ALL INDIA COORDINATED RESEARCH PROJECT ON BIOLOGICAL CONTROL OF CROP PESTS AND DISEASES
(AICRP-BC)

Technical Programme
(2020-21 & 2021-22)

Compiled and Edited by

Jagadeesh Patil, G Sivakumar, B Ramanujam, U Amala, K Selvaraj, M Sampath Kumar, Richa Varshney, A Kandan, Chandish R Ballal and N Bakthavatsalam

ICAR-NATIONAL BUREAU OF AGRICULTURAL INSECT RESOURCES
BENGALURU 560024, KARNATAKA

TECHNICAL PROGRAMME FOR 2020-21 & 2021-22

I. BIODIVERSITY OF BIOCONTROL AGENTS FROM VARIOUS AGRO-ECOLOGICAL ZONES

Objectives: To study the diversity of natural enemies of insect pests infesting crops in different agro-ecological zones catered by the all the AICRP centers.

II. SURVEILLANCE FOR PEST OUTBREAK AND ALIEN INVASIVE PESTS

Name of the study/trial	:	**Surveillance for pest outbreak and alien invasive pests - Crop Pest Outbreak Report (CPOR)**
Objectives	:	To monitor and report incidence, buildup and outbreaks of insects and diseases of different crops in the region catered by the AICRP center.
Trial allotted centers	**:**	**All Centres**
Method	:	Visit, survey and surveillance and interaction with state/line department officials and local farmers.
Periodicity	:	Once in a month.
Target area	:	Covering the district where centre is located and 2-3 adjoining districts. In case of pest outbreaks, affected area may be specifically visited.
Desirable important information	:	1. Specific site & date visited-District, Mandal (Taluk), village (Give specific GPS coordinates, if available). 2. Area covered in ha 3. No. of crops specifically examined and Variety grown 4. Major insects and disease (s) noticed and natural enemy occurrence 5. Severity of damage (low, moderate, severe) 6. Age of crop in severely damaged field(s) (in DAT/DAS and years for field and tree/ horticultural crops, respectively) 7. Previous crop grown in the area 8. Occurrence of the pest in weeds in surrounding area of the crop 9. Plant protection measures adopted by the farmer prior to the visit 10. Advice given to the farmer and follow up report if any

Crop Pest Outbreak Report Proforma

Name of Centre: Date visited:

1.	Site details	Village(s) with GPS Co-ordinates, Mandal/Taluk/ District

2.	Crop details	Crop*: Variety : Age of Crop (DAS/DAT/: Years in case of perennial crop: Area cultivated (ha) :
3.	Pest Scenario: Insects Natural enemy occurrence	Name of Insect : Level of infestation: Low/Moderate/Severe Predators: (Coccinellids/Chrysopids/Spiders/Others) Parasitoids:
4.	Disease Scenario	Name of Disease: Per cent disease incidence:
5	Previous crop grown in the area	
6	Occurrence of the pest in weeds (identification where possible) in surrounding area of the crop	
7	Plant Protection measures followed by the farmer	
8	Advice given to the farmer	
9	Sender's name	

*for each crop separate proforma to be used

For each insect, level of infestation, *viz*., Low/Moderate/Severe should be specified,

- **Low-**Pest is present at lower population with no significant damage to the crop
- **Moderate-**Pest population is nearing Economic Threshold Level (ETL) and needs constant monitoring to prevent economic damage
- **Severe** -Pest damage is higher and the crop needs insecticides sprays

Submission of report

- **As early as possible by e-mail (aicrp.nbaii@gmail.com**, ballalchandish@gmail.com, **m.kumar1@icar.gov.in, & amala.udayakumar@icar.gov.in) but not later than 5th of each month.**
- Send the insects and its natural enemies including spiders if any, desired for identification to the Director, ICAR-NBAIR, H A Farm Post, P B No 2491, Bellary Road, Hebbal, Bengaluru 560024.
- Photographs of the insect and disease damage symptoms, life stages of insects, natural enemies and field visits (wherever possible) should be sent along with this report.
- **In case of no pest outbreak in the centres for the reporting period, <u>Nil report</u> should be sent.**

