrepreneurs-40Nos. ICAR-KVK,MYRADA Erode (dt).
		Natural enemies of insect pests and biological control	TNAU	24.02.21	Students -15Nos. Institute of Forest Genetics and Tree Breeding, Coimbatore
		Mass Production of bio-control agents	TNAU	26.02.21	Students -15Nos. Institute of Forest Genetics and Tree Breeding, Coimbatore

		Mass Production of bio-control agents	TNAU	02.03.21	B.Sc.(Horticulture) Students-29 Nos. TNAU, Coimbatore
		Mass Production of bio-control agents	TNAU	03.03.21	B.Sc.(Horticulture) Students-31 Nos. TNAU, Coimbatore
		Mass Production of bio-control agents	TNAU	05.03.21	B.Tech. (Bio-tech.) Students-49 Nos. TNAU, Coimbatore
		Mass Production of biocontrol agents - Paid training	TNAU	05.03.21	Farmers-2 Enterpreneurs-3 Venture Capital scheme
		Mass Production of bio-control agents	TNAU	04.12.21	JAO's, TNAU 24Nos. , TNAU, Coimbatore
		Mass Production of bio-control agents	TNAU	08.12.21	Entrepreneurs - 38Nos. ICAR MYRADA KVK, Gopi
		Mass Production of bio-control agents	TNAU	23.12.21	Teachers -3Nos. - Sakthi Institute of Engineering and Technology, Chinniyampalaym
		Mass Production of bio-control agents - Paid training	TNAU	18.02.22	Entrepreneurs – 15Nos.
8.	**OUAT**	M.Sc(Ag) students were also taken up their **thesis work** on new invasive pests and other crop pest management with the bioagents	Dept. of Entomology,OUAT .**Dr.T.samal,** Dr.J.Padhi, Dr.S.M.A Mandal, Dr.B.Patro (**one student each) ***		
		Trainings were imparted to the 4th year B.sc students under "Experimental learning programme" (**ELP**) for productions and Handling of bioagents and Honeybee rearing	Bio control Laboratory of Entomology Department,OUAT ,Bhubaneswar **Dr.M.k.Tripathy, Dr.T.Samal and Dr.(Mrs)P.Behera**	8TH Semester of each Year(2017-18 to 2021-	Able to know the rearing tech.of beneficial insects and Honeybee cultivation.

		Techniques to **84** number of students during the last **five** years.	**2017-18: 11 students, 2018-19: 11 students, 2019-20: 11 students, 2020-21: 27 students, 2021-22: 24 students.**	22	
		Biological pest control in field crops and vegetable crops **DR.T.Samal**	KVK,ICAR-CIFA,BHUBANESWAR	1 (23/11/2022)	Able to know the beneficial effect of bioagents over chemical pesticides and how to use them
		Pest management in sugarcane crop **Dr.T.Samal**	RRS,Nayagarh	1	Use and beneficial effect of bioagents in sugarcane
		*Seasonal incidence and bio intensive Management of fall armyworm *Spodopterafrugiperda*(J.E. Smith)(Lepidoptera:Noctuidae) on Maize. 2021 .Dr.T.Samal (**Guide)** *Diversity and bio-ecology of trichogrammatids in coastal Odisha 2022Dr.S.M.A. Mandal (**Guide)** *****Effect of food supplements on the biological attributes and parasitisation potential of ***Goniozusnephantidis***mue seback.			
9.	**ANGRAU**	Trichocard production training at AICRP BC, RARS, Anakapalle on 15.3.2018	AICRP BC, ANGRAU	1	Learned skill

		Trichocard production training at AICRP BC, RARS, Anakapalle on 2.7..2018	AICRP BC, ANGRAU	1	Learned skill
		One day Fall army worm workshop ADA's, Ao's, AEO's, Progressive farmers and Dealers of Vizianagaram district, Andhra Pradesh on 6.11.2018 at Zillaparishad Vizinagaram	Special Commissioner of Agriculture, Andhra Pradesh	1 day	Alerted 600 No. District extension staff of Dept. of agriculture, Dealers and farmers on new invasive pest, fall army worm in maize as resource person
		District level one day orientation programmes at Srikakulam and vizianagaram on 22.04.2019 and 23.04.2019	Principal secretary (Agri & coop) and Special Commissioner of Agriculture, Andhra Pradesh	2 days	Advisory to 250 no. Department of agriculture and farmers on identification and management of new invasive pest, Fall armyworm, *Spodoptera frugiperda* .
		Awareness programme on maize fall armyworm at Cheepurupalli, Vizianagaram district on 17.08.2018	Department of Agriculture, Vizianagaram district	1 day	Advisory to 150 no. Agriculture Market Committee level Farmers, Mandal parishad extension officers, Agricultural officers as resource person
		Awareness programme on maize fall armyworm at Pusapatirega, Vizianagaram district on 18.08.2018	Department of Agriculture, Vizianagramdivison, Vizianagaram district	1 day	Advisory to 120 no. Agriculture Market Committee level Farmers, Mandal parishad extension officers, Agricultural officers as resource person
		Awareness programme on	Department of	1 day	Advisory to 100 no.

		maize fall armyworm at Kothavalasa, Vizianagaram district on 16.11.2018	Agriculture, Kothavalsa division, Vizianagaram district		maize farmers
		Awareness programme on maize fall armyworm at Cheepurupalli, Vizianagaram district on 22.12.2018	Department of Agriculture, Cheepurupalli division, Vizianagaram district	1 day	Educated 35 progressive farmers
		Awareness on production of *Isaria fumosorosea* at farmers level on 29.11.2019	AICRP BC, ANGRAU	1	Gained knowledge by Field staff (8 No) of NGO Reddy's mitra foundation, srikakulam
		Awareness programme on management of Coconut rugose spiraling whitefly at Venkataraopeta village , Ranasthalammandal, Srikakulam district on 6.1.2020	AICRP BC, ANGRAU with ICAR-NBAIR, Bengaluru	1 day	Team of ICAR_ NBAIR Scientists inaugurated entomopathogenic fungi, *Isaria fumosorosea* (NBAIR- pfu 5) production centre for farmer level production. Motivated Department of Horticulture staff - 12 No. ; 100 No.coconut farmers and 20 No. field staff of Reddy's mitra foundation of Srikakulam district Supplied mother cultures (10 kg) and formulation of *Isaria fumosorosea* fungus (50kg). Demonstrations

					conducted in 25 acres
		Farmers awareness programme on management of maize fall armyworm under at Pusapatirega, Vizianagaram district on 07.01.2020	AICRP BC , ANGRAU, CABI & ICAR-NBAIR , Bengaluru	1	Motivated 220 maize farmers and 12 department of agriculture staff Distributed biocontrol agents, to Department of Agriculture and maize farmers.
		Hands on training on farmers level production of Entomopathogenic fungi, *Isaria fumosorosea NBAIR Pfu5* in at RARS, Anakapalle (Visakhapatnam district), Koyyam village (Etcherlamandal, Srikakulam district) and Venkataraopeta village (Ranasthalammandal, Srikakulam district) on 5th, 6th and 7th February 2020 and 12thmarch, 2020	AICRP BC, ANGRAU & ICAR-NBAIR, Bengaluru	8 days	Motivated 200 No. coconut farmers of Srikakulam, Vizianagram, Visakhapatnam Godavari and Nellore districts ; Field staff of Dr. Reddysmitra foundation and Department of Horticulture officials of Visakhapatnam, Vizianagaramand Srikakulam districts
		Hands on training on farmers level production of Entomopathogenic fungi, *Isaria fumosorosea NBAIR Pfu5* in at RARS, Anakapalle (Visakhapatnam district) on 18.2.2020, 17.3.2020	AICRP BC, ANGRAU	2	9 No. coconut farmers of Vizianagaram district learned skill
		Hands on training on farmers level production of Entomopathogenic fungi, *Isaria fumosorosea NBAIR Pfu5* in at RARS, Anakapalle (Visakhapatnam district) on 7.3.2020	AICRP BC, ANGRAU	2	Two Scientists from ARS, Amadalavalasa, BCT KVK, Haripuram Learned skill

		Honey Bees rearing to tribal women on 17.12.2020	Korraikothavalasa	1	Learned skill
		Hands on training on mass production of Entomopathogenic fungi, *Isaria fumosorosea NBAIR Pfu5* 26.7.2021	AICRP BC, ANGRAU at RARS, Anakaplle	3 days	Learned skills by 3 field staff of NGO-Vikasa, Visakhapatnam district
		Mass production of biocontrol agent, *Trichogramma* spp. and Biopesticides (*Metarhizium anisopliae NBAIR Ma4, Ma35, Beauveria bassiana NBAIR Bb45, Isaria fumosorosea NBAIR Pfu5*) in July, august, October and December 2021.	AICRP BC, ANGRAU at RARS, Anakaplle	8 days	Training to field staff (3no.) of NGO, Vikasa operating in plan and tribal areas of Visakhapatnam district promoting organic cultivation
		Hands on training on mass production of Entomopathogenic fungi, *Isaria fumosorosea NBAIR Pfu5* in feb, april, 2022	AICRP BC, ANGRAU at RARS, Anakaplle	7 days	Motivated 13 farmers of Visakhapatnam district
		Hands on training for mass production of EPF, *Metarhizium anisopliae* as a part of experiential learning programme for final year B.Sc (Ag) students 25 No at Agricultural College, Naira on 16.11.2019.	AICRP BC, ANGRAU, at RARS, Anakapalle	1 day	B.Sc(Ag) students , Agricultural College, Naira produced entomopathogenic fungi and supplied for demonstrations
		Skill training on mass production Biocontrol agents and biopesticides to 15 rural youth RARS, Anakapalle for one week (13.2.2020 - 20.2 .2020).	RARS, Anakapalle	7 days	Motivated 15 rural youth
		Online training on "Analysis of Experimental data using SAS "	NAARM, Hyderabad	9 days	Gained Knowledge

		Undergone by M.Visalaskhi			
		Online training on "On farm production of Biocontrol agents and microbial Biopesticides" from 9-13 November, 2020 undergone by M.Visalakshi	NIPHM, Hyderabad	7 days	Gained Knowledge
		Online training on "Impact of indiscriminate use of chemical fertilizers and pesticides on food crops" from 16-18 November, 2020 undergone by M,Visalakshi	NIPHM, Hyderabad	3 days	Gained Knowledge
		Faculty development programme on statistical data analysis using R –Studio on 5-6, Feb, 2022. undergone by M.Visalakshi	faculty of agriculture, Sri Sri University, Cuttack, Odisha	2 days	Gained Knowledge
		Three days workshop on use of reference manager tools and software in research article writing on 25-27, march, 2022. undergone by M.Visalakshi	UAS, Raichur	3 days	Gained Knowledge
10.	**AAU, Jorhat**	Biological Control of Crop Pests By Dr.D.K.Saikia	Conference hall, DoEE, AAU, Jorhat	1 day, 01.06.2017	Benefited by SMS
		Leboratory techniques for making trichocard By Dr.D.K.Saikia R. N. Borkakati	ELP Laboratory, AAU, Jorhat	01.06.2017	Benefited by SMS
		Recent Advances in Integration of Bioagents in Pest Management By Dr.D.K.Saikia	Conference hall, Deptt. of Plant Pathology, AAU, Jorhat	07.09.2017	Scientist

		Pest and Disease Management in Post Flood Situation By Dr.D.K.Saikia	EEI, AAU, Jorhat	08.09.2017	Agricultural Inspector, Meghalaya
		CAFT training on "Culturing techniques for biofertilizers and biopesticides" By Dr.D.K.Saikia R. N. Borkakati	Department of Soil Science, AAU, Jorhat	21.11.2017	Scientist
		CAFT training on "Culturing techniques for biofertilizers and biopesticides" By Dr.D.K.Saikia R. N. Borkakati	Department of Soil Science, AAU, Jorhat	21.02.2018	Scientist
		CAFT training on "Mass multipliaction techniques of important biopesticide agents" By Dr.D.K.Saikia R. N. Borkakati	Department of Soil Science, AAU, Jorhat	1 day, 27/11/2018	Benefited by scientist
		Model Training Course on IFS for Sustainable Agriculture By Dr.D.K.Saikia R. N. Borkakati	DoEE, AAU, Jorhat-13	1 day, 26.11.2018	Benefited by scientist
		CAFT training on "BIPM for Pest management in organic farming" By Dr.D.K.Saikia R. N. Borkakati	Department of Soil Science, AAU, Jorhat	1 day, 19.02.2019	Benefited by scientist
		CAFT training on "Mass multiplication of biocontrol agents specially Trichogrammatids" By Dr.D.K.Saikia R. N. Borkakati	Department of Soil Science, AAU, Jorhat	1 day, 20.02.2019	Benefited by scientist
		CAFT training on "Exploitation of Beneficial Microbes in Organic Agriculture" By	Department of Soil Science, AAU, Jorhat	1 day, 18.09.2019	Benefited by Scientist

		Dr.D.K.Saikia R. N. Borkakati			
		CAFT training on "Exploitation of Beneficial Microbes in Organic Agriculture" By Dr.D.K.Saikia R. N. Borkakati	Department of Soil Science, AAU, Jorhat	1 day, 23.09.2019	Benefited by Scientist
		CAFT training on "Organic Agriculture and Soil Health" By Dr.D.K.Saikia R. N. Borkakati	Department of Soil Science, AAU, Jorhat	1 day, 06.03.2020	Benefited by Scientist
		Training programme to extension functioneries By R. N. Borkakati	ETC, Naltali, Nagaon	1 day, 11.02.2021	ADO and Sr. ADO
		Safe handling of Bioagents and biopesticides. By R. N. Borkakati	NAHEP sponsored training, Dept. of Entomology	1 day, 12.02.2022	Faculty, Ph.D and M.Sc.Students
11.	**MP KV**	1. Soft skill development programmes for personality development were organized for staff members working in the project 2. The staff of the project conducted hands on training "Experiential Learning Programme" on "Mass Production of Bioagents and Biopesticides" for last semester of UG and total 177 students in last 5 years (2017-2022) have been trained in production and marketing of biopesticides so that they became confident in entrepreneurship develop ment programme in biopesticides			

		production after the graduation.			
12.	**SKUAST-Jammu**	Thirty nine lectures were delivered to the officers of the line department, farmers, pesticide dealers, etc. under various training programs to make them aware of the benefits and use of various biocontrol agents.			
13.	KAU, Vellayani	Trainers training on Mass Production and Release techniques of *Anagyrus lopezii* for the Classical Biological Control of Cassava Mealybug in India	ICAR - National Bureau of Agricultural Insect resources, Bengaluru	1 day	Learnt toidentify the mealy bs species and their parasitoids Familirised with the mass production and release of *A.lopezi*
		Hands on training on Microbial identification – Biochemical and Genotype and Mass Spectrometric Methods	National Coir Research and Management Institute Trivandrum	21 days 15.2.2018 to 7.3.2018	Acquired hands on experience on use of technologies in the microbial research field like MALDITOF, VitexMs, Rep PCR etc
14.	**NRRI**	Entrepreneurship Development Program on 'Mass production of bioagents for insect pest management in rice' As Resource Person: Annamalai. M, Scientist, ICAR-NRRI	ICAR-NRRI	5 days	Created awareness for Entrepreneurship Development Program on 'Mass production of bioagents for insect pest management in rice'
15.	**KAU, Thrissur**	Dr. Smitha M. S. Nanotechnological approaches in pest and disease management	NBAIR, Bengaluru	10 days (15^{th} to 24^{th} Nov 2017)	Familiarization with Nanotechnology based l approaches in pest and disease management

					Nanotechnological approaches in pest and disease management
16.	**IGKV**	Mother culture of *Corcyra* and Trichocards provided at IGKV centre	College of Agriculture, Ambikapur,	2021 - 22	Established Biocontrol lab
		Mother culture of *Corcyra* and Trichocards provided	College of Agriculture, Kanker	2021 - 22	Established Biocontrol lab
		Mother culture of *Corcyra* and Trichocards provided	College of Agriculture Gariyaband	2019 - 20	Established Biocontrol lab

XXVII. Publications

Sl.No	Centres	Scientific articles published in journals (No)				Books	Book chapters	Papers presented in symposia, seminars, etc. / Published in local languages/ Technical bulletins/Folder setc	Total
		>8 NAAS Rating	>6 NAAS Rating	<6 NAAS Rating	No NAAS Rating				
1.	CPCRI	1	11	6	1	-	-	59	78
2.	NCIPM	-	-	1	-	-	-	6	7
3.	UBKV	-	-	6	2	-	-	9	17
4.	PAU	2	17	31	-	-	1	39	90
5.	SKUAST, Srinagar	4	4	1	-			19	28
6.	DrYSRHU	2	2	8	6	-	-	40	58
7.	GBPUAT	2	2	17	14	2	1	86	124
8.	IIMR	-	-	-	-	-	-	3	3
9.	IIRR			3	3			4	10
10.	KAU, Vellayani			9	4			21	34
11.	KAU, Kumarakom				1			2	3
12.	PJTSAU	1		6	3			7	17
13.	CAU				1			8	9
14.	CISH				1				1
15.	MPKV	-	-	7	21	-	-	15	43
16.	MPUAT	-	3	7	4			19	33
17.	TNAU		2	21	11			14	49
18.	OUAT				3			7	10
19.	ANGRAU	1		4	5	7	1	22	40
20.	AAU, Anand			10	15			52	73
21.	DrYSRHU	2	1	8	8			16	35
22.	AAU, Jorhat	1	2	9	19			53	84

XXVIII. Budget

Plan Budget (2017-2022)

5 years budget from 2017-18 to 2021-22

Year	Pay	capital	TA	RC	TSP	Total
2017-18	407.00	0.00	7.81	37.43	8.50	462.74
2018-19	213.55	0.00	70.90	334.85	62.00	683.30
2019-20	224.38	0.00	67.65	336.15	50.00	679.18
2020-21	204.70	0.00	14.23	380.77	40.00	640.80
2021-22	217.08	6.10	25.33	386.67	43.00	678.18
	1266.71	6.10	185.92	1475.87	203.50	3138.10

Centre wise budget from 2017-18 to 2021-22

Sl. No.	Name of the Centre	Pay	Capital	TA	RC	TSP	Total
1	AAU, Anand	140.64		11.86	90.71	21.81	265.02
2	AAU, Jorhat	135.90	6.10	11.74	69.96	26.60	250.30
3	RARS Anakapalle	66.47		10.72	69.88	20.07	167.14
4	PJSTAU, Telangana	105.20		5.32	25.44	0.00	135.96
5	DR.YSPUH & F, Solan	145.82		6.29	37.68	4.49	194.28
6	GPUAT, Pantnagar	63.89		8.13	57.24	25.17	154.43
7	KAU, Thrissur	82.29		6.79	66.28	5.00	160.36
8	MPKV, Pune	119.03		10.14	72.74	0.00	201.91
9	PAU, Ludhiana	173.44		9.24	65.36	0.00	248.04
10	SKUAT, Srinagar	136.61		9.66	44.60	22.76	213.63
11	TNAU, Coimbatore	103.52		8.41	51.78	3.17	166.88
12	MPUAT, Udaipur	0.22		4.99	7.00	16.21	28.42
13	OUAT, Bhubaneswar	0.75		4.13	9.95	3.23	18.06
14	CAU, Pasighat	0.30		3.60	28.25	21.60	53.75
15	UAS, Raichur	0.00		7.16	37.22	24.51	68.89
16	ICAR- CPCRI, KAYANKULAM	0.00		2.77	11.74	6.00	20.51
17	ICAR-CTRI, Rajahmundry	0.00		1.75	3.50	0.00	5.25
18	ICAR- IIHR	0.00		2.77	11.00	5.00	18.77
19	ICAR-P.C.CELL, B'LORE	0.00		0.00	612.57	0.00	550.32
20	ICAR-CISH,	0.00		3.54	9.33	5.20	18.07

	Lucknow						
21	ICAR-IIRR, Hyderabad	0.00		2.17	8.38	3.00	13.55
22	ICAR-IIMR, Hyderabad	0.00		2.27	7.23	3.00	12.50
23	ICAR-IIVR, Varanasi	0.00		2.27	11.88	1.85	16.00
24	ICAR-NCIPM, New Delhi	0.00		2.77	10.54	0.50	13.81
25	IGKV, Raipur	0.00		2.27	10.41	14.98	27.66
26	KAU, Kumarakom	0.00		2.84	16.08	23.67	42.59
27	KAU, Vellayani	0.00		2.90	15.15	7.50	25.55
28	Dr.YSRH, Ambajipeta	0.00		2.30	13.72	10.40	26.42
29	UBKV,Pundibari	0.00		3.27	13.10	3.66	20.03
	Total	1274.08	6.10	152.07	1488.72	279.38	3138.10

XXIX. SWOT Analysis of AICRP on Biological Control

Centres	Strengths	Weaknesses	Opportunities	Threats
AAU, Anand	Well-functioning facility for the research and production of bioagents and biopesticides, Competent scientific & technical staff	Very less supporting staff, No grants to procure equipments/ instruments	Research on climate resilient improved strains of bioagents and bioinoculants, Networking with organizations such as CABI-South Asia, Better cotton, Pidilite industries, sugar industries, private industries viz., Nico orgo manures, Anand to propagate the biocontrol technologies, Development of microbial inoculants with multifarious attributes, effective at both biotic and abiotic stresses	Heavy reliance of farming community on chemical pesticides/spurious biological products laced with chemical insecticides in vegetables cultivation

AAU, Jorhat	Well functioned laboratory, qualified internationally exposed biocontrol Scientists, excellent linkage with State Agriculture Department and KVKs	Small production unit, less supporting staff, lack of modern equipments	Assam is one of the organic hub, biodiversity hotspot and scope for exploration of various micro and macro organisms for pest management	Lack of molecular facilities for characterization of native bioagents becoming a threat for their original identity and spurious biological products availability
ANGRAU	Well established R & D System, Qualified Scientific staff, Functional AICRP on Sugarcane, AICRP on Post harvest Technology and Gramin Krishi Mausam SewaProject, Biofertilizer Production Units	Lack of modern lab equipments, Insufficient transport facility, lack of exposure to modern techniques	Scope for Isolation of native virulent strains of entomopathogenic fungi and development of biopesticides, Scope for utilization of Biocontrol in agricultural, Horticultural crops in andhra Pradesh, Development of Technologies for organic cultivation in export oriented crops	Host Specificity of Biocontrol agents, Direct risk of Biocontrol agents on non target
GBPUAT	1. G.B. Pant University has well equipped lab to do research work along with glass house and fields to conduct the research trials. 2. State government is also promoting organic Agriculture, in Uttarakhand state.	1. Scientific and supporting staff is very less (one each). 2. Required mass production lab with adequate human resources to meet out the	1. Biocontrol agents are continuously gaining popularity amongst the farmers of Uttarakhand. 2. Farmers who have significantly reduced pesticide and agrochemical use have identified the Biocontrol Lab Pantnagar for the direct supply of	1. Lack of reliable manufacturers for quality Biocontrol agents. 2. Farmers are not getting increased prices of quality produce (organically grown). 3. Lack of awareness for