III. BASIC WORK

(i) Evaluation of NIPHM white media for production of *Nomuraea rileyi (Metarhizium rileyi)* NIPHM MRF-1 strain for management of Maize Fall Army worm (*Spodoptera frugiperda*) (NIPHM, Hyderabad)

a. Mass production studies (Lab Studies)
Treatments: 2 and Replications: 13

T1. NIPHM-White Medium

T2. Broken Rice grains

Observations:

- Spore production & cfu /g estimated at 10, 15, 20 and 25 days after inoculation.
- Shelf life of the product (cfu/g) at room temperature (Hyderabad conditions) at monthly intervals

b. Laboratory Bioassay studies

Methodology: As per standard protocol of Lab. Bioassay of EPF
Observations:

- Percentage mortality and mycosis
- LC_{50} and LT_{50}

(ii) Isolation, molecular characterisation and mass production of *Metarhizium rileyi* collected from North Eastern Karnataka on fall armyworm, *Spodoptera frugiperda* (J.E.Smith) (UAS-Raichur).

Objectives	:	During 2019-20 intensive survey were made in North Eastern Karnataka and collected the fall armyworm cadavers infected by *M. rileyi* from six districts (Bidar, Kalaburgi, Yadgir, Raichur, Ballari and Koppal)
Location	:	Biocontrol Field, MARS, Raichur
Methodology	:	The collected cadavers have been stored as per the standard procedure and all the pathological parameters will be recorded to ascertain the proper identity of the entomopathogen through morphological, molecular characterisation and mass production protocols will be standrized.

(iii) Bioassay of *Metarhizium rileyi* collected from North Eastern Karnataka against fall armyworm, *Spodoptera frugiperda* (J.E.Smith) in laboratory condition (UAS-Raichur).

Objectives	:	The potential strain will be subjected for bioassay studies for mass multiplication of the potential isolate
Location	:	Biocontrol Lab, MARS, Raichur
Methodology	:	The IRAC method will be employed for bioassay (Diet incorporation technique). The stock culture of the FAW will be maintained at laboratory and third instar larvae will be

		selected for the bioassay studies.

(iv) Efficacy of *Aschersonia placenta* for the management of whitefly in sugarcane ecosystem (ICAR-SBI)

Basic studies on the potential of *A. placenta* on whitefly will be made. Experiments to characterize the pathogen in the laboratory and mass produce the entomopathogen for the management will be taken up. Pot culture and field experiments will be carried out on evaluation of the pathogen.

Mass production of entomopathogenic fungi

Suitable economic media will be developed for mass production and formulation of entomopathogenic fungi at cottage level. Spore harvest and virulence will be assessed.

(v) Isolation of the Biocontrol agents like *Trichoderma* and *Pseudomonas fluorescence* in Cooch Behar district during 2020-21 (UBKV-Pundibari)

Methodology	:	The information to be collected 1. Place of collection 2. Name of the plant/crop from where the agent is collected. **Note**: **In next year (2021-22**) the laboratory programme shall cover the following aspect c) Screening of efficient antagonist against any soil borne fungi *in vitro* d) Estimation of efficacy of the good performing isolates against any soil borne pathogen *in vitro* and *in vivo* in comparison with the other isolates (From UBKV and other parts of India).

CROP WISE PROGRAMME

CEREALS

1. RICE

1.1 Evaluation of identified bacterial and fungal isolates against stem borer (*Scirpophaga incertulas*), leaf folder (*Cnaphalocrocis medinalis*) and BPH (*Nilaparvata lugens*) in ICAR-NRRI, Cuttack in collaboration with ICAR-NBAIR, Bengaluru.

<u>Laboratory pathogenicity studies</u>

Methodology:

- Leaf dip assay for leaf folder (*Cnaphalacrocis medinals)*

Treatments (5) and Replications (3):

1. NBAIR-PEOWN isolate of *Pseudomonas entomophila*
2. NBAIR-BATP isolate of *Bacillus albus*
3. NBAIR-BtoyPS isolate of *Lysinibacillus sphaericus*
4. NBAIR-PFDWD isolate of *Pseudomonas fluorescens*
5. NBAIR-TATP isolate of *Trichoderma asperellum*
6. Control (Untreated)

Observations:

- Percentage mortality, Probit analysis calculation

Net house bio-efficacy studies

Methodology:

- Potted plant spray method for Yellow Stem Borer (YSB) and Brown Planthopper (BPH)

Treatments (6) and Replications (3):

1. NBAIR-PEOWN isolate of *Pseudomonas entomophila*
2. NBAIR-BATP isolate of *Bacillus albus*
3. NBAIR-BtoyPS isolate of *Lysinibacillus sphaericus*
4. NBAIR-PFDWD isolate of *Pseudomonas fluorescens*
5. NBAIR-TATP isolate of *Trichoderma asperellum*
6. Recommended Insecticide application
7. Control (Untreated)

Observations:

- Yellow stem borer - Neonate larvae will be released and assessed the dead heart per cent (Dead heart % = Dead tillers/Total tillers * 100)
- Brown planthopper - Nymphs will be released and assed the mortality, days to wilt of plants.

1.2 Management of rice stem borer and leaf-folder using entomopathogenic nematodes and entomopathogenic fungi (KAU, Thrissur)

Variety	:	Jyothi
Layout	:	Randomized Block Design.
Plot size		1 x 4 cents for each treatment, 1 cent = 8x5 m
Treatments	:	Five T1: *Heterorhabditis indica* (NBAIR strain) @ $1.2x10^9$ IJs ha^{-1} T2: *Bt* (NBAIR strain) 2g/l T3: *Beauveria bassiana* (NBAIR strain) @$1x10^8$ spores/g-5g/l T4: Flubendiamide 25g.a.i.ha^{-1} T5: Untreated control
Replications		Four
Observations		• Mean No. of dead heart/white ear/sq. m. • Mean No. of rolled leaves per sq. m.

		• Yield kg/plot
The treatments will be applied twice based on ETL.		

1.3 Large scale bio-intensive pest management on rice [PAU (25 ha); KAU- Vellayani (100 ha; KAU- Thrissur (150 ha), AAU-J (50 ha); OUAT (5 ha); IGKV (1 ha)]

Variety	:	Region specific popular rice variety
Treatments	:	**T1 = BIPM Package** 1. Seed bio-priming *Pseudomonas fluorescens*@ 10g/kg of seeds. *T. harzianum*@ 15g/kg of seeds (for PAU only) 2. Seedling dip with *Trichoderma harzianum* 15g/litre for few minutes (for PAU only) 3. Seedlings dip with *Pseudomonas fluorescens* 2% solution other centres. 4. Spray of azadirachtin 1500 ppm@ 3ml/litre at 45 and 65 DAT against foliar and sucking pest. 5. Erection of bird perches. 6. Spray of *Pseudomonas fluorescens* @ 1.5 kg/ha against foliar diseases 7. 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. Release of *Trichogramma chilonis* and *Trichogramma japonicum* @ 100,000/ha (6 releases to be made during season) at 7 days interval starting from 30 DAT for stem borer and leaf folder infestation (for PAU only). **T2** = Farmers Practice (pesticides used by farmers' in respective centres to be mentioned) **T3** = Untreated control
Replications	:	Divide each block into 5 equal sized units, each unit to be considered as replication (each unit = one replication)
Observations	:	• Observations on pest incidence should be recorded on 10 randomly selected hills in each replication (50 hills/ each treatment), *i.e*., total of 50 hills in BIPM block & 50 hills in FP block at each observation at fortnightly interval starting from 30 DAT./ • At each observation, record total tillers, dead hearts, silver shoots, total leaves, damaged leaves, number of plant hoppers/ hill. Record the yield from 5 places of 5x5 m area from each replication. • Cost-benefit ratio to be worked out.