	3. This lab has been certified as Central Insecticidal Lab by Govt. of India and as Referral lab for sample testing by DBT.	demand of local farmers. 3. Low contingency grant	Bioagents.	Biocontrol agents amongst the farmers as they need immediate results. 4. Big pressure of Agrochemical companies on whole system including farmers.
KAU, Thrissur	1. Forty five years of experience and expertise in research on biocontrol. 2. Excellent linkage with the State Department of Agriculture and other major agencies like Vegetable and Fruit Promotion Council, Keralam, State Horticultural Mission, ATMA etc. 3. Proximity to College of Agriculture, Thrissur, which ensures ready access to a large pool of expertise across disciplines as well as infrastructure facilities. 4. A mass production facility for bioagents in	1. Lack of adequate land for conduct of experiments. 2. Non availability of funds for upgradation of laboratory facilities since 2010. 3. Non availability of a serviceable vehicle. The present vehicle is twenty five years old and is due to be condemned. Hiring is not feasible for frequent short trips on a daily basis. 4. Gross inadequacy of technical an supporting staff	1. The increased awareness towards safe to eat food and increased popularity of urban agriculture among general public is expected to create greater demand for biocontrol technologies. 2. The rich biodiversity in the state offers possibilities for unearthing potential natural enemies	1. Frequent, unpredictable changes in physical environment and consequent changes in pest distribution and abundance leading to uncertainty in outcome of field experiments. 2. Reduction in outlay due to extraneous factors 3. Increasing orientation towards applied end of deliverables eliminates possibilities for basic research that can lead to impactful technologies.

	revolving fund mode which produces and distributes five microbial agents and one parasitoid, with an annual turnover of Rs. 25 lakhs.	consequent to reduction in staff strength from six to two 5. Lack of adequate support for registration of bioagents especially by PSUs hampers the potential for use of microbes in crop protection.		
MPKV	1. MPKV, Pune Centre has well established biocontrol &bipesticicdes production laboratory, Highly developed infrasturcture for the production of major bioagents and biopesticdes 2..We have a good collaboration with Department of Agriculture for large scale dissemination of biocontrol technologies at farmers' fields Strong linkages with extension scientists of KVKs and State	1. Lack of awareness among the farmers about the harmful effects of chemical pesticides and long term beneficial effects of biological control. 2. Farmers generally assess the pest management technology in terms of quick pest mortality and ignores the harmful effects of	1. Development of local effective strains of bio-agents and biopesticides will provide more opportunities for mass production and development of entrepreneurship. 2. Creating awareness about health cautiousness among consumers will result in a shift regarding use of biocontrol agents in the pest management strategies of crop pest 3. More farmers are turning towords organic farming. Augumentation of natural enemies in organic farming helps in conservation and	1. Indiscriminate use of broad spectrum chemical pesticides by farmers destroys the population of natural enemies to a great extent 2. There is competition among pesticide manufacturing companies which are having quick mode of action as compared to bioagents 3. Emerging pests problems are posing a new challenge 4.The non-availability of

	Agriculture/Horticulture Department for promotion of proven Biocontrol technologies 3. Diversity of biocontrol agents in different agroecological zones of maharashtra, 4. Successfully controlled Papaya mealy bug by using Acerophaguspapayae and predators, Schymnus, Mallada, etc. in Maharashtra. 5 Successfully controlled Sugarcane woolly aphids in Maharashtra by using the predators Diphaaphidivora, Micromusigoratus and Eupeodusconfrater .The scientists of this center have developed simple method of mass production of these predators.	chemical pesticides. 3. Lack of availability of micro and macro bioagents in large quantities to the farmers is a limiting factor.	enhancement of the exhisting biodiversity of natural enemies .Organic farming has given tremendous scope for popularizing biocontrol methods for suppression of crop pests.	natural enemies at appropriate time is hampering the adoption of biological control on a large scale. 5. Large scale mass production of bioagents is also one of the biggest threat in managing insect-pests
PAU	1. PAU centre has recommended 14 biocontrol technologies to farmers of Punjab (included in PAU	1. Limited availability of commercial biopesticides in the local market	1.Scope for increase in production of bioagents and area under biocontrol as eco-friendly and ecologically	1. Indiscriminate use of broad spectrum pesticides by farmers destroys the population of

	POPs) 2.Well-equipped biocontrol laboratory for the mass production of bioagents 3.Collaboration with sugar mills for large scale dissemination of biocontrol technologies at farmers' fields Strong linkages with extension scientists of KVKs, FASC and State Agriculture/Horticulture Department for promotion of proven Biocontrol technologies	2. Limited biocontrol production units in Punjab 3.Lack of awareness in the farmers as well as end users about the side effects of indiscriminate usage pesticides on environment, non-target species including human beings. 4.Area under organic farming in Punjab is quite less 5.Funds for dedicated production facility to enhance production at commercial scale are sparse 6.Microbial production up scaling on commercial scale limited due to registration issues	acceptable alternate way for bio-suppression of crop pests to produce residue free crop 2.Exploring BIPM technologies under organic and protected cultivation conditions 3.Integrating biogents/ biopesticides as a component of IPM to reduce the pesticide load in different crops in Punjab 4.Identification of potential natural enemies (arthropod and microbial) from various agro-ecological zones of Punjab Isolation, characterization and evaluation of indigenous isolates of entomopathogens against key insect pests in different crops	natural enemies to a great extent 2.Competition from pesticides which are having quick mode of action as compared to bioagents 3.The practice like stubble burning in Punjab is likely to pose a great threat to natural enemy and soil microbial fauna 4.Emerging pests problems are posing a new challenge

		Quality control of commercial biopesticides		
PJTSAU	1)Well established laboratory 2) strong linkages with the extension system and farmers to experiment biocontrol technologies in large scale 3) complete cooperation and guidance from the University policy makers	1) Lack of skilled manpower in the scheme to help in better conduct and dissemination of biocontrol knowledge to farmers 2) Less supporting staff 3) Lack of funds to carry out civil works of the scheme	1) Lot of interest from farmers regarding the use of biopesticides in the market 2) Good awareness about the use of biocontrol agents in farmers 3) Farmers come forward voluntarily to give land for experimentation to the scheme	1)Indisctriminate use of chemicals by farmers 2) Lack of manpower to carry out trials in large scale
SKUAST, Srinagar	1.Well established biocontrol laboratories for mass production.	Lack of heating in bio laboratories		Indiscriminate use of pesticides, Incursion of exotic pests and threat to crops, Farmers donot have faith on the biopesticides for complex pest atatcks and costlier ones
SKUAST, Srinagar	2. Initated the pheromone technology laboratory and prepraing lures.	Old computers and need to run the models to persue AI		Extensive use of synthetic insecticides
TNAU	1. Farmers are interested in using biological control	1.Lack of awareness about the long	1.Identification of new isolate of entomopathogens	Extensive use of synthetic insecticides

	agents for the management of insect pests 2. Department of Agriculture, Government of TamilNadu is showing keen interest in promotion of biological control agents 3. Sufficient infrastructure for the mass production of biological control agents available at TNAU	term benefits of biological control among the farmers 2.Slow action of biological control agents	viz., Beauveria bassiana and Metarrhizium anisopliae 2. Intensification of mass production of entomophages	
YSPUHF, Solan		Lack of awareness among the farmers about the harmful effects of chemical pesticides and long term beneficial effects of biological control. Farmers generally assess the pest management technology in terms of quick pest mortality and ignores the harmful	Ceating awareness about health cautiousness among consumers will result in a shift regarding use of biocontrol agents in the pest management strategies of crop pests. Collection and Identification as well as development of local effective strains of bio-agents will provide more opportunities for mass production and development of entrepreneurship.	The indescriminate use of pesticides is the biggest threat for diminishing of biocontrol agents. Lack of well trained extension personnels for dissemination of Biocontrol technology to the farmers in Pest Management. The non-availability of natural enemies at appropriate time is hampering the

		effects of chemical pesticides. Availability of *Metarhizium anisopliae* and *Neoseiulus longispinosus* in large quantities to the farmers is a limiting factor		adoption of biological control on a large scale. Large scale mass production of bioagents is also one of the biggest threat in managing insect-pests
CAU	Department of Agriculture, Government of TamilNadu is showing keen interest in promotion of biological control agents	Lack of skilled manpower, modern equipments for mass production of biocontrol agents of crop pests	Arunachal Pradesh being biodiversity hot spot, organic farming oriented state there are greater scope for exploration, demand for native strain based quality biopesticides and application of biocontrol agents for the promotion of organic plant protection and thus export of high value crops	Application of chemical pesticides, Lack of large scale active mass production laboratories, Lack of skilled man power for transfer of technology, Untimely availability of biocontrol agents due to transporation difficulties, Lack of awreness among farmers especilally of remote hilly zone areas and outbreak of new pests and diseases
MPUAT		Lack of skilled manpower	Scope of mass popularisation of bioagent &	Transfer of technology from lab to field

		and modern lack equipments, Insficicent fund for the regular opration of laboratories and mass popularisation of the technology	biopesticides in field & vegetable crops, Development of native bio control agents, which can tolerate salinity and water stress	would not be mate out due to lack of fund & manpower, Minimum support from Govt. functionaries for the popularisation of the use of bio agent & bio pesticides
OUAT	• Old laboratory for bio-agents production • Strong linkage with KVKs and state Agriculture departments of the state of Odisha for conducting the demonstrations (BIPM) in the farmers field in large scale. • BIPM practices on sugarcane and Rice crop showed promising results	• Old infrastructure facility and lack of funds to carry out the civil work of the scheme. • Lack of modern lab equipments. • Lack of supportive staff (laboratory & field) for mass production and release	· Bio-control agents are gaining popularity among farmers of Odisha in Sugarcane and Rice crop. • Scope of mass popularization of bio-agents and bio-pesticides in field as well as in vegetable crop.	. Due to indiscriminate use of broad spectrum pesticides by farmers in the field as well as in vegetable crops, population of natural enemies decrease to a great extent. •Lack of reliable manufactures of quality bio-control agents producer
UAS, RAICHUR	1. Well established laboratory with desired infrastructure to scale up production 2. Availability of dedicated and skilled manpower 3. RKVY funded project for new	1. Lack of liquid formulations of the biocontrol agents 2. Lack of large-scale production protocols like fermenter	1. Consumers are preferring the organic products which in turn promoting organic cultivation and the key input for organic cultivation is the use of quality biocontrol agents 2. Under ODOP scheme lot of demand	1. Legal threat due to lack of CIB and RC registration of biopesticides

	building and infrastructure exclusive for biocontrol production 4. Organic Agriculture is being promoted by the state government which demands quality biocontrol agents 5. Due to continuous efforts by the biocontrol team and KVK s farmers are coming forward to opt biocontrol agents	technology for mass production of EPF 3. Lack of quality control system for biocontrol agents	for biocontrol agents. 3. Few biopesticides have become very popular among the farmers and getting good results in chilli and sugarcane ecosystem 4. Diversity in cropping pattern allows to liquid ate the biocontrol agents in major crops of Northeastern Karnataka.	
CPCRI	Good laboratory facility for mass production of bioagents Qualified and potential faculties working as a team Multi-disciplinary experts evolve tangible biocontrol solutions for complex field issues Biological suppression of coconut black headed caterpillar and scale insects are pan India success storie	Perennial and tall system for effective spraying of microbials Need for field level contractual staff for assisting in data generatio	Bioagents (Entomophaga and Entomopathogens) are viable options in pest suppression of coconut Conservation biological control through zero-chemical tolerance can be boosted up in coconut system Ecosystem services and economic benefits in coconut needs documentatio	Biological solutions with mass production protocol for internal borers like red palm weevil and coreid bugs Potential invasive pests including exotic whiteflies and emergency preparedness module
IIHR	qualified scientist	lack of man power	large scale production	indiscriminate use of

				insecticides
IIMR, Hyderabad(Millets)	1. Largest group of plant protection, strong network of AICRP centers of Sorghum and small millets and Pearl millets for conducting multi-location trials for validation of technologies 2. Expertise in Insect host plant resistance as millets are grown in marginal lands and receives minimum or no inputs (fertilizer, pesticides)from farmers	1. Being dry land crops grown under rain fed condition (rabi) establishment of bio-control agents is poor, though success is there in irrigated crops where EPF are applied. 2. Slow results of biocontrol agents in comparision to insecticides	1. Millets are by and large grown under rainfed conditions with minimum or no fertilizers and pesticides hence biocontrol agent use and plant products for management of insect pests will help in organic labeling thus realizing higher margins. 2. Less or no use of pesticides throws scope for natural pest management and bio control interventions.	1. The area under millets especially sorghum is being lost to more remunerative crops like soyabean, cotton which command higher prices.
IIRR, Hyderabad	1. Largest network of Rice plant prpotection group under AICRP in rice with 44 centres spread across the country 2. PI and COPI are entomology and pathology combimation working in the field of rice biological control for several years. 3. Special training in Australia for novel methds to enhance	NO established production lab for mass production of biocontrol agents related to rice	1. Changing Climate needs to be adressed and its imapct on natural enemies need to be studies. 2. The pest and natural enemy diversity in terms of molecular taxonomy needs to be taken up. Species from across country needs to be studied. 3. Novel methods to enhance biocontrol through chemical ecology is an upcoming field for collaborative work. 4.	Rice cultivation is being threatened by lack of water, pest out breaks and monoculture of few mega varieties. Climate changes resultsin change in pest status. Minor pestsbecme major pests. Indiscrimintae dependence on pesticides and lac of avaiability of pheromone

	Biological control		Bioagernts and their metabolites for management of rice disseases can be studied	traps and bio control gaents is a major hurdle for bio intensive pest management. IN the institute level lack of infra structure and personnel for esatblishment and production of biocontrol agents is a major threat
IIVR,Varanasi	Qualified & potential faculties working as team	During summer high temperature accompanied with low humidity in and around Varanasi restrict the use of biocontrol agnets in the field	1. Short duration vegeatables 2. Use of entomopathogens have a graeterroel in vegetable pest management	Use of insectiides by the farmers
DRYSRUH, Ambajapeta		*lack of full fledged scientists under AICRP on biocontrol	*scope for research on predators, prasitoids and bioagents of coconut, cocoa and vegetables with special reference to Rugose spiralling whitefly in coconut and pod rot nd stem canker in cocoa, * exploitation of native biocontrol agents against major insect pests and diseases of cocoa	*outbreak of new insect pests and diseases due to climate change, *Difficulties in registartion of bioagents

IGKV	well established biocontrol lab	Lac of modenequipments (Steriomicroscpe BOD, refrigeretor etc). Limited production of bio agents	*scope for research on predators, prasitoids and bioagents of Rice, maize, chickpea, pigeonpea , vegetables and sugarcane, * identification and mass rearing of local native bioagents and exploitation against crop pests	1. lack of awareness of farmers about utilization/application of bioagents for crop pests 2. Less adoption of bio control agents, less area of natural/organic farming 3. Use of broad spectrum pesticides in the field
KAU, Kumarakom	well established biocontrol lab, qualified scientific staff	lack of qualified supporting staff,Shortage of land area for doing evaluation studies,non availability of sufficient labour	greater demand for bioagents and ample scope for mass popularisation,Development of native bio control agents which can tolerate salinity and water stress	Possibility of floods every year resulting in a situation to conduct all experiments during the same part of year, salinity during summer months, high weed menace
KAU, Vellayani	1. Expertise in biological control for 25 years 2.Well established Biocontrol Laboratory with basic facilities for research and mass production iii. A good rapport with State Dept of Agriculture Development and Farmer's Welfare	1. Lack of supporting staff 2. Lack of largescale production facilities 3. Lack of advanced research facilities. 4. Complicated and lengthy CIB & RC	1. Potential indigenous isolates of entomopathogenic fungi 2.Public awareness on “safe to eat food production “ 3.Ever increasing demand for biopesticides fungi	1.Frequent crop loss due to natural disasters 2.Changing climatic situations 3.Unprdicted pest outbreak 4.Spurious products of biopesticides

	iv. Wide dissemination of knowledge on biocontrol to the students as it is attached to the largest college of KAU v. Common outlet in college for sale of biocontrol agents vi. Funding from ICAR - NBAIR	registration procedures		
UBKV	Having one biocontrol laboratory under ELP programme	No seperate laboratory for mass production of bioagents under AICRp on Biological control. Lack of full fledged scientific and technical staffs.	This Sub-Himalayan region is very much rich in biodiversity of native bioagents which are yet to be explored. In this underdeveloped region several tibal farmers still follows natural farming practices where biocontrol technology can be implemented.	Lack of awareness and availability of commercially produced bioagents throughout the state. Small land holding and marginal farmers. Heavy rainfall area.
PDKV			2.Public awareness on "safe to eat food production "	
SKUAST - Jammu	Biocontrol lab is established, biopesticides are being multiplied as per demand			Lack of awareness among the farmers. Ready availability of effective bioagents is a major challenge for farmers of the whole region as no commercial

				biopesticide production unit is there.
UHAS, Shivamogga	* Well established state of art Biocontrol agents production laboratory *qualified research staff * well established research and development system		1.Ever increasing demand for biopesticides	
DRYSRHU, Tirupati	1. Higher each to the farming community 2. Field and irrigation facilities 3. Training halls and farmers guest house available 4. Expertise staff in plant protection and production of certified quality planting material	Bio-control Laboratory for mass production of bioagents not available, Technical staff required	Research on innovative formulations (biopesticides) which is needed by the fruit growers	Frequent pest outbreaks, Quality biopesticides a major concern due to which farmers are loosing trust
IIMR (WNC), Hyderabad	Expertise in insect host plant resistance aspects and strong linkage with AICRP centres of maize to validate experiments in multi location trials	Lack of laboratory space for the production of biocontrol agents at WNC ICAR-IIMR, Hyderabad and to be established at Ladhowal.	Development of potential biopesticides and biocontrol agents for sustainable management of insect pests Awareness creation among the farmers on biocontrol agents	Witnessing emerging pest problems
NIPHM	Well-equipped state of art biocontrol laboratory with suitable equipment	Lack of resources and funding to carry out AICRP BC	Facilities are available to take up adaptive research (Biocontrol laboratory,	Frequent, unpredictable changes in physical environment and

	required for production and quality control of biopesticides. Biocontrol lab is also having facilities for maintenance and production of predators, parasitoids and conducting exclusive training programs on production protocol for biocontrol agents and biopesticides and. In addition, NIPHM is conducting on-farm production of biocontrol agents to different stake holders (Agriculture Extension Officers and above of State Department of Agriculture / Horticulture of various States and Technical Officers and Scientific Staff of DPPQ&S, ICAR,SAUs and KVKs / Any Government officials related to the subject) including farmers.	work.	demonstration field and polyhouse). Identification and improvement of local strains of different entomopathogens.	consequent changes in pest distribution and abundance leading to uncertainty in outcome of field experiments. Emerging pests problems are posing a new challenge (Alien invasive species)
NRRI, Cuttack	1)Well established	1) Being a	1) Less exploration	1) Regular

	biocontrol laboratory, competent scientific staff working on biocontrol and application of different tools for increased performance of biocontrol agents 2) Globally competent institute on rice research, thus in-depth exploration on biological control of rice infesting insect/disease pests can be done 3) Hotspot location for many of the insect and disease pests. Thus, evaluation of bicoontrol agents and identifying the strain performing better against the insect/disease pest will be very authenticate 4) Many pathogens been submitted for patent where one product was provided with patent during the last year. Thus, more scope for developing a novel bicoontrol agent	voluntary centre lack of fund to carry out large scale activites 2) Lack of manpower to engage them fully on biocontrol activities based experiments. Only the manpower available with other projects were diverted for limited time and achieved the goal with painful effort 3) Farmers expectation of quick and knock down effect for pest management which they get satisied with chemical pesticides 4) Lack of promotion of biocontrol agents by the pesticide dealers	on native biocontrol agents exists. Thus, lots of opportunity to identify native biocontrol agents is possible 2) Development of novel biocontrol agents and climate resilient biocontrol agents is possible with availablity of modern biotechnology tools 3) Commendable area of cultivation is avaiilable near the forest, and delta area where the popular programme like TSP, SCSP sub-plans were already taken up very successfully with promising output in the institute. Thus, there is more possiblity to introduce the biocontrol agents and get a promising result in terms of reducing pesticide usage, promoting environmental safety etc. 4) Better coordination by the farmers and line government department personnel with the institute is a postitve platform to promote the well-proven technology	occurrence of natural calamities especially cyclones and super cyclones is a worse limitation 2) Ensuring availability of biocontrol agents in a large quantity and right time will be a major challenge 3) Convincing the farmers who practised with application of chemical pesticides and visualised the immediate effect to change to biocontrol agents which will have late effect will be a challenging task, but can be achieved with our proper approach

	which can be submitted for patenting. 5) State art laboratories on biocontrol, pesticide residue, availability of advanced equipments for mass production of biocntrol agents is a additional strength		5) Flagship programmes which is running in the institute has a place of activity concetrating on technologies for 30% pesticide usage reduction increases the scope for promoting the biocontrol based activity. 6) Lots of visits and contact with the institute by the farmers increases the scope to disseminate the better performing technology	

XXX. Infrastructure and physical facilities developed

Sl. No.	Centre	Infrastructure developed	Amount spent (Lakhs)	Purpose
1.	**GBPUAT**	Well Established Biological control laboratory having eight labs; a cold room and a smart class room. These labs are equipped with highly specialized equipments like Live Cell Image Analyser, Biolog, HPLC, PCR, RT-PCR, Flowcytometer, Spectrophotometer, Millipore water distillation machine, -80 & -20^0 C Deepfreezers, BODs, Laminar Flow	200.00	To conduct research work under biological control, trainings to researchers and mass production of Biocontrol agents

		Chamber, Autoclaves, Hot air oven, water Bath, and many more Biocontrol Laboratory, Pantnagar is a referral laboratory for testing qualityof biopesticides.		
2.	**PAU, LUDHIANA**	Renovation and upgradation of biocontrol (predator and parasitoid) laboratories	Rs. 15.00 (RKVY and ICAR)	Mass production of host insect and bioagents
		Net house facility	1.00 (From State Schemes)	To conduct research trials under net house conditions
3.	**CAU, Pasighat**	Renovation of Biocontrol laboratory	3.04	Renovation of Biocontrol laboratory for mass production of bio-pesticides
4.	KAU, Vellayani	Establishment of a Trichogramma production unit	2.00	Production of *T.japonicum* and *T.chilonis*
5.	**SKUAST, Srinagar**	Construction of Poly house	5.00	Rearing of insects under controlled conditions
		Laboratory for mass production of *Trichogramma* spp., predators and pathogens	1.00	Mass production of *Trichogramma*
		Camera	0.50	Images of insects
6.	**PJTSAU**	A green shadenet of 200 sq.m area	0.32	To conduct trials on testing of entomopathogenic fungi and bacteria on various crop pests
7.	**MPKV**	A well equippedreferral biocontol laboratory		Mass multiplication ofbiocontrol agents.Testing the quality of biopesticides
8.	**TNAU**	Renovation of *Corcyra* unit	2.55 (Private scheme	To enhance the production of entomophages

			funds)	
9.	**SKUAST-Jammu**	Production unit for production of *Trichoderma harzianum, T. asperellum, Pseudomonas fluorescens, Bacillus subtilis, Beauveria bassiana, Metarhizium anisopliae, Lecanicillium lecanii*		To supply the requisite bioagents to the line departments and farmers, as per their requirement
10.	**OUAT**	***Bio control laboratory***		***production of the following bio-agents Ex :*** *Trichigramma* spp., *Chrysoperla zastrowi sillemi ,Bracon hebetor, Goniozus nephantidis, Cryptolaemus montrouzieri. and Chelonus blackburni*
11.	**AAU, Anand**	Laboratory for the mass production of native biocontrol agents for insect pest management Facility for the mass production of microbial biopesticides for plant disease management	81.92 160.00s	For the mass production of microbial biopesticide *Metarhizium anisopliae* and *Bacillus thuringiensis* For the mass production of microbial biopesticide *Pseudomonas fluorescens*
12.	**AAU, Jorhat**	One Research Microscope 2 nos 1.5 ton Air Conditioner DSLR camera Computer and printer	2.60 1.10 0.61 0.74	For observation of predators, parasitoids etc To house the equipments *Trichogramma* rearing For documents printing
13.	**YSPUHF, Solan**	Stereo zoom microscope	0.88 6.00	Studying the morphological character of bioagents Maintenance of pure culture and study of

		BOD incubator		biology of bioagents
		Repair of culture room	1.14	For maintenance of culture of host insects and their natural enemies
		Hot air oven	1.00	For drying the glass wares making permanent slides
		Phase contrast compound microscope with image analysis system	-	Used for studying the morphological characters of insects and fungus
		Stereomicroscope with image analysis system	-	Used for studying the morphological characters of insects and fungus
		Autoclave	-	Used for sterilization of media for raising culture of microbials
		Environmental chamber	-	Maintenance of culture of host insects and natural enemies.
		Laminar flow	-	For inoculation of pure culture of microbials culture
		Polyhouse, *Corcyra* rearing facility	-	Rearing of crops and raising of culture of sp.
		Addition of New laboratory for Biocontrol	-	This laboratory will be utilized for insect pathological studies
14.	**KAU, Thrissur**	Renovated the insect pathology lab and instruments such as trinocular microscope with HD camera, cooling incubator shaker, micro fermenter etc were procured	78.03 (From SHM project)	Quality control of microbial biopesticides

		An additional unit for *Trichogramma* production was established.	3.50	Mass rearing of *Trichogramma*on *Corcyra* eggs
		A solar system was installed on the roof top of new building	Free of cost from DPP, KAU	Energy is being used for functioning of different equipments in incubation and inoculation rooms

XXXI. Collaboration with Inter-institutional and interdisciplinary linkages:

AAU, Anand

- Collaborated with Krishi Vigyan Kendra, Navsari Agricultural University (NAU), Vyara and Krishi Vigyan Kendra, Navsari Agricultural University (NAU), Dediapada and ICAR- Krishi Vigyan Kendra, Mangalbharti, Vadodara for tribal sub plan programme
- Collaborated with NGOs Triveni Kalyan Foundation (TKF) and Gram NirmanSamaj (GNS) functioning under the aegis of Pidilite Industries, Mumbai for the large-scale demonstration of bio-agent based IPM module for the management of whitegrub in groundnut in Mahuva and Bhavnagar area of Gujarat.

ANGRAU

Collaborative trials with ICAR- NBAIR, Bengaluru as co-investigator in developing technologies –

- *Metarhizium anisopliae* ICAR-NBAIR Ma4 for the management of white grubs in Sugarcane (2015-2016 to 2018-19)
- *Metarhizium anisopliae* ICAR-NBAIR Ma35 for the management of fall armyworm in Maize (2018-19 & 2019-20)
- *Bacillus thuringiensis* NBAIR Bt G4 for the management of Pigeon pea pod borer complex (2015-2017)
- Field evaluation of ICAR-NBAIR entomopathogenic strains against Rice stem borer (*Scirpophaga incertulas*), leaf folder (*Cnaphalocrosis medinalis*), Brown plant hopper (*Nilaparvata lugens*) (2019-2022)
- Field evaluation of ICAR-NBAIR strains against Rice Blast (*Magnaporthe oryzae*),Brown spot (*Bipolaris oryzae*) and Sheath blight (*Rhizoctonia solani*) (2019-2021)
- Management of leaf spot and color rot in groundnut through biocontrol agents (2019-2021)
- Management of thrips in Capsicum through biocontrol agents (2019-2021)

OUAT

- Linkages were developed with KVKs of the state and other laying departments of the state Govt. of Odisha like Department of Agriculture and food production of Odisha,

Dept of Horticulture, Odisha, CIPMC, Odisha and other institutes like ICAR-NRRI, Cuttack and ICAR-CIFA, Bhubaneswar etc.

TNAU

- Farmer's awareness campaigns, training programmes and field demonstrations were conducted in collaboration with the Department of Agriculture, Government of TamilNadu.
- Nymphal parasitoid, *Encarsia guadeloupae* and chrysopid *Apertochrysa astur* eggs were produce and supplied to the farmers for the management of coconut rugose spiralling whitefly, *Aleurodicu srugioperculatus* under the coconut development board scheme titled "Mission mode programme on the management of coconut rugose spiralling whitefly, *Aleurodicus rugioperculatus* Martin with nymphal parasitoid, *Encarsia guadeloupae* Viggiani".
- *Anagyrus lopezi* and *Apertochrysa astur* were released in cassava fields in Erode Dt. For the management of cassava mealybug in Colloboration with NBAIR, Bengaluru and SPAC, Poonachi.
- Field demonstrations on the use of Biological control agents were conducted by B.Sc. (Agri) Students under RAWE programme organized by Dept. of Agricultural Extension, TNAU, Coimbatore

MPKV

- MoU with *Pani Foundation*, State Department of Agriculture, Maharashtra and, MPKV, Rahuri.

CAU, Pasighat

- CAU-Pasighat with ICAR-NBAIR, Bengaluru
- CAU-Pasighat with ICAR-NCIPM, New Delhi
- CAU-Pasighat with AAU-Jorhat

SKUAST, Srinagar

- SKUAST-K & SKUAST-K AICRP-BC
- SKUAST-K, AICRP on Maize with AICRP-BC SKUAST Centre
- SKUAST-K, AICRP-BC and NBAIR
- SKUAST-K, AICRP BC
- SKUAST-K, AICRP-BC and Department of Horticulture, Kashmir
- SKUAST-K, AICRP-BC and Advanced Centre for Horticulture

UBKV, Pundibari

- The ongoing research programmes based on entomopathogenic fungi are being conducted in collaboration with scientist from the Department of Plant Pathology, UBKV.

IIRR

- BIO control products from NBAIR and collaborating institutes suchs s NRRI KAU are being tested through rice AICRP in multi institute mode

AAU, Jorhat

- Collaboration with Deptt.Of plant pathology for biopesticides production, M.Sc and Ph.D. research
- Collaboration with Deptt. Of Agronomy, Soil Science and Horticulture for pest management of organic and natural farming
- Research collaboration with BARC
- Collaboration with IPFT, Delhi
- Student research collaboration with Tezpur University
- Student research collaboration with Agricultural University of Athens, Greece

YSPUHF, Solan

- Collaboration with Inter-institutional and Interdiscplinary Linkages:18 numbers institutes /KVKs

KAU, Thrissur

- TSP programmes were conducted in collaboration with Department of Agriculture, National Seed Corporation and Kudumbasree Mission, Government of Kerala.
- Large demonstration trial, “BIPM in rice” is being carried out with the support from the Department of Agriculture and Alathurgrama panchayat (Palakkad district).

NRRI

- ICAR-NRRI has been included as a centre in AICRP-Biocontrol during 2020-2021. We also made collaboration with ICAR-IIOR, Hyderabad and evaluated the entomopathogenic strains against rice insect pests and diseases. Collaboration was done within the institute i.e., with microbiologist of Crop Production Division developed a bio-agent against rice leaf folder and promoted for multi-location trail.
- With intra-institutional collaboration a project named “Bio-Bank” funded by RKVY-Odisha was run in the institute concentrating on macrobials and microbials for management of major insect and disease of rice.

XXXII. 14. Extension activities

Sl. No	Centres	Topic	No of farmers	No of officials	Village covered	Training outcome
1.	CPCRI	Sensitization campaign and incursion management of exotic whitefly complex	4400	240	32	Knowledge empowerment and technology transfer
		Bio-suppression of black headed caterpillar by release of stage-specific parasitoids	950	20	7	Technology delivery and impact assessment
		Palm health management (Andhra Pradesh, Karnataka, Tamil Nadu, Kerala)	1560	100	45	Knowledge empowerment & Technology demonstration
		Bio-suppression of coconut rhinoceros beetle (Tamil Nadu, Kerala)	950	25	25	Women empowerment and technology transfer
2.	NCIPM	IPM in cotton	200	3	Bakainwala, Deewankhera, Hindumalkot, Haripura, Patrewala, Nihalkhera and ChudiwalaDhanna in Fazilka, Punjab	Awareness about whitefly and natural enemies identification and IPM in cotton
		FAW in pearl millet	50	4	Bharthna and Mahewa Block of	

					of Etawah district UP	
		IPM in chickpea	50	1	Chokari, Jhansi, UP	Awareness about Pheromone trap use and *Trichoderma* seed treatment
		IPM in chickpea	50	2	Ragauli village Jalaun, UP	Do
		IPM in chickpea	30	2	village Satraju, Jalaun UP	Do
3.	UBKV, Pundibari	Ecofriendly management of insect pest in vegetables and rice.	60	4	Latapata, Mathabhanga-II	Farmers became aware about non-chemical pest management.
		Biological control of pests and promotion of beekeeping	160	1	Patiram, Dakshin Dinajpur	Beekeeping adapted
		Field day on beekeeping	60	1	Danshin Latabari, Nimati Forest Alipurduar	Awareness on beekeeping
		Biological control of crop pests.	35	3	Ramsai, Jalpaiguri	Control of insect pests through biological approaches.
		Cultivation practices of mustard through biological intervention and beekeeping.	75	1	Nurpur, Alipurduar	
		Pests and disease	75	-	Nurpur,	

		management in mustard using botanicals and microbials.			Samukhtala, Alipurduar	
		Cultivation practices of litchi organically as the source of pollen and nectar for honey bees.	40		Nurpur, Alipurduar	
		Training cum bio-input distribution	20		Singimari, Coochbehar	
4.	PAU, LUDHIANA	Mass production and utilization of biocontrol agents (6-7.3.2018)	-	5	-	• Upgradation of knowledge • Skill development (Trainings for Technical Staff)
		Mass production and utilization of biocontrol agents (6-7.9.2018)	-	3	-	
		Mass production and utilization of tricho-cards in *kharif* crops (17.7.19)	-	3	-	
		Mass production of host insect and bioagents (4.3.2020)	-	4	-	
		Mass production of bioagents and their utilization for the management of major crop pests (2.3.2021)	-	5	-	
		Biological control of insect pests and diseases in organic rice (12.6.2018)	45	2	Villages of Sangrur district	• Increased awareness among farmers for non-chemical methods of pest control and good agricultural
		Biological control of insect pests in rice and maize crop (1.8.2018)	45	2	Village Badowal (Hoshiarpur)	
		Biological control of	25	3	Villages	

		insect pests (29.8.2018)			of Ludhiana district	practices • Technology adoption (Trainings for farmers)
		Biocontrol of insect pests (30.8.2018)	22	2	Villages of Kapurthala district	
		Management of insect pests through bioagents (12.10.2018)	12	3	Village Sahauli (Patiala)	
		Identification and utilization of bioagents in pest management (2.11.2018)	15	2	Village Gunike (Patiala)	
		Promotion of biological control of insect pests and diseases (21.11.2018)	34	2	Villages of Moga district	
		Good Agricultural practices in summer moong (5.4.2019)	25	3	Villages of Patiala disrict	
		Good Agricultural practices in summer moong (8.4.2019)	25	4	Villages of Sangrur district	
		Biological control of insect pests in *kharif* crops (26.4.2019)	48	2	Villages of Hoshiarpur district	
		Good agricultural practices in *basmati* rice (30.5.2019)	67	4	Villages of Patiala, Sangur& Ferozepur districts	
		Biological control of insect pests in organic *basmati* rice (5.8.2019)	25	1	Sarkaudi (Sangrur)	
		Utilization of	16	3	Kheri	

		bioagents for management of insect pests in *kharif* crops (14.8.2019)			Kalan (Barnala)	
		Biological control of insect pests in *kharif* crops (4.9.2019)	22	2	Bhadalwad (Sangrur)	
		Biological control of insect pests in sugarcane (13.9.2019)	45	2	Garhshankar (Hoshiarpur)	
		Biological control of insect pests in wheat (24.12.2019)	22	1	Village Biradwal (Patiala)	
		Biocontrol of insect pests in kharif crops(20.3.2020)	20	2	Village Gunike (Patiala)	
		Insect pest management through non-chemical approaches (26.6.2020)	12	1	Birdwal (Patiala)	
		Biocontrol on insect pests in basmati rice (29.7.2020)	10	2	Sakraudi (Sangrur)	
		Biocontrol on insect pests in rice (14.8.2020)	15	2	Dhira Patra (Ferozepur)	
		Eco-friendly management of sugarcane borers through biocontrol technology (20.11.2020)	23	3	Chaggran (Hoshiarpur)	
		Biocontrol based integrated pest management technology for insect pests (18.2.2021)	25	2	NeelaNaloya (Hoshiarpur)	
		Management of wheat insect pests by using non-chemical	16	2	BhojoMajri (Patiala)	

		methods (8.3.2021)				
		Validation and dissemination of biocontrol based technology in sugarcane (9.3.2021)	85	3	Garhshankar (Hoshiarpur)	
		Biocontrol of insect pests (1.10.2021)	45	2	Villages of Faridkot district	
		Biocontrol of insect pests (26.11.2021)	50	1	Villages of Muktsar Sahib district	
		Biocontrol of insect pests (30.11.2021)	48	2	Villages of Faridkot district	
		Biocontrol of insect pests (4.3.2022)	42	2	Villages of Ferozepur district	
5.	SKUAST, Srinagar	Biological Control of insect pests of cabbage	20	5	20	Exposure
		Ecological engineering for conservation biological control of insect pests of cabbage	20	10	20	Exposure & awareness
		Biological control an important component of IPM	20	5	20	Awareness
		Mass production of natural enemies and their field applications	60	2	20	Skill training
		Mass production technique of natural enemies and their field applications in	50	2	30	Skill training

		brinjal and tomato				
		Demonstrations of natural enemies of *Brevicoryn ebrassicae, Plutella xylostella* and *Pieris brassicae* on kale and cabbage	20	02	one	Demonstration
		Trichogramma spp against tomato fruit borer and shoot and fruit borer of brinjal	20	02	one	Demonstration
		Demonstration of pheromone traps	40	5	10	Skill training
		Regular training on the biological control techniques	20	10	10	Skill training
		Awareness camp	60	04	05	Fruit borer
		Awareness camp	55	04	10	Apple blotch leaf miner
		Awareness camp	60	05	12	Apple blotch leaf miner
		Awareness camp and trainings with line departments in incursion areas of Baramulla	40	08	13	Fruit borer
6.	SKUAST, Srinagar	Awareness camp and trainings with line departments in incursion areas of Shopian	60	07	14	Apple blotch leaf miner
7.	IIHR	Biological control and Integrated Pest management in Nursery and Vegetable crops	150	3	4	Farmers got benefited from the training.
8.	IIRR	IPM awareness workshop	60	20	Koraput region of odisha (5 districts)	Awareness about use of pheromones and Trichocards

						and seed treatment PGPRs
		IPM awareness workshop	20	2	Ibrahimpatnam telangana	Awareness on bund cropping benefits andreducing insecticides
9.	KAU, Vellayani	Biopesticides for pest management in coconut	25	5	Vilavoorkkal	
		Biopesticides for pest management in banana	25	5	Malayinkeezhu	
		Biopesticides for pest management in vegetables ‘’	25	4	Maranalloor	
		Biopesticides for pest management in banana	25	7	Malayinkeezhu	
		Potential of biocontrol agents in pest management	25	9	Malayinkeezhu	
10.	KAU, Kumarakom	Awareness programme of use of entomopathogenic fungi and other biological control agents was conducted at Krishibhavan Vazhoor, Kottayam district on 3.3.21	20	3	2	
		Online Interface with farmers at Vazhoor block as part of Prime Ministers address to farmers on 28.9.21	15	-	5	
11.	PJTSAU	Participated in seven Radio Talks on Bio Agents & Bio Pesticides at All	30	2	-	Farmers get info. On biological control of crop

		India Radio, Hyderabad during August 2017.				pests
		2. Participated in Doordarshan Phone in Live Programme and answered the queries of farming community on Biological Control at Doordarshan Kendra, Hyerabad during 2017	250	1	-	Farmers get info. On biological control of crop pests
		Participated in a phone-in-live programmes for farmers on 20.08.2022 to answer their queries on TV TSAT	-	-	-	Farmers get info. On biological control of crop pests
1 2.	CAU, Pasighat	Integrated Pest Management in Horticultural Crops at CHF Pasighat dated 23-25 March, 2019	100	03	04 nearby villages of Pasighat	Tribal farmers benefited with higher crop yields due to application of Neem oil, Light Trap and quality vegetables
		Training Programme on 'Bio-intensive Pest Management in Tomato and Cabbage'at CHF Pasighat dated 16th to 18th February 2021	30	-	03 Jampani Oyan, Sille, East Siang	Capacity building training helped the Non tribal NEH farmers to aware and usage of bio-intensive IPM in Tomato and Cabbage in the place of Chemical control alone
		Training Programme	30	-	01	Capacity

		on 'Biological Control of Mustard and Maize Pests' at Taki Lalungvillageduring 17th to 19th March 2021			Taki Lalung, East Siang	building training helped the Tribal NEH farmers to aware and usage of bio-intensive IPM in Mustard and Maizefor getting higher crop yields
		Five number of one day off-campus awareness cum inputs distribution programmes to tribal farmers at different villages (Feb-March, 2021)	200	-	05 Jampani, Taki Lalung (East Siang), Ditchik, Nachibon &Lower Dzoung, Nafra circle, (West Kameng)	Tribal farmers especially from Nafra circle of West Siang was given with awareness on talc based bio-pesticides which they given feedback as first of its kind
		Field day under FLD on biological control of insect pests of mustard during 19th Dec 2020.	25	-	01 Yagrung Todeng village (East Siang)	Significantly higher crop yield in Rapeseed with BIPM module (9.36 q/ha) compared to farmers practice (6.44 q/ha)
		Field day under FLD on bio-intensive pest management in cabbage during 29th Jan 2021	35	-	01 Jampani village (East Siang)	Nontribal NEH farmers were demonstrated with using BIPM technology for economic Cabbage

						production
		Field day under FLD on biocontrol based pest management in tomatoduring06th Feb 2021	25	-	02 Jampani &Sille villages (East Siang)	Tribal and Nontribal NEH farmers were demonstrated with using BIPM technology for economic Tomato production
		Field day under FLD on biocontrol based pest management in maizeduring31st March 2021	15	-	01 Berung village (East Siang)	Tribal NEH farmers were demonstrated with using BIPM technology for effective management of invasive pest FAW on Maize
		Nine number one day off-campus awareness cum inputs distribution programmes to tribal farmers at different villages (April 2021-March, 2022)	222	-	09 GuneBalek,Mirem, Sikatode & Taki Lalung (East Siang), Dechingtong,Sekor, Dorjeeling, Ropum, Lungte (ShiYomi)	Tribal farmers especially from ShiYomi district was given with awareness on talc based bio-pesticides which they given feedback as first of its kind
		Two number one day on-campus awareness cum inputs distribution	64	-	02 Dambuk (Lower Dibang	Benefitted Citrus growing farmers from Dambuk which

		programmes to tribal farmers at CHF Pasighat (29th Oct 2021 and 11th Dec 2021)			Valley) &Mebo (East Siang)	is known for export quality of Khasi Mandarin
		Seven number one day off-campus awareness cum inputs distribution programmes to tribal farmers at different villages (April 2022-December, 2022)	185	-	07 Berung, Mongku, Ayeng villages (East Siang) Padu village (Upper Siang), Riga (Siang), Ziro (Lower Subansiri), Nongkhon (Namsai)	Promoted the organic production of export quality Kiwi among 50 tribal farmers of Ziro valley, Lower Subansiri by distributing microbial pesticides
		FLD on BIPM module for FAW management in Maize	10	-	01 Tulap village (East Siang)	Effective management of invasive pest FAW on Maize
		Awareness cum Biocontrol Inputs Distribution Programme to Non Tribal Farmers under NBAIR-NEH Component during 03rd Sep 2022	34	-	01 Jampani (East Siang)	Prompted Organic production of Vegetables
		FLD Programme on BIPM in Okra	05	-	02 Jampani &Tulap villages (East	Demonstrated the economic production of Okra