Note: **centers using isolates from other centres may indicate**

1.4 Large scale bio-intensive pest management on rice (ICAR-IIRR, Hyderabad)

Location : Two locations in Nalgonda, Hyderabad (2 ha) and one location in Odisha (1 ha)

Area : 3 ha

Module	Details of treatments	Practices
BIPM 1	Seed	Seed treatment with *Psuedomonas flourescens* (@ 10 g / kg seed at the time of sowing or Wet seed treatment @ 10 g / litre of water / kg seed
	Nursery	FYM @ 1 kg / m^2 and 100g of rice husk ash / m^2 of the nursery bed and mix well with the soil at the time of preparation of the field
	Fertilization	5 tonnes of FYM/ compost/ green leaf manure or 2.5 tonnes of vermicompost as basal + 300-500 kg neem cake / ha half as basal and half as top dressing at active tillering stage
	Pest Management	1. Clipping of rice seedlings before Transplanting 2. Mass trapping of stem borer by installing pheromone traps @ 20 numbers/ ha. 3. *Trichogramma japonicum* 5 cc egg cards/ha, six times weekly from first week after transplanting 4. Need based application of neem formulations/ biopesticides for other defoliating pests 5. Foliar spray of *P. fluorescens* on the foliage @ 20 g / litre of water. Spraying can be repeated depending on the disease severity.
BIPM 2		Same as above in all respects except application of *Trichoderma* IIRR strain instead of *Psuedomonas*
Farmers Practice		General POP with RFD and need based application of insecticides

Observations to be recorded:

- Observations on pest and disease incidence will be recorded on 50 randomly selected hills in each treatment at fortnightly interval.
- Observations on natural enemies like predators and parasitoids by visual or sweep net count and by collection of egg masses for stem borer
- At harvest record yield in each treatment
- Benefit cost ratio will be calculated

1.5 Biointensive pest management in rice (KAU-Vellayani)

Major Pest	:	Leaf folder *Cnaphalocrocis medinalis*
Treatments	:	**T1 -Biological control** • Seed priming with *B. bassiana?* @ 10g/Kg of seeds • Seedling dip with *Pseudomonas flourescens?* @ planting @ 10g/L

		• Foliar spray with *B. bassiana?* @ 20 g/L at fortnightly intervals during vegetative phase (normal or chitin enriched?) • Foliar spray of chitin enriched oil formulation of *L. saksenae* at fortnightly intervals twice during reproductive phase • Placement of *Trichogramma japonicum* + *T. chilonis* from 30 DAP at 10 days interval till panicle formation **T2 - Farmers practice**
No. of Replications	:	7
Unit plot size	:	10×10 m^2
Observations to be recorded	:	1. Pre count of Major pest 2. Post count of Major pest 3. Precount of Predators 4. Post count of Predators 5. Yield per plot

1.6 Validation of BIPM practices against pest complex of organic Black rice (AAU-J)

Location: Dungdhora, Jorhat

Season: *kharif*, 2020

Area: 1 ha

Variety: Locally recommended variety

Treatments: 2 (organic and farmer's practice)

A) Organic package

- Use of *Pseudomonas fluorescens* (8g / kg of seed as seed treatment)
- Application of organic manure MUKTA 2t/ha
- Application of *Beauveria bassiana* 10^{13}spores/ha against sucking pests.
- Use of bird perch (10/ha)
- Release of *Trichogramma japonicum* @ 1 lakh/ha/week depending upon stem borer and leaf folder activity.
- Spray *Pseudomonas fluorescens* (as per university recommendation)
- Need based application of botanicals NSKE5%

Observation to be recorded

- Area (1ha) will be divided into 15 sub plots to serve as 15 replication.