					Siang)	
		FLD Programme on BIPM in Rice	10	-	03 Mirem, Bodak &Sille villages (East Siang)	Demonstrated BIPM in Paddy
		FLD Programme on BIPM in Brinjal	10	-	02 Jampani &Tulap villages (East Siang)	Demonstrated the economic production of Brinjal
13.	MPKV	Agro Technology Exhibition was organized by AC pune	more than 500			Scientists provided the information of Bioagent and Biopesticide
		Mass production of bioagents	80	3		Mass production of bioagents
		Ago Technology Exhibition	more than 400 farmers			The Scientists and students provided the information on Bio-agents and Biopesticide to the Dignitaries and farmers.
15.	MPUAT, Udaipur	Three farmer trainings were conducted on farmers field at Veerpura and Pilader villages of Jaisamand for awareness of bio-control and conserve the natural enemies populations	150		2	Technology delivery and knowledge empowerment
		Three farmer's training were conducted at farmers	Non-TSP Area246		11	Knowledge empowerment & Technology

		field in different villages and to aware the farmers for biological control of crop pests in *Kharif* and *Rabi* seasons 2019-20.	TSP-Area 234			demonstration
		Two farmer's training were conducted at farmers field in different villages and two trainings were conducted at RCA, Udaipur (On-Campus) to aware the farmers for biological control of crop pests in Kharif and Rabi seasons 2020-21.	192		4	Women empowerment and technology transfer
16.	TNAU	Farmers day – Exhibition 9.02.18 and 10.02.18	Above 300	12	Villages in Coimbatore	Awareness on biological control
		Management of Rugose spiralling white fly 31.08.18	Above 100 Farmers grievance day	35	Villages in Coimbatore	Awareness on biological control
		Rugose spiralling white fly and maize fall armyworm awareness campaign 16.11.18	25	3	Valukkuparai block	Awareness on biological control
		Maize fall armyworm awareness campaign 19.11.18	45	3	Udumalpet block	Awareness on FAW mangement
		Maize fall armyworm awareness campaign 30.11.18	25	3	Poonachi block	Awareness on FAW mangement
		Rugose spiralling	25	3	Karamad	Awareness on

		white fly and maize fall armyworm awareness campaign 8.2.19			ai	biological control
		Rugose spiralling white fly awareness campaign 11.3.19	25	3	Namakkal	Awareness on biological control
		Rugose spiralling white fly and maize fall armyworm-awareness campaign 27.5. 19	35	2	Kinathukadavu	Awareness on biological control
		Cassava mealy bug – Release of parasitoids – Demonstration 06.09.19	23	4	Edapadi	Awareness on biological control
		Coconut rugose spiralling whitefly – Field demonstration of IPM packages 24.09.19	25	3	Thippampatty - Pollachi	Awareness on biological control
		Awareness campaign on fall armyworm – RAWE students25.09.19	30	3	Valavadi	Awareness on biological control
		Coconut rugose spiralling whitefly – Field demonstration of IPM packages 26.11.19	55	5	Kalangal, Sulur	Awareness on biological control
		Awareness campaign - Coconut rugose spiralling whitefly - 11.12.19	35	3	Kosavampalayam, Sengodampalayam, Mulakarai	Awareness on biological control
		Awareness campaign - Coconut rugose spiralling whitefly 18.01.20	35	3	Kovilpudur, Madachur, Karapadi	Awareness on biological control

		Awareness seminar - Coconut rugose spiralling whitefly 23.01.20	20	2	Pichandampalayam	Awareness on biological control
		Management of Rugose spiralling whitefly in coconut 17.02.21	29	2	Sattakkalpudur	Awareness on biological control
		Management of Coconut Rugose spiralling whitefly – ATMA training 16.09.21	200	12	Ambarampalayam - Sungam	Awareness on biological control
		Management of Coconut Rugose spiralling whitefly – ATMA training 24.09.21	50	3	Idikarai	Awareness on biological control
		Management of Rugose Spiralling Whitefly 21.01.22	29	4	Kundadam, Tirupur Dt.	Awareness on biological control
		Management of Rugose Spiralling Whitefly 25.01.22	25	2	Kannakurichi, salem dt	Awareness on biological control
		Management of Rugose Spiralling Whitefly 09.03.22	40	4	Palakkarai, Erode Dt.	Awareness on biological control
		Management of Rugose Spiralling Whitefly 11.03.22	105	8	Uchipuli, Ramanathapralm Dt	Awareness on biological control
		Management of Rugose Spiralling Whitefly 15.03.22	43	3	Thondamuthur, Coimbatore Dt.	Awareness on biological control
17.	OUAT	Popularrisation of use of biocontrol agents in management of insect pests of sugarcane (TSP)	100	3 (29/03/2022)	Haladikundi, Dolpashi and Kharatangara of Kankada	Farmers were able to identify the damaged symptoms caused by the pests and know how to fix

					hada block of Dhenkanal districts	/release of bioagents
		Biological pest control in field crops and vegetable crops DR. T. Samal	20	2 (23/11/2022)	KVK,ICAR-CIFA,KHURDA DISTRICT	
18.	ANGRAU	Biointensive pest management in organic cultivation of rice , Rajmah and Ginger at Koyyuru, Visakhapatnam district on 30.10.2017	29	5	2	Farmers adopted Biocontrol
		Biointensive pest management in organic cultivation of rice, Rajmah and Ginger at Asarada, Chinthapalli on 22.11.2017	30	6	3	Farmers adopted Biocontrol
		Biointensive pest management in organic cultivation of rice, Rajmah and Ginger at Asarada, Chinthapalli on 22.11.2017	30	6	3	Farmers adopted Biocontrol
		Vittana Mitra Training programme and delivered lecture on Seed safety, storage and protection from pests and diseases in rice, pulses and oilseeds at RARS, Anakapalle on on 23.6.17.	30	3	10	Farmers motivated

		Vittanamitra programme on 6.11.17 and imparted training on Red gram, Green gram, Black gram, Horse gram, cowpea-Major pest problems and control measures at Chodavaram, Visakhapatnam district	40	4	15	Farmers motivated
		Training cum demonstration on coconut IPM at Govindapuram village, Vizianagaram districton 30.11.17	60	8	10	Demonstrated rhinoceros beetle management in cocont orchards .
		Trichocard production using Eri silkworm eggs and Corcyra eggs for farmers from Asarada, GK veedhimandal, Chinthapalli on 15.3.18	15	1	1	Farmers motivated and initiated Trichocard production at Asarada village
		Vittana Mitra Training programme and delivered lecture on Seed safety, storage and protection from pests and diseases in rice, pulses and oilseeds at RARS, Anakapalle on on 23.6.17.	30	3	10	Farmers motivated
		Training programme to MPEO's organized at by Scientist, Extension and Delivered talk on	25	5	25	Extension staff motivated

		Biological control of pests in sugarcane on 14.12.18 .				
		MPEO's Training programme organized by ADA, Cheepurupalli at Cheepurupalli on 22.12.18 and interacted on present status of fall armyworm in maize in cheepurupalli division and management practices adopted in *rabi* maize.	25	4	25	Extension staff motivated
		Vocational training programme on Friends of coconut tree and interacted with coconut farmers on rugose whitefly damage and management at KVK, Amadalavalasa on 2.2.19.	30	4	30	Motivated farmers on mass production
		Conserving soil biodiversity using biopesticides in pest management on 5.1.2019	30	16	30	Created awareness
		Orientation district level training programme to farmers and FPOs on Pest Identification and management during training programme on production technology of pulses	25	4	25	Created awareness to FPO's and farmers

		under APRIGP programme funded by SERP at RARS, Anakapalle on 7.1.19.				
		BIPM in vegetables at Marripalem, GK Veedhimandal, Visakhapatnam district on 25.2.2020	30	4	1	Utilised Bioagents in Demonstrations
		BIPM in vegetables at Kothapalem, Lambasingimandal, Visakhapatnam district on 10.12.2020	32	2	1	Utilised Bioagents in Demonstrations
		BIPM in rice, ginger, turmeric, vegetables at Kollaput – Kothavalasa , Dumbrigudamandal on 17.12.2020	25	5	2	Utilised Bioagents in Demonstrations
		BIPM in rice, ginger, turmeric, vegetables at Killoguda, Dumbrigudamandal on 27.8. 2021	40	2	18	Utilised Bioagents in Demonstrations
		BIPM in rice, ginger, turmeric, vegetables at Sovva, Dumbrigudamandal on 21.12. 2021	65	5	13	Utilised Bioagents in Demonstrations
		Ecological engineering to ADA's, Ao's of Department of Agriculture, Visakhapatnam at FTC, Anakapalle on 18.11.2019 for YSR Polambadi programme.	120	5		Awareness to Extension staff

		Training programme on Biological control agents (parasites, predators, fungi, bacteria) in pest management to ADA's, Ao's of Department of Agriculture, Vizianagaram on 03.01.2020 for YSR Polambadi programme.	120	5		Awraeness to extension staff
		Pink bollworm management in cotton farmers training programme organised by Daattcentre, Vizianagaram on 16.09.2019 at Piridi, Bobbillimandal, Vizinagaram district, gave lecture on Cotton pink bollworm worm identification, damage and management practices.	50	3	2	Conducted demonstration of pink boll worm management with Trichocards in 5 acres area.
		Awareness programme on Biocontrol agents and Biopesticides production at RARS, Anakapalle on 23.11.2019	50	3	2	Awareness to farmers
		Training programme conducted on paddy, pulses, rajmash for the Master Trainer farmers on 12.12.2019 at	30	2	30	Awareness to farmers

		Anakapalle				
		Skill training to Rural Youth (STRY) on "Preparation of Bio fungicides and Bio pesticides" on 13.2.20	25	2	25	Hands on training
		Farmers training programme on the occasion of World soil day on 05.12.2020 at RARS, Anakapallle, imparted training on Conserving soil biodiversity using biopesticides in pest management	30	4	30	Created awareness
		Farmers Awareness Programme on Climate, Weather and Crops to the Farmers of North Coastal Zone 12.2.2020	60	3	20	Created awareness on Biocontrol
		Master trainers training on single node seedling technology in sugarcane 13.3.2020 at RARS, Anakapalle	30	3	30	Created awareness
		Role of Biopesticides and Biocontrol agents in Organic farming" in Distance learning course on Organic farming on 26.9.2020	455	1	455	Organic farming certificate course given to participants under ANGRAU
		Dr. YSR Polambadi District workshop meeting organized by JDA,	120	4	120	Stake holders gained knowledge on biocontrol

		Visakhapatnam at Farmers Training Centre, Anakapallle on 12.10.2021 and discussed on implementation of pest management with biological control in organic farming in the district				
		Role of Biopesticides and Biocontrol agents in Organic farming" in Distance learning course on Organic farming on. 2021	175	1	175	Organic farming certificate course given to participants under ANGRAU
		Short course on Organic farming in Practice organised by Regional Agricultural Research Station, Chinthapalli, ANGRAU during 21.10.21 to 1.11.2021	80 agricultu re faculty	4		Gave lecture on Integrated pest management in organic cultivation
		Awareness programme on Biological control for farmers of Srikakulam, Vizianagaram, Visakhapatnam districts for adopting biological control in rice, maize on 29.11.2021.	100	3	25	Motivated on Biocontrol agents production
		Training programme on management of maize fall army worm	50	3	1	Motivated for adoption of demonstration on management

		to maize farmers at Thatithuru village, Bheemilimandal Visakhapatnam districts on 31.01.2022.				of maize FAW in 20 acres .
		Awareness programme on Biological control in coconut to coconut farmers at Govindapauram, Pusapatiregamandal, Vizianagaram district on 19.02.2022	100	9	4	Motivated for adoption of demonstration on management of coconut rugose spirallying whitefly in 50 acres.
		BIPM in Rice, Rajmah, Ginger at Asarada, GK Veedhimandal during Kharif & rabi, 2017 -18	112	4	6	Adoption in demonstrations
		BIPM in Rice, Rajmah, Turmeric at Kothavalsa, Dumbrigudamandal during 2018-19	78	2	5	Adoption in demonstrations
		BIPM in Rice, Ginger, Turmeric at Aratichetlaveedhi, GKveedhimandal during 2018-19	63	5	3	Adoption in demonstrations
		Biointensive pest management in vegetables at Marripalem, GKVeedhimandal in 2019-20	30	2	3	Adoption in demonstrations
		Biointensive pest management in vegetables at Kothapalem, Lambasingimandal in 2020-21	32	2	1	Adoption in demonstrations

		BIPM in rice, Ginger, Turmeric, vegetable at Kollaput, Dumbrigudamandal during 2020-21	25	2	1	Adoption in demonstrations
		BIPM in rice, Ginger, Turmeric, vegetable at Killoguda, Dumbrigudamandal during 2020-21	40	2	18	Adoption in demonstrations
		BIPM in rice, Ginger, vegetable at Sovva, Dumbrigudamandal during 2020-21	65	5	13	Adoption in demonstrations
19.	AAU, Anand	Farmers meet and input distribution programme under the TSP project Location – KVK, Navsari Agricultural University (NAU), Vyara, Dist. Tapi, Gujarat Date: 12/02/2018	64	--	Dolara, Katasvan, Virpore, Gatadi, Uccham ala, Degama	Significant reduction (55-60%) in pest and disease with 10-15%increase in the fruit yield.
		Farmers meet and input distribution programme under the TSP project Location –Tribal Research cum Training Centre, AAU, Devagadh Baria, Dist. Dahod, Gujarat Date: 23/03/2018	50	--	Ruvab ari, Thoya ni, Nanim angoy, Beyna Agara	There was a significant reduction (65-70%) in incidence of *Fusarium* wilt and *H.armigera* and 12-15% higher yield was recorded
		Farmers meet and input distribution programme under the	70	--	Dediyapa daand Sagbara	Significant reduction (15-20%) in use of

		TSP project Location – KVK, Navsari Agricultural University (NAU), Dediapada, Dist. Narmada, Gujarat Date: 04/10/2018 19/11/2018 02/03/2019			tehsils of Narmada district	chemical pesticides was recorded. Increase in yield 8-10 %
			100	--	Bujetha, Limpura Talvpura, Aambaliya	
			100	--	Timbapada Pansar, Alamavali PiplaKankal Panuda,Nivalda	
		Farmers meet and input distribution programme under the TSP project Location – KVK, Navsari Agricultural University (NAU), Dediapada,Dist. Narmada, Gujarat Date: 19-07-2019	100	--	Tilipala, Alamavadi, Garda, Nivalda Tapda, Pipla Pansar, Timbapada, Panuda	Significant reduction (35-40%) in use of chemical pesticides was recorded. Increase in yield 10-12%
		Farmers meet and input distribution programme under the TSP project Location – KVK, Navsari Agricultural University (NAU), Dediapada,Dist. Narmada, Gujarat Date: 19-08-2019	100	--	Nivalda, Tilipada Alamavadi. Tapda Soliya, Kanjal Relva,Nanibedvan, Navagam Mandala, Pipla,Pansar,Bhatpur,Kankala,Pipla,R	Significant reduction (20-25%) in use of chemical pesticides was recorded. Increase in yield 8-10 %

					ojghat,Nani, dor Amba, Almavali	
		Farmers meet and input distribution programme under the TSP project Location – KVK, Navsari Agricultural University (NAU), Dediapada, Dist. Narmada, Gujarat Date: 29-09-2020	50	--	Karatha, Rajpipla Sanjroli, Guvar Tankari, Kothara Timrva,Kareli Vanji,Gulvani Vagrali,Jetpur Haripura	Significant reduction (25-30%) in use of chemical pesticides
		Farmers meet and input distribution programme under the TSP project Location – KVK, Navsari Agricultural University (NAU), Dediapada,Dist. Narmada, Gujarat Date: 09-03-2021 16-03-21	25	--	Samariya ,Naniraval, Sengpura, Sakva, Bhilvasi, Moti Raval, Nava Vaghpura MotaAamba, Surjvad, Bhandra,Guvar Sanjroli, Karatha Tankari, Kothar Ammali, Vavdi Pratappura,Sakdi	Significant reduction (20-25%) in use of chemical pesticides was recorded. -

			50	--	Navagam ,Nani singlodi, Tmbapad a, Kaltar,Be bar Jadoli,Ch ikda Khurdi,C hamba Chikda,K unbar Jambar,V alpada	
		Farmers meet and input distribution programme under the TSP project Location – KVK, Navsari Agricultural University (NAU), Dediapada,Dist. Narmada, Gujarat Date: 28-10-2021 22-02-22 15-03-22	25	--	Soliya,M ohabhi Kham,Al mavadi Nigat,Bar san Guldacha m,Didiya pada Vedchha, Taval Nani bedva Navagam , Gajar gota,Aajn ai Timba pada Nana ,Suka amba Khokhara umer Sorapada Aalamav adi Gurnumb	Significant reduction (25-30%) in use of chemical pesticides was recorded. - -

					ar Khodaaamba Chikda	
			25	--	Khokharaumar Navagam Saburi Dabaka Jaragam	
			25	--	Aabhalod Singapur Sanjeli Motihandi	
20.	DrYSRHU, Tirupathi	Field Day on Production and Protection Technologies in Citrus (Sweet orange and Acid lime)"	52	3	D. B, Palli Gudipala mandal	Exposure to new varieties for area expansion
		Production and Protection Technologies in Acid lime on 09-06-2017	35	2	Chaganam village of Sydapuram Mandal, Nellore District	Latest pest management practices
		Farmers Producer Organization (FPOs) & Tomato Value Chain Intervention on 23rd& 24th	60	5	Madanapalli	Tomato pinworm – identification, and management

		October, 2018				
21.	AAU, Jorhat	Pest Management in organic Agriculture (Rice, toria, pea, potato and vegetable)	30	02	Hatkhola Village, Chabua	They became aware about biological control agents
		Awareness programme by Deptt. of Extension Education, AAU, Jorhat	30	02	Koronga Holowga on primary school	They became aware about biological control agents
		BIPM on Rice (2 training)	51&30	1& 4	Matikhua Gaon & DAO, Golaghat	They became aware about advantages of BIPM rice
		BIPM on Kharif vegatables (3 nos)	50, 50 & 50	2, 1 &1	Dangdhora, Neulgaon, Jorhat & Chaudangpothar, Golaghat	They became aware about advantages of BIPM on Kharif vegetable
		Farmers and Community Training on Crowd Sourcing Experiment	42	01	Alengmora	They learned about pests of rice and biological control agents
		BIPM on vegetables crops (4 nos)	40,48, 47 &40	1, 2,1 &1	Dangdhora, Kachumari, Garigaon Golaghat & Salaguri, Jorhat	They became aware about advantages of BIPM on vegetables.
		BIPM on Rice (2 nos)	40&40	1 &1	Hahsora, Golaghat &Titabar, Jorhat	They became aware about advantages of BIPM on rice.
		Biological control of pests of vegetables	40,40,40 30,30,32,	1,1,1,1,1, 1,2 &1	Alengmora,	They became aware on pests

		(8 nos)	25 &25		Lahonko charigaon, Chekuria, Salaguri Mazgaon ,Jorhat, Bohuabheti,Bamungaon, Nagaon, Borjangaon, &2.no Butulikhuagaon, Golaghat	and management of pests of rabi vegetables.
		BIPM of Rice (7nos)	25,25,25, 25,25,30 & 25	1,1,1,1,1 &1	Baghmora, Charighoria,Karengsapori, Nogabaat, Salaguri, Jorhat, Simoluguri, Nagaon& 2 no. TirualGaon,Golaghat	They became aware on pests and Bio intensive management of pests of rice.
		BIPM on Vegetables (7 nos)	25,25,26, 25,25,25, 25 &33	1,1,1,1,1, 1,5&1	Na-cheleria, Rajabahar,Baghmora, Charighoria,,Jorhat, Tirual Gaon,	They became aware of BIPM on Vegetables.

					BonkuwalGaon,Bokakhat, Golaghat &Sensuagaon, Nagaon	
22.	YSPUHF, Solan	.Total number of training camps organised: ii. Post graduate students guided: Undergraduate students guided:25 Numbers of farmers awarded / trained: vii. Scientist participated in trainings SMS participated in trainings: No. of input dealers participated in lecture	25 25 25 2335 16 30 30	3 2 5 2 3 4 2	Villages in and around the solan district	Capacity building Awareness on Biocontrol
23.	GBPUAT	Use of Biocontrol agents in Rice	70	0	Dumkabangar	Capacity building amongst the farmers for the use of Bioagents in transplanted and non transplanted crops and adoption of Biocontrol technology at their farm
		Setting up of soil solarization	85	1	Halduchaur	
		Seed treatment with Bioagents	40	0	Nathupur	
		Seed treatment of Pea with Bioagents	55	0	Motahaldu	
		Use of Pheromone trap in Rice	50	2	Dumkabangar	
		Use of Pheromone trap in Rice	30	0	Nathupur	
		Soil solarization of tomato Nursery	75	0	Davlamalla	
		Use of Biocontrol agent for seed treatment, soil treatment, seedling	80	1	Golapar	

		treatment in Tomato				
		Introduction of Bioagents to farmers	75	0	Vijayrampura	
		Implementation of CMP in vegetables	125	0	Vijayrampura	
		Use of Biocontrol agents in Rice	170	0	Vijayrampura	By the use of Biointensive disease management practices farmers are now able to reduce their cost of production due to lower doses of Agrochemicals
		Introduction of Bioagents to farmers	120	0	Seetpuri	
		Pea cultivation under Biological control	200	1	Seetpuri	
		Introduction of vegetable cultivation	165	0	Seetpuri	
		Seed treatment with Bioagent	45	0	Dumkabangar	
		Seed treatment with Bioagent	30	0	Jaggibangar	
		Use of Trichoderma	25	0	Haripur	
		Biocontrol agents for nursery management	40	1	Dhanpur	
		Seedling treatment of rice with Bioagent	70	0	Radheypur	
		Enrichment of Compost with Bioagent	45	0	Umapati	
		Use of PBAT 3 in rice	75	0	Nathupur	
		Trichoderma for tomato cultivation	95	1	Devlamalla	
		PBAT 3 for tomato cultivation	25	1	Kuwarpur	
		Trichoderma for tomato cultivation	22	0	Devlatalla	
		Use of Biocontrol agents	60	0	Shivpuri	
		Use of Bioagents in vegetables	80	0	Seem	
		Trichoderma in rice cultivation	45	0	Gangapur	
		Bioagents for rice cultivation	55	0	Dhanpur	
		Use of Bioagents in standing crops	60	0	Dumkabanger	