- Population of leaf folder, stem borer, case worm and natural enemies will be recorded in 20 randomly selected hills/plot before and after the release of bioagents and botanicals.
- In case of sucking pest population will be counted before and after each spray of *B. bassiana* from 20 randomly selected hills per plots.
- Grain yield of crop at harvest (kg/ha)
- CB ratio will be determined

1.7 Comparative efficacy of entomopathogenic fungi against sucking pests of rice, *Leptocorisa acuta* IIRR

Objective

To assess the comparative efficacy of KAU isolate of *Lecanicillium saksenae* (ITCC Ls Vs 1 7714) with NBAIR isolates of *L. lecanii*, *M. anisopliae* and *B. bassiana* in the management of major sucking pest of rice *Leptocorisa acuta*

Crop : Rice
Major pest : Rice bug, *Leptocorisa acuta*
Treatments :

T1- *L. saksenae* @ 10^7 spores ml^{-1}
T2- *B. bassiana* Bb5 @ 10^8 spores ml^{-1}
T3- *M. anisopliae* @ 10^8 spores ml^{-1}
T4- Thiamethoxam 0.2 g/L
T5- Untreated

Locations: 2
No. of Replications : 4
Unit plot size : 5 x 5 m^2
No. of sprayings: 2

Observations to be recorded

1. Pre count of rice bug
2. Post count of rice bug
3. Pre count of beneficial insects
4. Post count of beneficial insects
5. Yield per plot

1.8 Field evaluation of ICAR-NBAIR entomopathogenic strains against Rice stem borer (*Scirpophaga incertulas*), leaf folder (*Cnaphalocrocis medinalis*), Brown planthopper (*Nilaparvata lugens*) (ICAR-NRRI, Cuttack).

Variety	:	Susceptible variety
Replications	:	03
Design	:	RBD
Date of sowing	:	As per the package of practice
Treatments	:	1. NBAIR-PEOWN isolate of *Pseudomonas entomophila* 2. NBAIR-BATP isolate of *Bacillus albus* 3. NBAIR-BtoyPS isolate of *Lysinibacillus sphaericus* 4. NBAIR-PFDWD isolate of *Pseudomonas fluorescens* 5. NBAIR-TATP isolate of *Trichoderma asperellum* 6. Recommended Insecticide application 7. Control (Untreated)
Observations	:	• Mean No. of dead heart/white ear/sq. m. (weekly intervals) • Mean No. of damaged leaves per sq. m. (weekly intervals) • The population of plant hoppers will be recorded from 25 hills selected at random at weekly interval starting from 30 days after transplanting (DAT) from each plot. • The population of predators will be also recorded at weekly intervals. • Growth promotion character viz., plant height (cm), biomass (gm) • Yield (kg/plot)

Note: Four rounds of foliar sprays of talc and liquid formulations of entomopathogenic fungi and bacteria at **dosage of 10^8 cfu/ml** has to be given at 14 days interval.

2. MAIZE

2.1. Laboratory bioassay of *Metarhizium rileyi* (Anakapalle strain AKP-Nr-1) against Fall armyworm, *Spodoptera frugiperda* (ANGRAU- Anakapalle)

Treatments	**:**	Seven concentrations of *Metarhizium rileyi* isolate from 1×10^6 to 1×10^{12} spores / ml prepared by 1-10 fold dilution from main stock culture and tested under controlled conditions (26 ± 2°C and 65 ± 5% RH) against third instar and fourth instar larva. 1. Fresh maize leaves sprayed with desired fungus concentration as larval feed with untreated leaves as control. 2. Topical application of *M .rileyi* spore suspension of seven concentrations from 1×10^6 to 1×10^{12} spores/ ml prepared by 1-10 fold dilution from main stock culture on larvae of *S. frugiperda* Ten third instar larvae of *S. frugiperda* per each concentration Replications : Three
Field study :		
Treatments	**:**	Efficacy of *M. rileyi* isolate against FAW in maize at different dates of sowing T1: *M. .rileyi* (Anakapalle strain AKP-Nr-1) concentration 1×10^8 spores / ml

		T2: Untreated control Three sprays at weekly interval
Plot size	**:**	8 × 5m
Observations	:	**Laboratory study :** Number of Dead larvae recorded from 5th day of spore inoculation Percent larval mortality **Field study :** • Number of larvae per plot • Number of damaged plants per plot • Number of dead larvae due to fungus per plot 20 plants randomly selected for FAW incidence and larval mortality

2.2 Field efficacy of *Metarhizium rileyi* (Anakapalle strain AKP-Nr-1 (ANGRAU, Anakapalle; UAS Raichur) against Fall armyworm, *Spodoptera frugiperda* in maize