		Trichoderma for protected cultivation	25	0	Motahaldu	
		Seed treatment of rice with PBAT 3	30	0	Dina	
		Utilization of Trichoderma for value addition of vermicompost	40	0	Paskarpur	
		Seed treatment in pea with Bioagents	55	0	Bakulia	
		Trichoderma for seed treatment in chickpea	70	0	Sakulia	
		Utilization of Trichoderma for value addition of vermicompost	45	0	Dumkabangar	
		Seed treatment of rice with PBAT 3	70	0	Halduchaur	
		Bioagents for rice cultivation	75	0	Nathupur	
		Introduction of Bioagents to farmers	40	0	Motahaldu	
		Trichoderma for seed treatment in chickpea	32	0	Dumkabangar	
		Seed treatment of rice with PBAT 3	23	0	Nathupur	
		Bioagents for rice cultivation	85	0	Davlamalla	
		Utilization of Trichoderma for value addition of vermicompost	154	0	Golapar	
		Trichoderma for seed treatment in chickpea	145	0	Vijayrampura	
		Seed treatment of rice with PBAT 3	55	0	Dhanpur	
		Trichoderma for seed treatment in chickpea	23	0	Radheypur	
		Seed treatment of rice with PBAT 3	45	0	Umapati	
		Utilization of Trichoderma for value addition of	25	0	Nathupur	

		vermicompost				
		Bioagents for rice cultivation	114	0	Devlamalla	
		Trichoderma for protected cultivation	45	0	Kuwarpur	
		Utilization of Trichoderma for value addition of vermicompost	87	0	Devlatalla	
24.	DrYSRHU-HRS	Mass production of *Isaria fumosorosea* NBAIR pfu 5 for the management of Rugose spiralling whitefly	20	5	5 Villages of Srikakulam district	Successfully Imparted hands on training on low cost mass production of *I. fumasorosea* to the farmers
		Mass production of *Isaria fumosorosea* NBAIR pfu 5 for the management of Rugose spiralling whitefly	20	5	7 Villages of East godavari district	Successfully Imparted hands on training on low cost mass production of *I. fumasorosea* to the farmers
		Method demonstrations on entomo pathogenic fungus (*Isaria fumosorosea* NBAIR pfu 5)spray against Rugose spiralling whitefly on coconut	20	4	Gangalakurru village	Successfully Imparted hands on training on low cost mass production of *I. fumasorosea* to the farmers
		Method demonstrations on management practices which included application of Biocontrol agent *Trichoderma reesei* cake on stem bleeding infected portion. Basal application of *T.*	50	4	Aividi village	Adoption of bio control based recommendation for management of stem bleeding in coconut

		reesei @ 50gm plus 5kg neem cake per palm as soil application in basins of coconut palm				
		Method demonstrations on management of coconut stem bleeding disease management with the *T. reesei*	50	6	Mamidikuduru	Adoption of bio control based recommendation for management of stem bleeding in coconut
		Method demonstration on maintenance of drip irrigation in Coconut and Cocoa.	100	6	Mamidikuduru	Installation and advantages of drip irrigation system in coconut
		Method demonstration on coconut stem bleeding management.	50	6	Mamidikuduru	Management of stem bleeding of coconut
		Method demonstration of Biocontrol management of Rugose spiralling whitefly in coconut.	100	6	Mamidikuduru	Demonstration of Biocontrol management of Rugose spiralling whitefly in coconut
		Method demonstration on spraying of *isaria* on rugose spiraling whitefly infested coconut orchards.	100	6	Mamidikuduru	
		one day Training Programme on "Predator Rearing Technique (*Apterochrysa astur*)"	50 members	10	Department of Horticulture officials, VHAs, FPO members	Predator Rearing Technique (*Apterochrysa astur*)"

					and progressive farmers of East Godavari	
		Field Demonstration on farm mechanization	100-150 members	10	Department of Horticulture officials, VHAs, FPO members and progressive farmers of East Godavari	field Demonstration on farm mechanization in coconut harvesting, climbing and value addition to the farmers
		Kisan mela,	150	25	Scientistes of APRRI & RARS, Maruteru, A.N.G.R.A.U.	Explained about the coconut production and protection technologies
		Oneday "Awareness programme on pests and diseases of coconut"	65	10	Department of Horticulture, Government of AP at T.Kothapalli and Katrenikona villages	Created awareness on pests and diseases of coconut and their management
		Rythu Sadassu	100	25	Horticultural Research Station,	lecture on Pest management in cocoa

					Kovvur, DRYSR HU	
		Farmers interaction meeting	125	12	Department of Horticulture, Government of AP Aratikatla village of West Godavari district	Explained about the RSW symptoms and management
		Awareness meeting on Rugose spiraling whitefly and its management strategies	80	7	M/s. Krushivala Coconut Producer Company and Department of Horticulture, Government of AP at Rollapalem village of East Godavari district	Created awareness meeting on Rugose spiraling whitefly and its management strategies
		Awareness meeting on Rugose spiraling whitefly	120	12	Kadiyapulanka village	Created awareness on Rugose spiraling whitefly and its management strategies
		Awareness meeting on Rugose spiraling whitefly	100	8	Kadiyapulanka village	
		Awareness meeting on Rugose spiraling whitefly	120	8	Malkipuram village of East	

					Godavari district	
		Awareness meeting on Rugose spiralling whitefly	80	12	Mungandra, K.Yengupalli villages of East Godavari district	
		Awareness meeting on Rugose spiraling whitefly	120	10	Kadiyam village of East Godavari district	
		Awareness meeting on Rugose spiralling whitefly	90	5	Amalapuram village of East Godavari district	
		Friends of coconut trees (FOCT)	50	10	HRS, Ambajipeta financial assistance of Coconut Development Board	Training on scientific management aspects, quality seedlings production and plant protection measures in coconut to Twenty trainees
		One day awareness training programme on Rugose spiralling whitefly incidence, symptoms and management	50	3	Department of Horticulture, Government of AP	Created awareness on Rugose spiraling whitefly and its management strategies
		Awareness meeting on Rugose spiraling whitefly	100	8	Department of Horticultu	Created awareness meeting on

					re, Government of AP Mummidivaram village of East Godavari district	Rugose spiraling whitefly and its management strategies
		Awareness meeting on spiraling whitefly	100	10	Department of Horticulture, Government of AP Razole village of East Godavari district	Created awareness on Rugose spiraling whitefly and its management strategies
		Awarenessmeeting on coconut pests	120	8	Department of Horticulture, Government of AP Sakinetipalli of East Godavari district	Created awareness on Rugose spiraling whitefly and its management strategies
		Replanting & Rejuvenation scheme on coconut	80	5	Department of Horticulture, Government of AP Kommaragiripatnam and Goganna matam villages	Discussion and suggestions made on the replanting and rejuvenation of coconut scheme

		Awareness meeting on Rugose spiralling whitefly	80	5	Department of Horticulture, Government of AP Kalavalapalli village of West Godavari district	Created awareness on Rugose spiraling whitefly and its management strategies
		Awareness meeting on Rugose spiralling whitefly	100	12	Department of Horticulture, Government of AP Ravada village Ranastalam mandal of Srikakulam district	Created awareness on Rugose spiraling whitefly and its management strategies
		Awareness cum training programme on Rugose spiralling White fly	120	8	Department of Horticulture, Government of AP Kadiyam village of East Godavari	Created awareness on Rugose spiraling whitefly management
		Kisan Kalyan Karyasala as a part of Gram Swarajya Abhiyan with focus on the strategies for Doubling farmers income by 2022	120	15	Department of Horticulture, Government of AP Kadiyam	Created awareness on Rugose spiraling whitefly management

					village of East Godavari	
		Workshop on "Management of Coconut Rugose spiraling whitefly"	50	10	ICAR-CTRI, Rajahmundry	Discussions on the RSW management strategies
		Rugose spiraling whitefly awareness meeting and a demonstration on the feasibility of using Drone technology in Rugose spiraling whitefly management.	100	8	ICAR-CPCRI and Department of Horticulture, Government of AP Kadiyapulanka village	Rugose spiraling whitefly awareness meeting and a demonstration on the feasibility of using Drone technology in Rugose spiraling whitefly management.
		Training programme on Rugose spiralling whitefly on coconut and oilpalm.	50	5	Department of Horticulture, Government of AP Neeladevipuram and Kurukuru village of Eluru division	Created awareness meeting on Rugose spiraling whitefly and its management strategies
		Human Resource Development Training Programme (HRD) on Rugose Spiralling Whitefly on coconut, oilpalm and other Horticultural Crops	100	12	Department of Horticulture, Government of AP Kadali village	Created awareness meeting on Rugose spiraling whitefly and its management strategies
		Training programme	100	8	Departme	Created

		on Production and protection aspects of coconut			nt of Horticultu re, Governm ent of AP Kaviti village of Srikakula m district	awareness meeting on Rugose spiraling whitefly and its management strategies
		UDYANA 2018 – Horti Expo (Horticulture show & Organic Exhibition)	120	15	Departme nt of Horticultu re, Governm ent of AP Velagapu di	UDYANA 2018 – Horti Expo (Horticulture show & Organic Exhibition)
		World coconut day	150	20	Coconut develop ment board, Vijayawa da at Ichapura m, Srikakula m Dist	Created awareness on pest and disease management in coconut
		World coconut day	100	8	Departme nt of Horticultu re, Governm ent of AP at AMC, Ambajip eta	Created awareness on pest and disease management in coconut
		Scientist farmer interaction meeting	75	5	Departme nt of Horticultu re, Governm ent of AP ADH,	Scientist farmer interaction meeting on coconut

					Amalapuram	
		Awareness on Rugose spiralling whitefly and its control	100	12	Department of Horticulture, Government of AP Vakkalanka village, Ambajipetamandal	Created awareness on Rugose spiraling whitefly and its management strategies
		Awareness meeting on Rugose spiralling whitefly	50	5	Department of Horticulture, Government of AP Punyakshetram village of Rajanagaram Mandal	Created awareness on Rugose spiraling whitefly and its management strategies
		Awareness meeting on Rugose spiralling whitefly	75	5	Department of Horticulture, Government of AP Chinthapalli village of Pusapatiregha Mandal	Created awareness on Rugose spiraling whitefly and its management strategies
		Incidence of black headed caterpillar in coconut and its management through biological control	100	8	Department of Horticulture, Governm	Incidence of black headed caterpillar in coconut and its management

					ent of AP S.Yanam village, Uppalaguptamman dal	through biological control
		One day sensitization training programme on “Rugose spiraling whitefly”	100	5	Departme nt of Horticultu re, Governm ent of AP Kommug udem village of Tadepalli gudemm andal	Created awareness on Rugose spiraling whitefly and its management strategies
		Awareness meeting on Rugose spiralling whitefly	50	3	Departme nt of Horticultu re, Governm ent of AP Rajanaga ram village	Created awareness on Rugose spiraling whitefly and its management strategies
		Awareness meeting on Rugose spiralling whitefly	60	4	Departme nt of Horticultu re, Governm ent of AP B.V.Lan ka village of Alamuru mandal	Created awareness on Rugose spiraling whitefly and its management strategies
		Awareness meeting on Rugose spiralling whitefly	50	3	Departme nt of Horticultu re, Governm	Created awareness on Rugose spiraling whitefly and its

					ent of AP Kadiyam village	management strategies
		Awareness meeting on Rugose spiralling whitefly	50	2	Department of Horticulture, Government of AP Vanapalli, Billakurru villages of Kothapetamandal and Velicheru village of Atreyapurammandal	Created awareness on Rugose spiraling whitefly and its management strategies
		Training programme on Rugose spiralling whitefly management	50	3	Department of Horticulture, Government of AP Ghantavarigudem village , Nallagerla mandal	Created awareness meeting on Rugose spiraling whitefly and its management strategies
		Farmers scientist interaction meeting	75	5	Department of Horticulture, Government of AP Rajahmundry	Created awareness meeting on Rugose spiraling whitefly and its management strategies
		Training programme	50	3	AICRP on	Created

		on “Rugose spiraling whitefly”			Nematodes, Kovvur DRYSRHU Department of Horticulture, Government of AP Kadiyam	awareness meeting on Rugose spiraling whitefly and its management strategies
		Awareness meeting on Rugose spiralling whitefly	75	3	Department of Horticulture, Government of AP K. Gangavaram village of Ramachandrapuram mandal	Created awareness meeting on Rugose spiraling whitefly and its management strategies
		One day training programme on “Management of Rugose spiraling whitefly”.	80	4	Department of Horticulture, Government of AP Kalavalapalli	Created awareness meeting on Rugose spiraling whitefly and its management strategies
		Bimonthly Training & Visit (T&V) Programme	95	3	DRYSRHU KVK, VR Gudem	Delivered lecture on Management of Rugose Spiraling white fly in plantation crops
		Meeting on Replanting & Rejuvenation scheme on coconut	50	2	Department of Horticulture,	Meeting on Replanting & Rejuvenation scheme on

					Governme nt of AP Dangeru village of Gangavar mmandal, East Godavari district	coconut and explained protection measures to be taken during Replanting of coconut under R&R scheme and created awareness on Rugose spiraling whitefly and its control measures to the farmers.
		Awareness meeting on management of Rugose spiralling whitefly.	50	2	Departme nt of Horticultu re, Governme nt of AP Gopanna palem, West Godavari	Delivered lecture on Integrated Pest management of Rugose spiralling whitefly
		Rugose spiralling whitefly incidence and its management measures	75	3	Departme nt of Horticultu re, Governme nt of AP Jiyyamm avalasam andal, Vijayana garam district	Rugose spiralling whitefly incidence and its management measures and created awareness to farmers
		Padipantacharchaved ika on “Pests and diseases in coconut”	75	2	Departme nt of Horticultu re, Governme	Explained about Pests and diseases management in coconut” and

					nt of AP Ambajipeta	delivered lecture
		One day training programme on IPM in protected cultivation under MIDH programme.	50	2	Department of Horticulture, Government of AP AmbajipetaVelagapudi, Guntur	Delivered a lecture on IPM in protected cultivation under MIDH programme.
		Coconut Development Board block level meeting on Rugose spiraling whitefly.	100	2	Coconut Development Board Kommargiri village of I. Polavaram mandal	Coconut Development Board block level meeting on Rugose spiraling whitefly.
		Rugose spiraling management	75	2	Department of Horticulture, Government of AP Madimilli village of Ainavelli mandal	Delivered a lecture on Rugose spiraling whitefly and its management practices to the farmers.
		Awareness meeting on Rugose white fly.	100	5	Department of Horticulture, Government of AP Avidi village, East	Delivered a lecture on Rugose spiraling whitefly and its management practices to the farmers.

					Godavari district	
		Webinar on “Rugose spiralling whitefly”	75	2	Coramandal fertilizers limited	Delivered a lecture on Rugose spiraling whitefly and its management practices to the farmers.
		Webinar on “Rugose spiralling whitefly in coconut”	85	4	Navasari Agricultural University, Gujarat	Delivered a lecture on Rugose spiraling whitefly and its management practices to the farmers.
		Webinar on Biocontrol management of pest and diseases in coconut	100	2	DRYSR HU KVK, VR Gudem.	On Biocontrol management of pest and diseases in coconut
		Virtual Brainstorming Session on Invasive whitefly complex on plantation crops: Technical knowledge and Technological interventions for management	125	3	ICAR-Indian Institute of Oil Palm Research, Pedavegi, West Godavari	Biocontrol based management of rugose spiralling whitefly in plantation crops’
		Awareness on bio control based management of coconut Black headed caterpillar *Opisinaarenosella*	75	2	DRYSR HU PBS, Sompeta	Bio control based manangement of coconut black headed caterpillar in Makarapuram village

						Sompetamandal and Jadipudi in Kanchalimandal of Srikakulam
		one day training programme on Bio-control management strategies of insect pests in Flower crops	120	2	ICAR – DFR Floriculture Regional Station, Vemagiri, East Godavari district	Bio control based pest management in flower crops
25.	KAU, Thrissur	IPM in major crops		Agrl. Officers Palakkad (24)	Palakkad district	Biocontrol of pest and diseases
		IPM in paddy		Agrl. Officers, Palakkad (25)	Palakkad district	
		Production technology of common biocontrol agents		Agrl. Officers, Palakkad (22)	Palakkad district	
		Biocontrol agents an introduction		Students (24)	Ramavar mapuram	
		Mass production of natural enemies	Farmers (34)	State officials-1	Thrissur district	
		Production technology of common biocontrol agents		Agrl. Officers (30)	Palakkad district	
		Recent plant protection techniques in cashew	Farmers (28)		Malappuram district	
		Biological control of crop pests		30 students	Thrissue dt	
		Pest management in organic spice	Farmers (39)		Thrisur dt	

		cultivation				
		Biocontrol of crop pests	Farmers (36)		Palakkad district	
		Mass production of bioagents (Dr. Madhu Subramanian)		Agrl. Officers (29)	Palakkad district	
		Post flood soil crop management	Farmers (48)		Kuzhur	
		Monthly Agro Clinic and Farm Advisory Conclave	Farmers		Kodungallur	
		Mass production of bioagents		Agrl. Officers (32)	Kerala state	
		Mass production of bioagents	Farmers (31)		Palakkad	
		Mass production of bioagents	Farmers (30)		Palakkad	
		Biocontrol of crop pests	Farmers(32)		Muvattupuzha	
		Mass production of bioagents		Agrl. Officers (30)	Palakkad	
		One day training and demonstation – Biocontrol in rice	Farmers (40)		Kottathara	
		One day training and demonstation – Biocontrol in rice	Farmers (36)		Vengappalli	
		Biocontrol of Rugose Spiralling Whitefly		Agrl. Officers (31)	Kozhikode	
		Biocontrol of crop pests	ST farmers (35)		Varantharappalli	
		Farmer-scientist interface	Farmers		Ollukkara block	
		Farmer-scientist interface	Farmers		Mathilakam block	
		Farmer-scientist interface	Farmers		Thrissur district	
		Biopesticides		Pesticide		

				dealers (22)		
		Biological control (Smitha Revi)		DAESI Trainees (24)	Palakkad	
		Monthly Technology Advice (Smitha Revi)		Dept. Officials (29)	Thrissur District	
		MTA (Smitha Revi)	Farmers		Thissur (Online)	
		Training programme - production ofcost effective biopesticides		Kudumb asree members (15)	Alathur	
		Biological control in rice (Smitha Revi)	Farmers (30)		Arimbur	
		Biological control in rice (Smitha Revi)	Farmers (28)		Thekkink ara	
		Biocontrol agents – on farm production (Smitha Revi)		Agricult ure Assistant s	Vytilla (online)	
		Biological control (Smitha Revi)		Farmers (25)	Tavanur	
		Biocontrol agents (Smitha Revi)		Farmers (34)	Thrissur	
		Biocontrol agents (Smitha Revi)		Farmers (30)	Thrissur	
26.	IGKV	Initially a training and demonstration programme of preparation of Trichocards was given to the farmers, during the year 2018 – 19.	30 farmers	Dr. Jayalaxm i Ganguli, Smt. Rashmi Gauraha	Village – Badecha kwa(Jagd alpur)	Conducted Awareness Programme about use of Biocontrol agents.
		Awareness programme and use of biocontrol agents. During the year 2019 – 20.	73 farmers	1	Dantewa da	Awareness Programme about use of Biocontrol agents.
		Awareness programme and	73 farmers	2	Village – Dhondra,	Awareness Programme

		benefits of biocontrol agents through a lecture in hindi. During the year 2020 – 21.			Pharasagaon, Kondagaon (Bastar)	about use of Biocontrol agents.
		Delivered 3 lectures in the Skill Development of Rural Youth (STRY) training program on "Production of Biocontrol agents" organized at CoA & Res. Stn., Fingeshwar (Gariyaband) during the year 2021 - 22.	30 trainees attended the program.	1,	Fingeshwar (Gariyaband)	Awareness Programme about use of Biocontrol agents.
		One day traning programme and use of benefits biocontrol agents. during the year 2021 - 22.	78 tribal farmers participated in the program.	2	Village – Arajkund, Block – Ambagarh Chowki, Rajnandgaon	Awareness about use of Biocontrol agents.
27.	UAHS	Formers meet on Importance of bioagents in agriculture and horticultural crops and inputs distribution name of the officer: Dr. S Pradeep and Dr Divya, M	50	5	Challakere, taluku, marikanive, kunchenahalli, togarsi, choradi, kommanahalu, Gilalagundi,rangapura	50% Reduction in soil born diseases in pepper, ginger, ragi,

XXXIII. Distribution of Extension material and social media presence

Sl.No	Centres	Technical folder/leaflet /pamphlet/ Booklet	Audio visual developed and distributed (Bio-suppression of exotic whitefly, Ecological engineering, Invasive pests, Nematodes as friends and foes	Facebook/ YouTube/ Instagram	WhatsApp group developed/	e-folders/ e-charts	TV and Radio Talks on the importance of indigenous natural enemies and their conservation
1.	**PAU, LUDHIANA**	9		1		14	
2.	**CPCRI**	2500	7	75	2		
3.	**SKUAST, Srinagar**			5	1		7
4.	**KAU, Vellayani**			4	1		
5.	**KAU Kumarakom**			1	1		
6.	**PJTSAU**		1				
7.	**CAU, Pasighat**	1			1		
8.	**MPKV**	3950	5	1			
9.	**TNAU**	2000	1	1			2
10.	**SKUAST-Jammu**	14		6	2		
11.	**OUAT**	1					
12.	**ANGRAU**						5
13.	**AAU, Anand**	11					1
14.	**DrYSRHU, Tirupathi**	3			3		
15.	**AAU, Jorhat**	20	2				29
16.	**YSPUHF, Solan**	500		400	1		1
17.	**GBPUA&T**	5000	2	3	1		
18.	**NCIPM**	200			4		
19.	**PAU, LUDHIANA**			3	8		

20.	**DrYSRHU**	1200	3	2	1		
21.	**MPUAT, Udaipur**	16	1	1	10		
22.	**IGKV**	9	2				
23.	**KAU, Thrissur**	3	1				
24.	**UAHS**	120			2		

XXXIV. Brief report and Impact of the TSP programmme

GBPUA&T, Pantnagar

Under Tribal Sub-Plan (TSP), demonstrations on bio-control technologies were conducted covering 1072 farmers. A total of 50 q of Pant Biocontrol agent - 3, which is a mixture of *Trichoderma harzianum*-14 (Th) and *Pseudomonas fluorecens*-173 (Psf), was distributed to the farmers for soil treatment, seed treatment, seedling treatment and foliar spray. Input distributed to Tribal farmers are Neem oil (440 L); Pheromone traps and lures (2980 Nos.); Poly sheet (548 Nos.); Vermicompost (30 Q); seeds of vegetable kits (2000Nos.) and distributed quality seed of Paddy (15q) and Vegetable pea seeds (500 kg). Demonstrated Soil Solarization technology to farmers for the application of polysheet (2x10m) on nursery beds of paddy. Placed Pheromone trap (nos.2000) with lure control rice stem borer. Yellow sticky trap (5000 Nos.) for control of sucking pest were installed. A total of 30 field days and 14 training programmes were conducted.

UBKV, Pundibari

Trainings on biological control of crop pests and bio intensive cultivation of mustard and litchi were provided to the tribal farmers and all essential inputs were distributed. Litchi saplings were distributed among the farmers for planting in the backyards of their house to encourage them in fruit cultivation to meet up their home consumption requirement as well as will enhance their income. 30% increase in yield of rapeseed-mustard due to replacement of local variety. Replacement of area under fallow land (25 acres) with introduction of mustard crop.The distributed beehives were maintained with utmost care by the group of tribal farmers and a good amount of honey was extracted and sold in the local market.

KAU, Vellayani

Conducted three awareness programmes on potential of biopesticides to the farmers in collaboration with the State Department of Agriculture as a part of “Azadikaamritmahotsav”, where in around 100 participants including farmers and extension officers were trained on the use of biocontrol agents.

SKUAST, Srinagar

Six tribal areas of Kargil including Bagh-e- Khomini, Chanigund, Hardass, Kirkichoo, Mingy and Slikchey were selected for benefiting the farmers with IPM technologies of Management of Codling moth. Six core groups of literate orchardists were made to implement the programme and help a total of 130 farmers. Each core group was provided basic training related to IPM of Codling moth, including timing of chemical spray, use of

Tricho cards and pheromone traps, trunk banding of apple for trapping and killing of larvae, debarking of old trees and disposal of infested fruits etc.

The tribal community of Ladakh (Kargil and Leh) views this program of ICAR–NBAIR led by the SKUAST-K with utmost positive gesture and as apple saving mission. With inputs since last three years and on-the-spot awareness programs, the beneficiaries of TSP were observed to adopt and implement IPM of codling moth. The cheapest method of trapping the apple codling moth using trunk banding was adopted by the farmers in large scale.

CAU, Pasighat

2018-19: 100 numbers of tribal farmers were adopted and given positive feedback on importance of light trap, Knapsack spryer, Neem oil, and vegetable seeds for the effective management of insect pests in Vegetables.

2020-21: Total 180 tribal farmers (Male: 102 and Female: 184) were benefitted by application of microbial pesticides for pest management and organic production of horticultural crops. The districts covered were East Siang (02 villages) and West Kameng (03 villages). First time TSP programmes on application of Biocontrol agents in West Kameng district.

2021-22: Around 286 numbers of tribal farmers (Male: 102 and Female: 184) were benefitted by application of microbial pesticides for pest management and organic production of horticultural crops like Export Quality Khasi Mandarin and Organic Crucifers. The districts covered were East Siang (05 villages), ShiYomi (05 villages) and Lower Dibang Valley (01 village). First time TSP programmes on application of Biocontrol agents in remote villages of Shi Yomi district.

MPKV, Pune

Demonstrated the effectiveness of biopesticides *L. lecanii, M. anisopliae, B. bassiana, T. viride* in tribal area of Nashik district against pest of mango, guava, and cashew.

MPUAT, Udaipur

Farmer's field demonstration has been carried out in TSP area in which a total of 159 farmers have been benefited.Three farmer's training were conducted at farmers field in different villages and to create awareness to the farmers for biological control of crop pests in *Kharif* and *Rabi* seasons 2019-20 in which total of 234 farmers were benefited.

TNAU, Coimbatore

TSP program trainings on production of biocontrol agents and biointensive pest management were conducted to benefit the tribal farmers from Coimbatore (Jambukandy, Senguttai villages), Erode (Bejeletti) and Tirupur (Karumutti) districts. Parasitoids, Predators, battery operated sprayer, neem oil, teepol, plastic bucket, plastic mug, plastic trays, cumbu grains, maize grains, vegetable seeds and training bags were provided. About 100 farmers participated in the programme.

OUAT, Bhubaneshwar

During 2021-22, TSP programme was taken up in Haladikundi, Dholpashi and Khairatangara villages of kankadahada block of Dhenkanal district where 100 tribal farmers were participated.

ANGRAU, Hyderabad

Tribal farmers successfully cultivated rice in 288 acres and obtained good yields by adopting organic farming practices. BIPM in rice organic farming farmers recorded higher yields (4394 kg/ ha) compared to traditional tribal farmers (2224 kg/ha) without any fertilizer application and plant protection measures.

BIPM farmers realized additional yield of 2170 kg/ha, additional income of Rs.14625/- with high incremental benefit cost ratio (1:6.5) and cost benefit ratio (1:3.68) compared to traditional tribal rice cultivation. BIPM FLD farmers of rajmash cultivated in 50 acres recorded higher yields (568.75 kg/ ha) compared to 443.75 kg / ha in farmers practice with additional yield of 125 kg/ha ; additional income of Rs. 7500/-and incremental benefit cost ratio of 1: 6.7 compared to farmers practice of no fertilizer and no plant protection.

Ginger FLD farmers recorded higher yields (3480 kg/ ha) in 195 acres compared to 2895 kg / ha in farmers practice with additional yield of 582 kg/ha with additional income of Rs. 23,280/-and incremental benefit cost ratio of 1: 17.1 compared to traditional farming.
Turmeric FLD farmers realized good yields (3400 kg/acre with additional yield of 600 kg/ha with additional income of Rs. 31,525/- and incremental benefit cost ratio of 1: 23.1 compared to traditional cultivation (2800 kg/acre). Tribal farmers adopted biointensive practices in vegetable cultivation (chillies, brinjal, tomato, cabbage) and benefitted with additional income ranging from Rs. 3000 to 4000/- per acre.

Promotion of biological control techniques in rice, ginger, turmeric, rajmash and vegetables covering 709 acres in 66 villages in Arakuvalley and Chinthapalli divisions, Visakhapatnam district, Andhra Pradesh through front line demonstrations, farmers trainings, method demonstrations, exposure visits, rythusadassus's, field days created awareness to 859 tribal farmers on biocontrol agents, biopesticides and biofertilizers. Adoption of biological control and biofertilizers in organic cultivation improved the crop yields compared to farmers practice in tribal areas from the year 2015-16 to 2021-22 through ICAR-AICRP on Biological control.

AAU, Anand

2017-18: Fifty tribal farmers (chick pea growers) were selected from Dahod district and distributed bio-inputs. There was a significant reduction (65-70%) in incidence of *Fusarium* wilt and *H. armigera* and 12-15% higher yield was recorded in the treated fields compared to untreated. Fifty tribal farmers (okra growers) were selected from Tapi district and distributed bio-inputs. Significant reduction (55-60%) in pest and disease was observed with 10-15% increase in the fruit yield.

2018-19: Two hundred tribal farmers were selected from Dediyapada, Sagbara and Tilakwada talukas of Narmada district. In association with Krishi Vigyan Kendra (KVK), Dediyapada, Navsari Agricultural University, khedutshibir and training programmes were organized in the month of September, November 2018 and March 2019 to train the farmers

on use of biocontrol inputs and strategies to tackle key pests and diseases to achieve sustainable crop production. Biocontrol inputs were distributed to farmers.

2019-20: Hundred tribal farmers were selected from Dediyapada, Sagbara and Tilakwada talukas of Narmada district. In association with Krishi Vigyan Kendra (KVK), Dediyapada, Navsari Agricultural University, khedutshibir and training programmes were organized in the month of July and August 2019 to train the farmers on use of biocontrol inputs and strategies to tackle key pests and diseases to achieve sustainable crop production. Biocontrol inputs were distributed to farmers. Significant reduction (35-40%) in use of chemical pesticides was recorded.

2020-21: In the year 2020-21, 125 tribal farmers were selected from Dediapada, Nanded and Garudeshwartalukas of Narmada district. In association with KrishiVigyan Kendra (KVK), Dediyapada, Navsari Agricultural University, Khedutshibir and training programmes were organized in the month of September 2020 and March 2021 to train the farmers on use of biocontrol inputs and strategies to tackle key pests and diseases to achieve sustainable crop production. Biocontrol inputs were distributed to the farmers. Significant reduction (25-30%) in use of chemical pesticides was documented with the use of bio-inputs provided.

2021-22: In the year 2021-22, Fifty tribal farmers were selected from different villages of Dediyapada taluka of Narmada district and twenty-five farmers from different villages of Dahod district were selected. In association with Krishi Vigyan Kendra (KVK), Dediyapada, Navsari Agricultural University, khedutshibir and training programme was organized in the month of October 2021 and February 2022 to train the farmers on use of biocontrol inputs and strategies to tackle key pests and diseases to achieve sustainable crop production. Further, in association with KVK, Dahod, Anand Agricultural University, Anand khedutshibir and training programme was organized in the month of March 2022 to train the farmers on use of biocontrol inputs and strategies to tackle key pests and diseases to achieve sustainable crop production. Biocontrol inputs were distributed to the farmers. Significant reduction (25-30%) in use of chemical pesticides was documented with the use of bio-inputs provided.

AAU, Jorhat

2018-19 to 2021-22

Under TSP programme, 22 villages covered from 5 district of Assam with 820 tribal beneficiaries were selected and inputs were supplied. Microbial formulations of Beauveria, Metarhizum, agricultural tools like sickle, apron, khurpi, water can, backpack sprayer, falcon kit, rain coat and neem pesticides were supplied to the farmers.

Glimpses of the TSP training programme

The trainings were conducted with cooperation from KVKs, and ADOs. A total of 920 numbers of farmers were benefited from the programme. The main subjects covered in the trainings were insect pest of rice and vegetables. The eco-friendly way of management of insect pests were emphasized along with the proper use of biopesticides, different trap materials, use of neem-based pesticides instead of chemical pesticides, use of knapsack Sprayer and the cares and safe handling of biopesticides.

YSPUHF, Solan

Demonstrations on the use of eco-friendly methods of pest management for apple and vegetable crops covering an area of 145ha (apple), 21 ha (almond), 5 ha (apricot), 37.5 ha (peas), 15 ha (beans) and 40.5 ha under cauliflower and cabbage during the period under report. In this programme, about 600 farmers were benefited through 14 number of training camps. In tribal areas, most of the farmers were exposed to the use of bio-pesticides for the first time. The bio-inputs and literature suppled were *Metarhizium anisopliae* (360 Kg), *Beauveria bassiana* (235L), *Trichoderma viride* (690Kg), Neem baan (245 L) and yellow sticky traps (160 nos). The literature supplied were Package of Practices of fruit crops (100 nos.) and Kisan diary (600 nos.) In case of cauliflower number of pesticide sprays was reduced by 2-3. In apple, farmers saved about Rs.14000/ha to Rs.17000/ha as cost of insecticides for the management of root borer.

KAU, Thrissur

2019-20: The project activities were undertaken with the support of ATMA (Agriculture Technology Management Agency), Department of Agriculture, Wayanad. A total of 184 farmers in Kottathara, Padinjarethara, Kuppadithara and Vengappalli Panchayats in Mananathavadi Taluk and Edavaka and Nallurnad Panchayats in Vythiri Taluk were provided with biopesticides. Training programmes were also conducted for the above farmers on the proper use of biopesticides including trichocards.

2020-22: Activities under tribal sub plan (TSP) for the year 2020-21 were carried out at Wayanad and Thrissur districts. The tribal hamlet of Thirunelli was adopted and National Seed Corporation, GoI distributed seed kits that comprised seeds of vegetables, millets and pulses. The centre provided biocontrol agents and biofertilizers to promote organic farming. As the tribal farmers had expressed non availability of sprayers as a major constraint, 15 knapsack sprayers were also distributed for proper application of bioagents. As part of this programme, a total of 216 farmers of Thirunelli panchayat were benefitted. TSP activities in Thrissur district were carried out in the Kallichithra tribal colony. Vegetable seeds and bioagents were provided to 41 farmers (121 family members). Training programme was also conducted for the farmers on proper use of biocontrol agents in organic vegetable cultivation.

XXXV. Brief report and impact on initiatives on National Priorities

CPCRI

a) Doubling farmer's income

- A crop habitat-based pest regression module has been developed at ICAR-CPCRI with Kalpasankara (Chowghat Green Dwarf x West Coast Tall) coconut hybrid and intercrops such as nutmeg, rambuttan, banana, curry leaf, jack, marigold, custard apple *etc.,* for framing farming to fullness.
- A significant attraction of honey bees on coconut and coral vines is indicated in ecological engineering plot. Reduction in pest incidence and systematic crop care could boost up the coconut yield averaging 161 nuts per palm per year after five years of planting.
- In addition to pest regression, a sustained income and employment through complementary utilization of resources was the star attraction of this module that would de-risk farmers who generally adopt for intensive mono-cropping suppressing diversity. Doubling income and self-reliance are accomplished in this approach of crop integration for inclusive development

b) Atmanirbhar Bharat

- ICAR-CPCRI has found a potent green muscardine fungus, *Metarhizium majus* that could control the coconut rhinoceros beetle, *Oryctes rhinoceros*. Spores of *M. majus* enter on cuticular contact and kill the grubs in a fortnight. A dosage of 5×10^{11} spores per cubic metre of pest breeding material is recommended for field application.
- ICAR-CPCRI has also developed technologies for mass multiplication of *M. majus* in inexpensive locally available substrates, such as, coconut water, cassava chips and semi-cooked rice. Women farmers in different panchayaths of Kerala, were organized as clusters, sensitized and trained by ICAR-CPCRI scientists, for mass production of *M. majus* by using semi-cooked rice.
- The active participation and facilitation of extension officials and people's representatives were also ensured for sustainability and continuity of the initiative. The women groups functioned as master trainers for further spread of technology to nearby villages. They also ensured timely supply of bioagents. The entire farming community is now convinced of this technology. Cattle farmers were also targeted by the group in distributing the locally multiplied *M. majus* for delivery on to the cow dung pits, the main breeding point of the beetle. Mass multiplication is recognized as an effective strategy for revenue generation and several *Kudumbasree* missions have taken up this programme.

UBKV, Pundibari

a) Doubling Farmers' Income:

- If the farmers follow the bio-intensive pest management practice, the cost of pest management in different crops will be reduced in long run. The vegetables and fruits produced under bio-intensive pest management system are free from hazardous chemicals and are fetching higher monetary return. In case of mustard, replacement of local variety has helped increasing yields.

- Moreover, inclusion of bee keeping, wherever applicable, in that pesticide free cultivation areas have ensured double income for the farmers as enhancement of yield was recorded due to better pollination. Lastly the honey that they are getting from those bee hives is providing surplus income to the farming community.

b) Atmanirbhar Bharat (Entrepreneurship development):

- The trainings imparted on beekeeping and the inputs distributed for adaptation of bee keeping under TSP is helping the farmers towards entrepreneurship development. They have started levelling their produced honey and are selling in local market.
- Development of bio-agent production unit in the rural areas can also be a part of Entrepreneurship development, if necessary technical and financial supports will be provided.

Dr YSRHU

a) Doubling Farmers' Income

- The usage of biocontrol agents instead of insecticides for pest management in coconut reduced the input cost substantially in coconut based cropping systems. The farmers experiences and case studies details are enclosed in separate file

b) Atmanirbhar Bharat (Entrepreneurship development)

- Mass production technology of predator *Apertochrysa astur* against rugose spiralling whitefly was commercialized to Oil palm processing companies namely, 3F OilpalmTadepalligudem, Godrej Agrovet, Chintalapudi West Godavari district of Andhra Pradesh and private firms *viz.*,and SSD enterprises, Gopalapatnam West Godavari district GIFT Farmer producer organization, Rollapalem, PACS Devaguptam of East Godavari district in Andhra Pradesh and to Cryptoxbiosolutions, Kanyakumari and Echocare limited, Trichy of Tamil Nadu

SKUAST, Srinagar

a) Doubling Farmers' Income

- Various training programmes were organised with the department of Horticulture and awareness programmes were conducted for increasing the farmers' income in various districts of Kashmir. Mostly, the introduction of high density plantations in Kashmir valley will act as a game changer for the fruit industry of Kashmir valley but unfortunately the recent new incursions of new insect pests is the cause of concern in the twin districts of Kashmir Valley especially in Baramullaha and Shopian.

b) Atmanirbhar Bharat (Entrepreneurship development)

- Two start-ups have been created using light traps for turf grub management in Royal Spring Golf Course & another start up as, pheromones for the future; both were funded by JKDST in collaboration with National Institute of Technology, Srinagar. Among the two start-ups, one turned into company as it has got Big Innovation Award funded by DBT, GoI, New Delhi. This is the first of kind company known as M/S Pherobank technologies Pvt. Ltd registered and working in the incubation centre of SKUAST-K.

CAU, Pasighat

a) Doubling Farmers' Income:

- Tribal farmers especially from remote villages of various districts such as West Kameng in Feb-2021, ShiYomi in Oct 2021 and Lower Dibang Valley in July 2022 were probably having lower income due to reduced crop yields. It was due to non awareness on crop pests, natural enemies, biocontrol techniques and also non availability of quality plant protection measures. Thus farmers were given with need based bio-pesticides for the organic production of vegetables for their consumption and selling in their own village markets. Application of bio-pesticides not only increased the vegetable yields but also the helped in improvement of nutritional and economic stability of some tribal farmers.

b) Atmanirbhar Bharat (Entrepreneurship development):

- For the promotion of entrepreneurship development farmers were encouraged to carry out on-farm conservation, production and application of bio-control agents for pest management by carrying out capacity building training programmes. Training Programme on 'Bio-intensive Pest Management in Tomato and Cabbage' at CHF Pasighatbenefitted 30 participants. Training Programme on 'Biological Control of Mustard and Maize Pests' at Taki Lalung village also benefitted 30 participants.

MPKV

a) Doubling Farmers' Income :

- AICRP on Biocontrol, Pune has conducted large scale demonstration trials on management of white grubs on sugarcane, biological suppression of *Spodoptera litura* with *Nomuraea rileyi* in soyabean and large scale demonstration on *Trichogramma* spp. against sugarcane borer. From these demonstrations farmers has got confidence in use of biopesticides for the pest management, also by this approach the farmers will get higher yields and return because of reduced cost input. Thus, it will help for doubling farmer's income.

b) Atmanirbhar Bharat (Entrepreneurship development)

- AICRP on Biocontrol, Pune has attempted for production and demonstration of biopesticides through Experimental Learning Programme for last semester of UG and 177 students in last 5 years have been trained in production and marketing of biopesticides. Thus they became confident in entrepreneurship.

MPUAT, Udaipur

- Various bioagents have been produced and made available to the farmers for the use. After that farmers shows interest in using them and over the period bioagents become popular in the area.
- Tricho-cards were distributed for the use by poor farmers having small holding which rarely uses the chemical pesticides and eventually the use of provided bioagents resulted in an increase in the farmers' income.
- Production units have been setup for the production and sale of bioagents so that they will be available for the use by farmers on time.
- Free distribution of biopesticides and bioagentstaken up so that farmers can adopt them in their package of practices and to make them familiar with the use of bioagents.

TNAU

a) Doubling Farmers' Income:

- TNAU adopted a village Sattakkalpudur in Coimbatore district. Demonstration of biological control against RSW of coconut and release of parasitoids in vegetable crops has been conducted.

OUAT

a) Doubling Farmers' Income

- Enhanced yield in prioritised crops *viz.* Rice, Sugarcane, Brinjal and Maize due tobio intensive pest management module intervention increased the income of farmers.

b) Atmanirbhar Bharat (Entrepreneurship development)

- The very purpose of ELP is to develop entrepreneurship skill development among the B.Sc (Agri.) graduates. They should be job provider (Atmannirbhar) instead of job secure.

ANGRAU

a) Doubling Farmers' Income

- The farmer, K. Apparao, Kothavalasa, Dumbrigudamandal, Araku, Visakhpatnam district used to get annual income of Rs 115700 from rice, ragi, ginger, turmeric and vegetable cultivation during 2015-16. He faced problems like poor crop growth, severe incidence of stem borer, leaf folder, blast and sheath blight in rice; wilt and leaf feeders in rajmash; rhizome rot, termites in ginger and turmeric; different pest and disease problems in vegetables resulted in low yields. With Doubling farmers income interventions like biointensive pest mangement practices, growing improved high yielding varieties, use of liquid biofertilizers, neem cake and mixed vegetable cultivation, he realized increased production in rice (4550 kg/ha), ragi (1000 kg/ha), ginger (3500 kg/ha) , turmeric (750 kg/ha) and vegetables (2200 kg/ha) with net income of Rs.165833 /ha during 2020-21.
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b) Atmanirbhar Bharat (Entrepreneurship development)

- Adoption of eco-friendly low cost biocontrol agent, *Trichogramma chilonis* production system by tribal farmers through establishment of eri silk worm based tricho card production unit in 2017-18.
- Training imparted to 25 tribal farmers on *T. chilonis* production. Trichocard production unit at Asarada village, Chinthapalli division.Trichocardrythumithra group" was formed with 15 tribal farmers of Asarada village and trichocard production by the tribal farmers initiated from kharif, 2018. Production of trichocards (600 No) by tribal farmers resulted in effective utilization of trichocards in 80 acres for pest management in rice organic cultivation during 2018 -2020.
- Ecovibes- Araku Tribal Women Apiary unitwith Honey bee keeping boxes (10No) and honey extractor given to ten tribal women farmers of KorraiKothavalsa village,

Dumbrigudamandal, Araku division, Visakhapatnam district in 2020-21. Tribal women produced 120 kg honey from apiary unit during 2020 -2022.

- Technical support in Establishing Farmers level production unit of *Isaria fumosorosea* NBAIR Pfu35 inaugurated by NBAIR, Bengaluru scientists during January, 2020 maintained NGO-Reddy's Mitra foundation, Srikakulam at Venkataraopeta, Ranasthalammandal resulted in production of *I. fumosorosea* NBAIR Pfu35 (1250 kg) and utilization in 250 ha coconut orchards during 2020-22 gave effective management of coconut rugose spirallying whitefly.
- Technical support in establishing biocontrol laboratory by NGO Vikasa at V.Madula during 2021 facilitated production of *T. chilonis, T. japanicum* cards @ 50 per month and *M. anisopliae* NBAIR Ma35 and *Beauveria bassiana*, NBAIR Bb45 @ 20 kg per month and utilization in demonstrations on organic cultivation in rice, maize, vegetables in agency and plain areas of Visakhapatnam district during 2022.

AAU, Anand

a) Doubling Farmer's Income

- The impact of large-scale demonstrations and tribal sub plan programme witnessed the significant reduction in the usage of chemical pesticides (30-40%) with increased yield (10-12%). The reduction in the input cost has assured the better income to the farming community

a) Atmanirbhar Bharat (Entrepreneurship development)

- The large-scale diffusion of on-farm production and use of microbial biopesticides technology among the farming community has resulted in self-reliance on bio-inputs required for sustainable management of crop pests and diseases.

KAU, Thrissur

a) Doubling Farmers' Income

- The income of progressive famers who adopted bio-intensive pest management in rice was analysed. Earlier, they faced problems like weeds, pests and diseases, water management, soil nutrient issues etc. With DFI interventions like the adoption of biological control of crop pests and diseases, soil nutrient management and integrated weed management, they earn better income.
- Adoption of BIPM practices led to substantial reduction in infestation by major pests and increase in population of natural enemies. The increased yield in BIPM plots as well as reduced the cost of cultivation resulted in the increase in profit.