Treatments	**:**	T1: *Metarhizium rileyi* (Anakapalle strain AKP-Nr-1) concentration 1×10^{8} spores/ml T2: *Metarhizium rileyi* (Anakapalle strain AKP-Nr-1) concentration 1×10^{10} spores/ml T3: *Metarhizium rileyi* (Anakapalle strain AKP-Nr-1) concentration 1×10^{12} spores/ml T4 : *Metarhizium rileyi* (UASR strain KK-Nr-1) concentration 1×10^{8} spores/ml T5 : *Metarhizium rileyi* (UASR strain KK-Nr-1) concentration 1×10^{10} spores/ml T6 : *Metarhizium rileyi* (UASR strain KK-Nr-1) concentration 1×10^{12} spores/ml T7: Untreated control Three sprays at weekly interval Three sprays at weekly interval
Replications	**:**	Three
Plot size	**:**	8 × 5m
Observations	:	• Number of larvae per plot • Number of damaged plants per plot • Number of dead larvae due to fungus per plot 20 plants randomly selected for FAW incidence and larval mortality

2.3 Evaluation of entomopathogenic fungi and *Bt* against maize stem borer (PAU)

Variety	:	Any susceptible high yielding variety
Layout	:	Randomized Block Design.
Plot size		1 × 5 cents for each treatment, 1 cent = 8x5 m
Variety	:	Recommended variety at each place
Treatments	:	Seven T1: *Beauveria bassiana* (NBAIR Bb45) 1x 10^8 spores /ml)-5 ml/lt. T2: *Metarhizium anisopliae* (NBAIR Ma4) 1x 10^8 spores /ml)-5 ml/lt. T3: Two sprays of *Bt* formulation (commercial)@ 1250 ml/ha on 10 and 17 days old crop T4: Two sprays of *Bt* formulation (NBAIR formulation) @ 2% on 10 and 17 days old crop T5: Chemical control (region specific for maize crop as per university recommended / as per label claim) T6: Release of *T. chilonis* 1 lakhs/ha, 2 releases at weekly interval on 10 and 17 days after germination T7: Control
Replications		Three
Observations		• Dead heart count at weekly interval starting from from 20 randomly selected plants at 30 and 45 DAS. • Leaf damage at weekly interval starting from initial incidence of stem borer. • Number of exit holes/plant. • Grain Yield at harvest

2.4 Biological control of maize stem borer, *Chilo partellus* using *Trichogramma chilonis* [PAU (120 ha); MPUAT (1 acre)]

Variety	:	Location specific recommended variety
Treatments	:	Three T1: Three releases of *Trichogramma chilonis* @ 100,000/ha/release at 15, 22 and 29 days after crop germination. **(For PAU only two releases of *Trichogramma chilonis* @ 100,000/ha/release at 10 and 17 days after crop germination)** T2: Farmers' practice (to be recorded at each location) T3: Untreated control
Replications	:	Divide each block into 8 equal sized units, each unit to be considered as replication (each unit = one replication)
Observations		• Dead hearts from 20 randomly selected plants at 30 DAS • Yield (t/ha) and incremental benefit cost ratio

2.5 Bio-ecological engineering for the management of major insect pests of maize and benefit of their natural enemies (SKSUAT-Jammu)

Number of treatments: 12 Number of replications: 3, Design: RBD and Plot size: 4.5 × 4.5 m^2

Treatments	Treatment detail
T1	Maize + okra (intercrop) + sorghum (border crop)
T2	Maize + mash (intercrop) + sorghum (border crop)
T3	Maize + cowpea (intercrop) + sorghum (border crop)
T4	Maize + sesamum (intercrop) + sorghum (border crop)
T5	Maize + okra (intercrop) + naiper (border crop)
T6	Maize + mash (intercrop) + naiper (border crop)
T7	Maize + cowpea (intercrop) + naiper (border crop)
T8	Maize + sesamum (intercrop) + naiper (border crop)
T9	Sole maize
T10	Sole maize + sorghum (border crop)
T11	Sole maize + naiper (border crop)
T12	Sole maize with cartap hydrochloride (Recommended check)

A buffer distance of 15 m shall be maintained in between the treatments with napier and sorghum as border crop, so as to nullify their effect on each other.

Observations to be recorded

- Insect pest succession on maize, intercrops and border crops in correlation with its phenophases
- Percent infestation of major insect pests on maize, intercrops and border crops with special reference to stem borer
- Natural Enemy abundance on maize, intercrops and border crops
- Grain Yield
- Equivalent maize grain yield

2.6 Demonstration of BIPM module against fall army worm, *Spodoptera furgiperda* on *rabi* maize (AAU-J).

Target pests: *Spodoptera furgiperda*

Location: RARS (AAU, Jorhat), Diphu, Dist. Karbi Anglong

Season: *Rabi*, 2020

Variety: Vijoy/ Kisan (locally recommended variety)

Plot size: 20m × 20m

Treatments: 2

T_1 = BIPM package

T_2 = Farmer's field.

(Two blocks, each 20m x 20m, one for farmers practice and one for IPM module. Each block will be divided into 8 sub plots to serve as 8 replications. A distance of atleast 200m will be maintained in between IPM and farmer's practice plots. Analysis will be done using't' test.)

BIPM module

1) Rogue out of infested plants as early as possible.
2) Collection and destruction of egg masses.
3) Erection of bird perches @ 10 nos./ha
4) Installation of pheromone trap (Faw lure) @ 15traps/ha
5) Application of NSKE 5% starting from 25 days after germination, 3 sprays will be made.
6) Three release of *Trichogramma pretiosum* @ 100,000/ha at 10 days interval, starting from 30 days after germination (4-5 releases will be made).

Farmers practice

Alternate spray of Lamda cyhalothrin 2.0% @ 1.5 ml/lit and emamectin benzoate 5% SG @ 0.4gm/lit

Observation:

- Larval counts of *S. furgiperda* to be taken before and 7 and 10 days after release of bio agents and application of insecticides from 5 randomly selected plants in each sub plots.
- Percent egg and larval parasitization will be calculated out.
- Number of predators/plant will be observed.
- Yield data from each sub plot at harvest.

2.7 Field trial against Fall Armyworm in maize at AICRP-BC centres (NBAIR, IIMR, Maize Hyderabad, PAU, PJTSAU, AAU-Anand, OUAT, MPKV, CAU and TNAU).

Treatments= 10

T1. *Trichogramma chilonis* 1 card per acre (2 releases, first release after one week of planting & second one after one week of first release) + NBAIR Bt 2% (2-3 sprays depending on pest incidence, first spray after 20-25 days of planting & then the next sprays at 10 days intervals)

T2. *Trichogramma chilonis* 1 card per acre (2 releases, first release after one week of planting & then second one after one week of first release) + *Metarhizium anisopliae* NBAIR -Ma 35, 0.5% (2-3 sprays depending on pest incidence, first spray after 20-25 days of planting & then the next sprays at 10 days intervals)

T3. *Trichogramma chilonis* 1 card per acre (2 releases, first release after one week of planting & then second one after one week of first release) + *Beauveria bassiana* NBAIR -Bb 45, 0.5% (2-3 sprays depending on pest incidence, first spray after 20-25 days of planting & then the next sprays at 10 days intervals)

T4. *Trichogramma chilonis* 1 card per acre (2 releases, first release after one week of planting & the second one after one week of first release) + EPN *H. indica* NBAIIH38 (1-2 whorl sprays @ 4kg/acre, first spray after 30 days of planting & if required next spray should be at 10 days interval)

T5. *Trichogramma chilonis* 1 card per acre (2 releases, first release after one week of planting & then second one after one week of first release) + *Pseudomonas fluorescens* (Pf DWD 2%) (2-3 sprays @ 20 gm/litre depending on pest incidence, first spray after 20-25 days of planting & then the next sprays at 10 days intervals)