XXXVI. Significant outcome

CPCRI

- Morphological and molecular identification of five exotic whiteflies *viz*., *Aleurodicus dispersus, A. rugioperculatus, Paraleyrodes bondari, P. minei* and *Aleurotrachelus atratus* occurring on coconut system done.
- Pesticide holiday approach and conservation biological control using the aphelinid parasitoids *viz*., *Encarsia guadeloupae*, *Encarsia dispersa*, predators such as *Apertochrysa* sp. *Jauravia pallidula* and *Cybocephalus* sp. and *in situ* habitat preservation of the scavenger beetle, *Leio chrinus*. *Nilgirianus* subdued the invasive potential of *A. rugioperculatus* from >80 % to <10 %.
- Heterogenous landscapes with crop pluralism in coconut garden induced stimulo-deterrence by disorientation of exotic whiteflies and de-risking farming community by realising sustainable farm income (>160 nuts per palm per year).
- Three lady beetles and their grubs, *viz*., *Chilo corusnigritus*, Sasaji *Scymnus dwipakalpa*, and *Pharoscymnus horni* as well as the aphelinid parasitoid, *Aphytis* sp. were found effective in the bio-suppression of the coconut scale, *Aspidiotus destructor* disallowing pest flare up.
- Augmentative release of the stage specific parasitoids *viz*., *Goniozus nephantidis, Bracon brevicornis* and *Brachymeria no satoi* bio-suppressed *Opisina arenosella* infestation significantly and regained palm health.
- Area-wide application of green muscardine fungus, *Metarhizium majus* ($5x10^{11}/m^3$) in the breeding zones reduced leaf damage by 80% and enhanced nut yield by 13%.

IIMR (Millets), Hyderabad

Management of Fall army worm in sorghum with bioagents:

- Release of *Trichogramma chilonis* @ one card/acre twice at weekly intervals commencing at 7 DAE, 14 DAE of sorghum followed by spray of *Metarhizium anisopliae* (Ma 35) @ 0.5 % at 20, 35 DAE was found to decrease the egg patches, larvae numbers (42.0 %) and whorl damage (59.9%) caused by *Spodoptera frugiperda*, significantly. There was 11.1 and 15.4 % increase in the grain and fodder yield in comparison to control.

KAU, Kumarakom

- *Isaria fumosorosea* followed by neem oil spray could bring about reduction in live colonies and nymphs of Bondars nesting whitefly. Neem oil spray could only bring aboutslightreduction.The production and distribution of bioinputs have been strengthened under the project.

KAU Vellayani.

- Carried out multilocation trials in 12 AICRP plots outside Kerala under the supervision of RRI, Hyderabad on the new indigenous potent isolate *L. saksenae* from Kerala. Produced various biocontrol agents for the benefit of farmers of the state. Established a *Trichogramma* production unit.Created awareness on the benefits and

usage of biocontrol agents in pest management of major crops of Kerala, among the farmers.

NCIPM

- BIPM technology was found effective in the management of major pests of chickpea with a significant reduction in infestation of pod borer (70.52%) and disease incidence of collar rot (77.4%), *Fusarium* wilt (73.77%) and dry root rot (62.5%) over farmers practiceand pest remained below ETL. BIPM strategy proved economically viable with BC ratio 3.87 compared to 3.06 in farmers practice. Implementation of BIPM strategy provided >29 per cent increase in seed yield and >42 per cent increase in net return over FP.

UBKV, Pundibari

- The training programme on use of biocontrol agents for management of pests and diseases has been imparted to 558 tribal farmers of the villages Singimari, Nurpur and Baniagaon of Coochbehar and Alipurduar districts through 17 trainings. Tricho cards (30 pieces/month), pheromone traps (50/month) and antagonist microbials (40 kg/ month) against diseases are being produced and distributed among farmers.

PAU, Ludhiana

- Technology for the management of stem borer using two releases of *T. chilonis* at 10 & 17 days old crop @ 1,25,000/ha in fodder maize has been recommended for farmers of Punjab
- Integrated management of stalk borer, *Chilo auricilius,* early shoot borer, *C. infuscatellus,* and top borer, *Scirpophaga excerptalis* with pheromone traps and *T. chilonis* in sugarcane has been recommended for farmers of Punjab
- Management of gram caterpillar with biopesticide, *Bacillus thuringiensis kurstaki* 0.5 WP (DOR Bt-1) @ 800 g/acre and with Helicop 2 % as (HearNPV) @ 200 ml/ acre in gram has been recommended for farmers of Punjab
- Management of leafhopper in okra with neem based biopesticide, Ecotin (azadirachtin 50000 ppm) @ 80 ml/acre has been recommended for farmers of Punjab
- Management of stem borers and leaffolder with neem based biopesticide, Achook (azadirachtin 1500 ppm) @ 1000 ml/acre or application of Ecotin (azadirachtin 50000 ppm) @ 80 ml/ acre in *Basmati* rice under organic and normal cultivation conditions has been recommended for farmers of Punjab
- BIPM module involving installation of pheromone trap @ 10 traps/acre, two release of *T. chilonis* @ 1,00,000 eggs/ ha *(*first release after one week of sowing & second one after one week of first release), NBAIR Bt-25 @ 10 ml/ litre of water (1-2 sprays depending on pest incidence, first spray afte*r* 20 *days after sow*ing to target early instars of FAW larvae) and NBAIR Ma-35 @ 5g/ litre of water (1-2 sprays depending on pest incidence, first spray 10 days after first spray of Bt-25 to target late instars of FAW larvae)

- BIPM module involving *Chrysoperla zastrowi sillemi* releases @ 4 larvae/ plant + yellow sticky traps @ 4 per 250 m^2 for the management of sucking pests in capsicum and tomato under net house conditions
- Management of stem borer with commercial Bt formulations (Delfin WG and Dipel 8 L) and NBAIR formulations (NBAIR Bt G4, Ma-35 and Bb-5a) in maize and fodder maize
- Validation and dissemination of biocontrol technologies for the management of sugarcane borers at farmers' fields using bioagents, *T. chilonis* and *T. japonicum* in sugarcane conducted over an area of 4493, 4806, 4823, 2004 and 2915 hectares during 2017, 2018, 2019, 2020 and 2021, respectively in collaboration with sugar mills of Punjab
- Validation and dissemination of biocontrol based pest management technologies using bioagents, *T. chilonis* and *T. japonicum* for the management of leaffolder and stemborersconducted over an area of 81, 118, 131, 124 and 139 hectares during 2017, 2018, 2019, 2020 and 2021, respectively in organic rice
- Validation and dissemination of bio-suppression of maize stem borer, *C. partellus* using egg parasitoid, *T. chilonis* at farmers' fields in maize/fodder maize crop conducted at farmer's fields over an area of 162, 177, 179, 24 and 2 hectares during during 2017, 2018, 2019, 2020 and 2021, respectively 2012-13, 2013-14, 2014-15, 2015-16 and 2016-17, respectively

PJTSAU, Hyderabad

- The centre has established mass production techniques of various natural enemies, *viz.*, egg parasitoid, *Trichogramma* spp and maintains cultures of six species: *T. japonicum, T. chilonis, T. pretiosum, T. brassicae, T. bactrae*. *Chelonis blackburni* and predator, *C. zastrowi sillemi.*
- The centre scaled up the production of Trichocards and started selling them to farmers, scientists, DATTC and KVK centres. During 2021, Trichocards were sold for 125 acres of land, while in 2022, cards for 400 acres of land were sold to rice, maize and cotton farmers.

CAU, Pasighat

- The centre has successfully isolated native entomopathogenic fungi strains *viz., Metarhizium rileyi, Beauveria bassiana and Lecanicillium lecani* during 2021-22. *Under* Tribal Sub Plan the centres has conducted its first time training programmes at remote villages of different districts *viz.,*at Nafra circle, West Kameng, ShiYomi and Hunli-Desali, Lower Dibang Valley. The centre also recorded first incidence of Coconut Rugose spiralling whitefly and *Aniso pteromalus calandrae* (Howard) on Bruchids in Green gram from Arunachal Pradesh

MPKV, Pune

- Amongst the biopesticide, *Lecanicillum lecanii* @ 5 g/L is found effective for controlling the sucking pest in *Bt* cotton.

- In efficacy studies, *Heterorhabditis indica* @ 10kg/ha (NBAIR WP formulation) wasfound most promising and recorded 64.63 % white grub reduction as against 70.64% in chemical check Fipronil 40% + imidacloprid 40 WG @ 500g/ha.
- BIPM module (*T. pretiosum* @ 1.0 lakh/acre at 10 and 20 DAS, *Metarhizium rileyi* 1×10^8 spores/g @ 2.0 gm/l at 30 DAS and *H. indica* NBAIIH 38 @ 4 kg/acreat 40 and 50 DAS) is superior in fall armyworm control (28.55%) after farmers practice (6.03%).
- Two applications of *H. indica* @ $1.0x10^5$/ m^2 (NBAIR WP formulation) at 30 days intervalis effective against white grub in sugarcane.
- Three sprays of *Bt v*ar. *Galleriae* (*Bt*) @ 1 kg/ha 45 days after sowing at 15 days interval is recommended for the effective control of shoot and fruit borer, *Earias vittella* on okra.
- The eight releases of *T. chilonis* TTS @ 50,000 parasitoids/ha at weekly interval starting from 45 days after emergence of shoots found significantly superior to untreated control in reducing the ESB infestation and recorded significant cane yield.

MPUAT, Udaipur

- The demonstrations on the releases of *T.chilonis* were conducted at farmer's fields in an area covering 10 hectares in Udaipur district of Rajasthan.
- Large scale field trials for the management of *Helicoverpa armigera* (Hubner) on tomato.
- On the basis of 3 years station trials, following recommendations are included in the POP OF MAIZE against FAW **:**
- Two releases of egg parasitoids *T.chilonis* or *T. pretiosum* @ 1 lakh/ha at weekly interval starting at 10 days after sowing for the management of fall armyworm in maize
- Whorl application of entomofungal pathogen *M. anisopliae* @ 5 g/L for the management of fall armyworm in maize

TNAU, Coimbatore

- Biointensive management of pink bollworm on *Bt* cotton: Pink bollworm damage was 22.00 per cent in BIPM (Erection of pheromone traps (Funnel type) @ 10/ plot/PB Robe and 6 releases of *T. bactrae* 100,000/ha/release, starting from 55 days after germination) plots while it was 32.00 per cent in control. The yield increase in BIPM plots was 20.00 per cent over control plots.
- Biological suppression of rugose spiralling whitefly in coconut: BIPM module *ie.*, *Encarsia guadeloupae* natural conservation + Release of *Apertochyrsa astur* eggs @ 1000/ha + Yellow sticky traps @ 20/ha was demonstrated in Chinnappampalayam, Anaimalai Block, Coimbatore Dt. In BIPM field, there was 80.00 per cent reduction in the population of Rugose spiralling whiteflies (RSW) while in control plot there was 60.00 per cent reduction in RSW population. Similar trend was observed in the population of Bondars Nesting Whiteflies also.
- Bio-intensive insect management in brinjal: In BIPM plots (Azadirachtin 1500 ppm @ 2ml/lit (one round of spray) + *Lecanium lecanii* (one round of spray) + *T.*

pretiosum (8 releases) + Pheromone traps @ 20/ha + Cowpea as bund crop), the fruit damage in brinjal due to *Leucinodes orbonalis* was significantly low (21.80%) when compared to (32.55%).

- Card board boxes for transport and release of Chrysopids eggs: Small card board boxes for release of Chrysopids eggs have been designed and boxes are pined in coconut leaflets without any damage to Chrysopids eggs.
- Labour saving (70%) method for collection of *Corcyra cephalonica* moths has been developed. 3477CC of Tricho cards and 11million predators were supplied to the farmers.

OUAT, Bhubaneswar

- Demand for the biocontrol agents utilization in sugarcane and brinjal crops has been increasing in Odisha due the adoption of BIPM practices for the borers pest management.

ANGRAU, Hyderabad

- Empowering Tribal Farming community through ICAR-Tribal Sub Plan Programme in Araku valley and Chinthapalli regions of Visakhapatnam district by popularization of Organic Farming practices in Paddy, Rajma, Turmeric, Ginger, niger and Vegetables.
- Isolated, characterized local Bioagent, Microbial- *Metarhizium (Nomuraea*) *rileyi* from infected maize fall armyworm larvae from our region (RARS, Anakapalle, Andhra Pradesh) (AKP-Nr-1) and confirmed as *Nomuraea rileyi* during 2019. The ITS generated sequence was deposited in NCBI Gene Bank database and obtained with accession number *(*MN 960559). Mass production of *Metarhizium (Nomuraea*) *rileyi* AKP Nr-1 was standardized
- Isolation of native macrobials *T. chilonis* from fall armyworm eggs from Sugarcane crop of RARS, Anakapalle, Andhra Pradesh (MN116707) and DNA barcodes were generated; *Telenomus remus* from fall army worm eggs of Sugarcane crop of RARS, Anakapalle (MW052800) ; *Trichogramma chilonis* from fall armyworm eggs from maize crop of RARS, Anakapalle (MW052801) ;*Telenomus remus* from fall armyworm eggs of maize crop of RARS, Anakapalle (MW052708).
- Commercial production of Biocontrol agent, *Trichogramma chilonis* with new protocol developed by ICAR- NBAIR, Bangalore as per the protocol of ICAR-NBAIR, Bengaluru from 2016 to 2022 helped in pest management in. Developed a farmer friendly system for production of *T. chilonis* on Eri silkworm (*Samia ricini)* for promotion in tribal areas during 2017. Mass production of Entomopathogenic fungi *i.e., B. abassiana* and *M. anisopliae* mother cultures as conidiated rice from the year 2016 to 2022 and mass production of entomopathogenic fungi, *Isaria fumosorosea* from 2019 -2022 with technical support and protocol of ICAR-NBAIR, Bengaluru.
- New initiative in Establishing New Biocontrol laboratory by NGO Vikasa at V. Madula on 18.12.21 and facilitating production of Trichocards (*T. chilonis*, *T.*

japanicum) @ 50 cc per monthand *M. anisopliae* NBAIR Ma35 and *B.bassiana*, NBAIR Bb45 @ 20 kg per month and utilization for pest management in demonstrations on organic cultivation in rice, maize, vegetables in agency and plain areas of Visakhapatnam district.

AAU, Anand

- The native isolate *T. chilonis* was documented from the castor and cotton ecosystem and native isolate of *H. indica,* AAU-R strain (Genbank accession no. MW418203) was documented from the soil collected from Talala (LAT21^{0}13'44''N, LONG70^{0}31'53''E), Dist. SasanGir, Gujarat. Documented the NPV infecting spotted pod borer, *Maruca vitrata* in the cowpea fields of AAU campus (LAT22.534745^0, LONG72.981918^0), Dist. Anand, Gujarat.
- Successfully conducted eight research experiments focusing on mustard aphid, shoot and fruit borer in okra, fall armyworm in maize, shoot and fruit borer of brinjal, ecological engineering in cabbage, onion thrips and early blight disease in tomato and potato.
- Three technologies were developed and incorporated in university package of practice/university research recommendation
- Successfully conducted large scale demonstration trials to validate the technologies of BIPM modules in okra, cabbage, mango and pigeonpea covering the area of 580 ha.
- During the period under report, the center has produced 27,312 trichocards and 36.21 tons of microbial biopesticides.
- Established state of the art 'Biopesticide Research and Production Unit' under the project funded by Organic Farming Cell, Govt. of Gujarat with outlay of Rs. 160 lakhs

AAU, Jorhat

- Developed 7 technologies for management of insect pests on rice, rape and mustard, brinjal, papaya, okra and cabbage
- Collected and identified 17 spider species, 7 dragonfly species, 4 dam selfly species, 5 coccinellids species, 2 tiger beetle species, 2 dipteran predator and 1 parasitoid, 4 hymenopteran parasitoid, 1 mirid predator and 1 dermapteran.
- Two technologieson BIPM of cow pea and cucumber were evualuated under multi locational trials

YSPUHF, Solan

- *Trichogramma embryophagum* resulted 16.6 per cent parasitization. The parasitism resulted by *T. achaeae, T. pretiosum* and *T. chilonis* was 5.6, 8.9 and 11.1 per cent, respectively, Adult emergence from the parasitized host eggs was 80, 75, 70 and 86.6 per cent for *T. achaeae, T. pretiosum, T. chilonis* and *T. embryophagum*, respectively.
- *Metarhizium anisopliae* treatment resulted in 71.1 to 82.2 per cent mortality of the apple root borer grubs in different orchards whereas chlorpyriphos (0.06%) resulted 77.4-86.6 per cent

- Bio-intensive Pest Management (BIPM) and chemical insecticides were statistically equally effective in reducing the fruit infestation by *T. absoluta* in tomato. The yield was maximum (22t/ha) in BIPM and was statistically on par (21.3t/ha) with chemical treated plots. The highest fruit infestation (0.62 - 1.18 %) was caused by *H. armigera*.
- Among biocontrol agents, *Chrysoperla zastrowi sillemi* (4 larvae / plant) resulted maximum reduction (49.1%) in aphid population in capsicum under polyhouseover control after the first release, which was, statistically on par with other bioagents (40.3-55.8%) except *M. anisopliae* (5g/l of 10^8 spore/ g) where the reduction was 35.9 per cent. Ten days afterthe second spray/ release, *C. zastrowi sillemi* (4 larvae / plant) resulted highest (73.8-78.1%) reduction in the aphid population followed by azadirachtin (2ml/L of 1500ppm) (66.5 -68.9%) and *L. lecanii* (5g/l of 10^8 conidia/ g) (66.2%). Other biocontrol agents resulted in 44 to 58.3 per cent reduction in the aphid population over control.
- Management of phytophagous mites on cucumber using *Blaptostethus pallescens* and *Neoseiulus longispinosus* under polyhouse condition.The highest yield (6.3kg/plant) was recorded in plants treated with spiromesifen (100g a.i./ha) followed by *N. longispinosus* (1:20), *N. longispinosus* (1:30), *B. pallescens* (20nymphs/m row) and *B. pallescens* (10 nymphs/m row).
- Seed treatment with *Trichoderma asperellum* formulation @10g/kg seed + soil application of *T. asperellum* formulation after mixing with FYM (10g/Kg FYM) @40g/m^2 could be an ecofriendly option for *Fusarium* wilt/ root rot of peamanagement.

IGKV

- Production of various biocontrol agents vizi.e Trichocards (4351 no), Braco cards 7 to 2022 (1820 no), *Zygogramma* beetles (10,902 no.), Coccinellid beetle (2695 no.), Reduviid bugs (2017 no.), Low cost light trap (32 no.), *Corcyra* eggs (26 cc.) and *Crypto laemus* (10 no.)

NRRI

- NBAIR isolates i.e., NBAIR-PEOWN (*Pseudomonas entomophila*), NBAIR-BATP (*Bacillus albus*), NBAIR-BtoYPS (*Lysinibacillus sphaericus*), NBAIR-PFDWD (*Pseudomonas fluorescens*) and NBAIR-TATP (*Trichoderma asperellum*) shown lesser dead heart and white ear-head damage caused by rice yellow stem borer, leaf damage caused by rice leaf folder but increased plant height and grain yield than the untreated control. Based on this lead result, NBAIR-BATP (*Bacillus albus*) which performed better was carried forward for the multi-location evaluation against rice insect pests.
- Similarly, with respect to disease evaluation trail against rice diseases, NBAIR-PFDWD (*P. flourescens*) was the most effective isolate against rice diseases *viz*., sheath blight, brown spot and blast with lesser Percent Disease Index (PDI) followed by NBAIR-TATP (*T. asperellum*) under field conditions. Field results revealed that NBAIR-PFDWD treatment enhanced the plant growth of rice plants in terms of plant height, fresh shoot weight, fresh root eight, dry shoot weight, dry root weight and

yield as compared with control plants. Based on this lead result, NBAIR-PFDWD (*P. flourescens*) which performed better was carried forward for the multi-location evaluation against rice disease pests.

KAU, Thrissur

- BIPM in rice: The BIPM practices (*P. fluorescens* @ 10 g/kg of seed, followed by five releases of *Trichogramma* spp. @ 1 lakh/ha starting from 10 days after transplanting or 30 days after sowing, and application of *Beauveria bassiana*) recorded higher population of natural enemies and resulted in reduction in stem borer and leaf folder infestation in rice by 65 and 38%. The rice bug population was 46 per cent low in BIPM plots. Similarly, incidence of bacterial leaf blight was mild in BIPM plots. Adoption of IPM practices led to also substantial increase in yield as well as net returns.
- Plots treated with bioagents namely, *Bt, B.bassiana* and *H. indica* have consistently recorded stem borer and leaf folder damages that are comparable or less than the insecticide check and can be effective substitutes to the same.
- Release of *B. pallescens* @ 20/m row in polyhouse effectively reduced the population of spider mite in salad cucumber.
- BIPM in brinjal: The BIPM practices in brinjal (Seven releases of *T.chilonis* @ 1 lakh per ha, two sprays of *Bts* (NBAIR - BtG4) and *L. lecanii* (NBAIR-Vl 8) @ 15 day interval) resulted in reduction in brinjal shoot and fruit borer and mealybug infestation. Fruit infestation by borer was lower in plots where insecticides were applied (31.51%), followed by BIPM plots (40.05 %). The economic yield was recorded as 57.0 and 42.73 q/ha respectively for BIPM and chemical plots, which were on par. The studies indicated that the BIPM package could be a viable alternative to chemical methods against insect pests in brinjal.

XXXVII. Success stories

CPCRI

Bio-management of coconut black headed caterpillar, *Opisina arenosella* Walker through timely release of parasitoids.

The black headed caterpillar, *Opisina arenosella*, is a major pest of coconut distributed in almost all coconut growing tracts across the country. Extensive feeding of caterpillars causes a crop loss of 45.4% in terms of nut yield in addition to rendering the fronds unsuitable for that ching and other purposes. Area-wide field validations on biological suppression of coconut black headed caterpillar through release of stage-specific parasitoids *viz., Goniozus nephantidis* and *Bracon brevicornis* @ 20 parasitoids/palm at monthly intervals for a period of eight months in various locations of coastal Kerala and south Karnataka by ICAR-CPCRI covering 1500 ha led to good recovery of palms in a period of 18 months with enhanced nut yield as well.

Bio-suppression of Rugose Spiralling Whitefly on Coconut

Rugose spiralling whitefly (RSW), *Aleurodicus rugioperculatus* Martin is the recently emerged invasive pest on coconut palm introduced in India during 2016. RSW rapidly spread

across the Peninsular India (Kerala, Tamil Nadu, Karnataka, Andhra Pradesh, and Goa) and other coconut growing tracts in the country as Pan India pest of coconut palm. Pesticide holiday at tandem with conservation biological control using *E. guadeloupae* as well as bio-scavenging by Leiochrinid beetles, *L. nilgirianus* adopted in Kayamkulam, Kerala could reduce the pest incidence (*A. rugioperculatus*) to more than 90% and bio-cleansing of palms to the tune of 95% in a period of six to eight months without using any insecticide in the system. In this conservation tactics, natural defenders, scavenger beetles and the pollinators are conserved in the coconut system which enhanced ecosystem vitality and delivered economic benefits to the tune of 1760 crore rupees.

DrYSRHU

The management strategiesof spraying of Azadirachtin 1% EC, installation of yellow sticky traps, conservation biological control using *E. guadeloupae* coupled with need based releases of predatory insect *A. astur* and utilizing entomopathogenic fungi *I. fumasorosea* NBAIR pfu 5 as another spraying option offered an integrated package for checking RSW. The large scale demonstrations and assured supply of bio agents along with awareness campaigns andprogrammes carried out in collaboration with, Rytubharosakendras, Department of Horticulture showed a tremendous impact at grass root level in effectively managing RSW in coconut and oil palm plantations.

GBPUAT

Large scale demonstrations of biocontrol agents against plant diseases, at farmers' field covering an area of 1659 ha were laid out on rice, tomato, chickpea, and pea crops, in the districts of U.S.Nagar & Nainital.More than 93 quintals of quality biocontrol agents mass produced in Biocontrol Lab at Pantnagar was distributed to 2800 farmers. Through the adoption of biocontrol technologies, farmers were able to reduce their cost of production and minimized losses due to diseases resulting in increased benefit-cost ratio and a healthy crop.

PAU

Biological control of sugarcane borers:

The augmentative releases of egg parasitoids, *Trichogramma chilonis* and *T. japonicum* have been recommended for eco-friendly management of early shoot borer, top borer, and stalk borer in Punjab. The technology regarding mass production of *Corcyra* eggs and tricho-cards has been transferred to different sugar mills in the state. These sugar mills are successfully running biocontrol laboratories under the technical guidance of PAU centre. PAU is acting as nodal agency for transfer of technical expertise as well as core point for resources like nucleus culture of bioagents and training to staff of biocontrol laboratories in the state. The proven biocontrol technology was disseminated on large scale at farmers' field in collaboration with sugar mills, KVKs and FASCs. The adoption of biocontrol technology involving time specific multiple releases of Trichogrammatids resulted in noteworthy impact with respect to area coverage, lowering input cost (3800 to 4600 per ha), reduction in incidence of sugarcane borers (52.4 to 58.7 %) and gave higher yield (10-15 % increase) with additional economic benefits of Rs. 16205 to 19774/- per ha during different years to sugarcane growers.

Biointensive pest management in organic rice:

BIPM technology involving augmentative release of *Trichogramma chilonis* and *T. japonicum* each @ 1,00,000 parasitoids/ ha, 5-6 times at weekly interval starting from 30 DAT for stem borers and leaf folder was disseminated in organic basmati rice on large scale at farmers' field in various districts of Punjab in collaboration with KVKs and FASCs. The adoption of BIPM technology has resulted in significant impact with respect to increase in area and reduction in the incidence of stem borers (50 to 55 %) and leaf folder (55 to 60 %). Grain yield in BIPM fields was also significantly more in BIPM fields as compared to untreated control. Consequently, the yield increase (11-14 %) in BIPM fields gave additional monetary returns of Rs. 7070 to 8200/- per ha to organic rice growers.

TNAU

BIPM module*ie., Encarsia guadeloupae* natural conservation + release of *Apertochrysaa astur* eggs @ 1000/ha + Yellow sticky traps @ 20/ha. has been adopted by coconut farmers in TamilNadu. In Chinnappampalayam, Anaimalai Block, Coimbatore Dt., there was 80.00 per cent reduction in the population of Rugose spiralling whiteflies (RSW) in BIPM field, while in control plot there was 60.00 per cent reduction in RSW population.

For the management of brinjal fruit and shoot borer, BIPM module (Azadirachtin 1500 ppm @ 2ml/lit (one round of spray) + *Lecanium lecanii* (one round of spray) + *Trichogramma pretiosum* (8 releases) + Pheromone traps @20/ha + Cowpea as bund crop) and got the marketable fruit yield of 12140 Kg/ha in BIPM plots which was 30.00 per cent more yield than the control plot.

AAU, Anand

IPM module for the effective management of white grub in groundnut:

In the year 2018-19 and 2019-20, in association with NGOs (Triveni Kalyan Foundation & Gram NirmanSamaj, Mahuva, Bhavnagar District, Gujarat) functioning under the aegis of Pidilite Industries, Mumbai adopted 100 ha area of groundnut to demonstrate bioagent based IPM module to curb white grub menace. Large scale demonstration was carried out at cluster level in farmers' fields of Gundarna and Kojnli Village, Mahuva Taluka, Bhavnagar, Gujarat. Significant difference was observed between bioagent based IPM module and farmers' practice. The demonstration module revealed 73% reduction in pest incidence and 46% higher yield ensuring net profit of approx. Rs. 20,000/ ha compared to farmers' practice where sole application of chemical insecticide was noticed. We conclude that the large-scale adoption of bioagent based IPM module is promising for the effective management of white grub in groundnut.

Bio-intensive management of mango hopper

The large-scale demonstration of bio-intensive management of mango hopper was conducted at five different locations across the Gujarat state.The BIPM module comprising microbial biopesticide *Metarhizium anisopliae* (NBAIR Ma-4) 1% WP.was found effective in reducing the mango hopper population.

KAU, Thrissur

BIPM in rice

The large-scale validation of BIPM technologies in rice was carried out over an area of 100, 150,150, 200 and 240 hectares during 2017-18, 2018-19, 2019-20, 2020-21 and 2021-22 respectively at farmers' fields. The IPM practices comprised of *Pseudomonas fluorescens* @ 10 g/kg of seed, followed by five releases of *Trichogramma japonicum* and *Trichogramma chilons* @ 1 lakh/ha starting from 10 days after transplanting or 30 days after sowing, and application of *Beauveria bassiana* @ $1x10^8$ spores/ml. Adoption of BIPM practices led to substantial reduction in infestation by major pests. The mean infestation by stem borer and leaf folder in BIPM plots was 65 and 38 per cent lower as compared to non BIPM plots. The yield obtained from IPM plots was 23 % more than that obtained from non IPM plots. The increased yield as well as reduced cost resulted in an increase in profit by Rs.46705/ha. The cost benefit ratio, at 2.18 was almost double for IPM fields as compared to 1.40 for non IPM fields. The paddy harvested from the BIPM plots in Palakkad district is being processed and sold as "Nira" brand of safe to eat rice under the supervision of Panchayat and Kishibhavan. Encouraged by the results of the large-scale validation trials over the last two years, Alathur Grama Panchayat of Palakkad district sanctioned a project for establishment of a mass production unit for *Trichogramma* egg cards. The unit, supported by Thrissur centre and manned by rural women (Kudumbasree members), successfully produce, and distribute Trichocards among the farmers.

XXXVIII. Quantity of bioagents produced and area covered

S. No	AICRP centre	Macrobial		Quantity (Nos.)	Microbial Biopesticides	Quantity (Kgs)	Area covered (ha)	Crops
		No. Tricho Cards	Other Predators					
	PAU, Ludhiana	86140	*Chrysoperla* eggs *Bracon* adults *Blaptostethus* adults *Telenomus* adults *Chelonus*	1,50,000 1,25,000 25000 15000 12000	*Beauveria bassinana* *Metarhiziuman isopliae*	150 150	2017 8	Sugarcane, Rice and Maize

	CPCRI	----------	*Bracon brevicornis* *Goniozus nephantidis*	21,690 18,250	*Metarhiziummajus* *Oryctes rhinoceros* nudivirus EPN cadaver capsules	1850 1560 (nos.) 12000 (nos.)	527	Coconut
	NCIPM	----------	----------	----------	*Trichoderma harzianum*	100	150	Chickpea Rice
	UBKV, Pundibari	30	Pheromone traps 50 pieces/month	----------	*Trichoderma harzianum*	40	120	Tea, rice, maize, vegetables
	GBPUAT, Pantnagar	----------	----------		*Trichoderma harzianum*	92,710	1659	Rice, Tomato, Chickpea and Pea
	KAU Vellayani	170	----------	3829		5573	207 247 300 285	Rice, cardamom , vegetables, banana, mango, coconut
	KAU, Kumarakom	954	----------	----	-------	11653	1358	Rice, Vegetables, fruit plants,Spices

	SKUAST-K	440	*Blaptostethus pallescens* *Blaptostethus pallescens* *Blaptostethus pallescens* *Blaptostethus pallescens* *Blaptostethus pallescens* *Blaptostethus pallescens*	1,50,000 1,50,000 1,50,000 2,00,000 2,00,000 1,60,000	EPN	20,00000	22	Apple, cabbage, cherry and cole crops
	PJTSAU	330	----------		-		132	Rice, maize, cotton, vegetables
	CAU-Pasighat	----------	----------		(150 kg) 75 kg each talc based *Metarhiziumanisopliae* and *Beauveria bassiana* (2022)		30	Paddy, Potato, Crucifers, Chilli, Tomato and Maize
	MPKV, Pune	3118	----------	13747	13081		2103	Sugarcane, Paddy, Custard apple, Grape, Pomegranate, Vegetables grape and

								amize
	MPUAT, Udaipur		----------	5726	SpliNPV HearNPV *Trichoderma viridae* *Beauveria bassiana* *Metarrhiziuma nisopliae*	26 20 1620 5 70 19		
	TNAU	3477	*Acerophagus, Goniozus and Bracon* *Chrysoperla, Apertochrysa and Cryptolemus*	87,400 1,10,48 ,000			3067 0	Coconut , Cassava , Brinjal, Tomato, Bhendi, Cotton Grapes, Paddy, Jasmine, Ornamentals Mulberry
	SKUAST-Jammu	----------		-----		8302		
	OUAT	1316 9	*Australian lady bird beetles and *C. cornea*	-----			1448	Sugarcane, Rice, Brinjal and Maize
	ANGRAU, RARS, Anakapalle	3435 2	----------	-----		3555	7582	Rice, Maize, Sugarcane , Vegetables, Ginger,

								Coconut
	AAU,Anand	27375	(*Chrysoperla zastrowi sillemi* Larvae (*Chrysoperla zastrowi sillemi* larvae) (*Mallada* sp. larvae) (*Mallada* sp Adults) *Cryptolaemus montrouzieri* (Larvae) Reduviid bugs	5349 23755 11810 45 232 5961		36210	7559	Paddy, Pigeon pea, Maize, Tomato, Chilli,*Bt* cotton, Cabbage, Mango, Okra, Vegetable crops, Banana, Groundnut
	AAU, Jorhat	2725	*Neochetinaeichhorniae*, *N. bruchi*, *Coccinella transversalis*, *C, septempuctata* were maintained in laboratory for practical classes, training, demonstration and ELP students.	-----		1950	335	Rice, cabbage, brinjal, sugarcane, tomato, ginger, turmeric and other vegetables
	YSPUHF, Solan	24	Predatory mite, (*Neoseiulus longispinosus*)	6250000	*Metarhizium anisoplia*	22,000	230	--------

	IGKV	4351	Bracon cards *Zygogramma* beetles Coccinellid beetle Reduviid bugs	1820 10,902 2695 2017	--------		120	Rice, Maize, Chickpea, Cowpea, Okra, *Parthenium* weed
	KAU, Thrissur	27282	----------	-----	1128796		13955	Rice, vegetables, coffee, tea, banana, cardamom *etc*.
	UAHS **Total**	---------- **209663**	---------- ----------	----- **19,950,228**	*Trichoderma* *Pseudomonas fluorescens* *Bacillus megaterium (PSB)* VAM (Glomus mossae) *Paceliomyces lilacinus* *Metarhizium anisopliae* *Bacillus subtilis*	41921 26645 10927 2823 480 86632 745 **2370668**	4263 **93480**	

XXXIX. Strategic plan (2022-2027)

ICAR-CPCRI, Kayamkulam

- Conditioning bioagents to abiotic stress and evolve potent defenders (Parasitoids/Entomopathogens) to mitigate climate change.
- Environmentally responsible farming approaches through heterogeneous land scaping for pest regression and biodiversity conservation
- Development of pest forecasting models for effective prediction and diminution of pestilence outbreak
- Pest surveillance and evolving sensitive digital devices for pest diagnosis and bio-suppression using IoT technology.
- Sensitizing potential invasive pests and develop emergency preparedness module

Dr. YSRHU, HRS, Ambajipeta.

- Commercialization and transfer of biocontrol technology to the prospective private firms
- Production and supply of coccinellid predators to farmers
- Studies on alternate factitious hosts (other than *Corcyra z. sillami*) suitable for bio-agents culture maintenance and multiplication
- Establishment of bio control labs in villages earmarked for organic farming and training the rural youth for self employment
- Survey and identification of bio agents for invasive and emerging pest diseases
- Documentation on rate of establishment of bioagents after field releases especially under out break conditions
- Identification of potential native strains for management of coconut and cocoa diseases

GBPUAT, Pantnagar

- Screening of new promising fungal, bacterial isolates and developing new consortia of microbial antagonists against the important diseases of Rice, tomato, Chickpea and Peaunder glasshouse and Experimental field conditions.
- Large scale training & demonstration of Bio control technology at farmers' field.
- Development of the repository of tested microbial Biocontrol agents against the Pathogens of economically important crops of the region

ICAR-IIMR, Hyderabad

- Large area multilocation trial (2 centers) for management of *Spodoptera frugiperda* in Rabi sorghum

ICAR-IIHR, Hesaraghatta

- Survey and surveillance of invasive pests
- Mass production of *Trichogramma chilonis* and *Cryptoleamus montrouzeri*
- Demonstration of IPM for Brinjal shoot and fruit borer in farmers field

- Trainings on biological control of horticultural pests to the farmers and state department officials.

ICAR-IIRR, Hyedrabad

- Demonstration of bio control-based techniques in farmers fields
- Testing and validating of bio agents developed through AICRP BC and NBAIR at IIRR and through the AICRP on rice system.
- Collection and molecular characterization of natural enemies from rice fields in collaboration with NBAIR.

KAU, Kumarakom

- Demonstration of the bioefficacy of *Trichoderma asperullum* KAU strain application for the management of *Fusarium* wilt in cowpea
- Demonstration of bio-intensive management practices for the management of pests (fruit borer/ sucking pests) of Brinjal
- Evaluation of entomopathogens against sucking pests of cowpea
- Evaluation of microbial antagonists for the management of ginger rhizome rot
- Scaling up the productionand distribution of *Beauveria bassiana*, *Lecanicillium lecanii*, arbuscular mycorhizal fungi, Trichocards (against rice leaf folder and stem borer) and pheromone traps (for fruit flies in vegetables and mango), and mass production of entomopathogens like *Purpureocillium lilacinum* and *Metarhizium anisopliae* for the benefit of farmers of the district.

KAU, Vellayani

- Field validation of improved formulations of biopesticides at multiple locations.
- Registration of indigenous isolates of KAU - *L. saksena* and *B. bassiana*
- Initiation of TSP in the tribal areas of Trivandrum and Kollam districts
- Establishing production facilities for *Chrysoperla zastrovi sellami* for cardamom plantations and *Apertochrysa* sp for coconut plantations.
- Scaling up the production targets of Trichocards and biopesticides.

ICAR-NCIPM, New Delhi

- Large-scale demonstration of bio-intensive pest management on rice.

UBKV, Pundibari

- Creating awareness among the farmers and adopting villages for the promotion of biocontrol
- Scaling up the proicrobial agents including the isolate one local strain of *Beauveria bassiana*
- Exploratory survey on the biodiversity of Sub-Himalayan or Terai zone of West Bengal, identification and elucidate their role in biocontrol of crop pests.

PAU, Ludhiana

- Documentation of arthropod and microbial natural enemies in various agro-climatic zones of Punjab
- Mass production of potential bioagents (macrobials and microbials) and promotion of proven biocontrol technologies on large scale at farmers' fields
- Identification of new and potent local isolates of microbials for pest management

PJTSAU, Hyderabad

- Mass production and Scalling up of Trichocards
- To cater the need of the marginal & small farmers of the State.
- Upscaling of production levels and commercialisation of predator, Brown lace wing for the IPM tactics or natural/organic farming for Oil palm and other crops.

CAU, Pasighat

- Large scale evaluations and demonstration of BIPM module for the management of pests of cereals and vegetables
- Evaluation of microbial antagonists for the management of ginger rhizome rot
- Production and distribution of Biocontrol agents to the farmers

MPKV, Pune

- Maintenance of nucleus cultures of parasitoids, predators and entomopathogenes as repository for their supply to Biocontrol Units in the state as well as Country wide.
- Mass production, large scale demonstrations and supply of bioagents to the end users.
- Organization of demonstrations and validation of BIPM practices against important pests in crops like sugarcane, maize, pigeon pea, vegetables (tomato, brinjal, okra, cabbage) and fruit crops (mango, grapes, pomegranate, custard apple and papaya).
- Organization of farmers training programmes, mass production of bioagents.
- Isolation, characterization and evaluation of potential entomopathogens against sucking pests and tissue borers in important crops.
- Development and evaluation of pesticide tolerant strains of bioagents for polyhouse crop pests.

MPUAT, Udaipur

- Production and popularization of various bioagents for vegetable crops
- Conducting large scale demonstrations and awareness programmes.
- Survey and surveillance for the biodiversity of natural enemies invasive species
- Validation of biocontrol agents and developing Package of practices recommendations.

TNAU, Coimbatore

- Surveillance for pest outbreak and alien invasive pests

- Evaluation of efficacy of entomofungal pathogens and botanicals for the management of sucking pests in cotton, Onion thrips, spotted pod borerin green gram, tobacco caterpillar in ground nut and leaf miner
- Evaluation of *Bacillus subtilis* TNAU BS1 against major diseases of rice
- Field evaluation of parasitoids and predators for the management of cassava mealybug
- Large scale evaluation of biointensive management of pink bollworm on *Bt* cotton
- Demonstration of bio intensive management practices for the management of pests (fruit borer/ sucking pests) of Brinjal
- Large scale suppression of coconut rugose spiralling whitefly using parasitoid *Encarsia guadeloupae* and *Apertochyrsa astur*
- Training to farmers, rural youths, students, self help groups, NGOs, entrepreneurs etc. on biocontrol agents for the management of pest and diseases of crops

OUAT, Bubaneshwar

- Large scale demonstrations of biocontrol modulesagainst pests of rice, sugarcane, maize and Brinjal
- Production of Bioagents and off campus Training programmes for farmers and Extension functionaries
- Survey of alien invasive pests and other pestsof crops of Odisha

NIPHM, Hyedrabad

- Conducting training program in the area for biological control for various stake holders.
- Maintenance of biocontrol agents for training and demonstration purposes

ANGRAU, Hyedrabad

- Development of ecofriendly pest and disease management technologies suitable for organic cultivation in major agricultural and horticultural crops of Andhra Pradesh
- Promotion of Biocontrol Technologies by conducting more number of Large scale demonstrations,training programmes, field visits covering major crop areas
- Validation of virulent strains of entomopathogens for developing effective pest management strategies under changing climatic conditions.
- Studies on integration of Biocontrol with chemical management for sustainable pest management.

AAU, Anand

- Generation of bio-efficacy and toxicology data as per CIBRC norms for registration and commercialization of effective local strains of microbial biopesticides
- Development of abiotic stress tolerant strains of bioagents
- Development of improved formulations of microbial biopesticides
- Exploration of native mycorrhizal fungus for the biological control of crop pests and diseases

- Development of inter-institutional linkages for research and development e.g., CABI, ICAR and CSIR institutes
- Focused research/extension activities on emerging pest and diseases of the region.
- Human resource development programmes in the area of biologicals for plant health management

DrYSRHU, Tirupathi

- Evaluation of entomopathogens against sucking insect pests (Citrus psylla, aphids, black fly and scales) of citrus
- Promotion of non- chemical management strategies (sex pheromone traps) for the management of citrus leaf miner in nursery and young orchards
- Testing the compatibility of entomopathogens with botanicals for developing management methods against citrus thrips, mites, scales and leaf miner.

AAU, Jorhat

- Develop suitable technologies for insect pests and disease management for major crops of Assam under natural farming.
- Exploration of locally available parasitoids predators andmicrobial agents for crops pests and diseases management
- Development of plant-based products for management of insect pests and diseases
- Development of para pheromone based lure as insect attractant and nano bioformulation for smart delivery and effective management of insect pest
- Technology showcasing in Tribal dominant district of Assam
- Development of model village and local biocontrol experts/ biocontrol Ambassador master trainers for at least one in each district.
- Develop atleast 5 entrepreneur in biopesticide sector
- Training on biocontrol for various stakeholders.

YSPUHF, Solan

- To harness and exploit biodiversity of local natural enemies for bio-control of crop pests in various agro-ecological zones of HP
- Monitoring the invasive crop pests and search for their natural enemies
- Conservation of biocontrol agents by adopting natural farming practices.
- Evaluation of macrobials and microbials for the management of insect-pests of fruit, vegetables and floriculture crops
- Mass production of *Trichogramma* sp., *Metarhizium anisopliae* and predatory mite.
- Demonstration of effective biocontrol agents in farmers' field.

ICAR-NRRI, Cuttack

- Identifying local microbial isolates to manage insect pests and diseases of rice
- Validating the promising strains of microbials against insect pests and diseases of rice

- Evaluating identified isolate at multi-location and best performing isolates will be promoted for the large scale demonstration

KAU, Thrissur

- Bioprospecting for native entomopathogenic microbes and macrobials for the benefit of farmers.
- Evaluation of *Bacillus thuringiensis* isolates from Western Ghats against major pests of crops in Kerala
- Developing novel formulations and microbial consortia of entomopathogens
- Expand the number of bioagents maintained in the centre
- Monitoring the invasion of invasive alien pests
- To expand cumulative area under BIPM validation to 1200 ha.
- Registration of *Beauveria bassiana* local isolate against rice gundhi bug
- Production & distribution of Bio agents *viz.Trichogramma*, *Bracon*, Reduviid bugs, Coccinellid beetles & *Zygogramma* beetle at different centers of KVKs comes under IGKV.
- BIPM trials conducted in Chickpea & Okra.