T6. *Trichogramma chilonis* 1 card per acre (2 releases, first release after one week of planting & then second one after one week of first release) + SpfrNPV (NBAIR1) (2-3 sprays @ 2ml/liter depending on pest incidence, first spray after 20-25 days of planting & then the next sprays at 10 days intervals)

T7. *Trichogramma chilonis* alone (1 card per acre (2 releases, first release after one week of planting & then second one after one week of first release)

T8. Pheromones @15 traps/acre (install one week after planting and the lures to be replaced once in 25-30 days)

T9. Insecticidal check (Emamectin benzoate 0.4gm/lt)

T10. Untreated check (control)

Plot size 8 × 5m, three replications; Separate blocks should be used for each treatment giving sufficient isolation distance between the treatment blocks

Observations:

Select 10 plants randomly per plot and take observations on following parameters,

1. Number of egg patches per plot
2. Number of larvae per plant/plot
3. Number of damaged plants/plot
4. Number of dead larvae (due to bacteria/virus/fungus) per plot
5. Percent egg parasitization and larval parasitization
6. Number of predators per plant
7. Final yield

Nucleus culture of *T. chilonis*, formulations of microbials, pheromone traps and lures will be supplied by NBAIR.

2.8 Evaluation of BIPM module for fall armyworm, *Spodoptera frugiperda* in maize ecosystem (UAS-Raichur)

Variety/ Hybrid	:	Syngenta NK-6240
Area	:	1acre

Treatments	:	5
Replication	:	3
Treatment Details		**T1: BIPM** • *Trichogramma preteosum* @ 1.0 lakh/ha at 10 and 20 DAS • *Metarhizium rileyi* 1×10^8 spores/g @ 2.0 gm/l at 30 DAS • *Heterorhabditis indica* NBAIIH-138 @ 4 kg/acre at 40 and 50 DAS **T2: Farmers' practice** • Application of Emamectin benzoate 5 SG @ 0.2 G/lit at 20, 30 and 40 DAS **T3: Control**
Methodology	:	Number of egg patches per plot The percent egg parasitisation Number of larvae per plant/plot Number of damaged plants/plot Number of dead larvae (bacteria/virus/fungus) per plot Final yield

2.9 Large scale demonstration of Management of fall armyworm using biological control agents and Biopesticides (ANGRAU, Anakapalle)

Location	:	Farmers fields (3 ha)
Treatments	:	T1: *Trichogramma chilonis* 3 cards (50,000 eggs per ha) 2 releases (first release after one week of sowing & second one after one week of first release) + NBAIR Bt @ 2g/lt (2-3 sprays depending on pest incidence, first spray after 20-25 days of sowing & then the next sprays at 10 days intervals) T2: *Trichogramma chilonis* 3 cards (50,000 eggs per ha) 2 releases (first release after one week of sowing & then second one after one week of first release) + *Metarhizium anisopliae* NBAIR -Ma 35 @ 5g/lt (2-3 sprays depending on pest incidence, first spray after 20-25 days of sowing & then the next sprays at 10 days intervals) T3: *Trichogramma chilonis* 3 cards (50,000 eggs per ha) 2 releases (first release after one week of sowing & then second one after one week of first release) +

		Beauveria bassiana NBAIR -Bb 45 @ 5g/lt (2-3 sprays depending on pest incidence, first spray after 20-25 days of sowing & then the next sprays at 10 days intervals) T4: Insecticidal check : Spraying Azadirachtin 10000 ppm @ 2 ml/lt at 15 days after sowing + Chlorantraniliprole 18.5 SC@ 0.4 ml/lt at 25 days after sowing + Emamectin benzoate 5SD@ 0.4gm/lt at 35 days after sowing
Observations	:	• Number of egg patches per plot • Number of larvae per plot • Number of damaged plants per plot • Number of dead larvae(due to bacteria/virus/fungus) per plot • Percent egg parasitization and larval parasitization • Number of predators per plant • Final yield 20 plants randomly selected for FAW incidence and larval mortality

2.10 Evaluation of BIPM module for fall armyworm, *Spodoptera frugiperda* in maize ecosystem (MPKV-Pune)

Objectives	:	To develop the suitable BIPM module for fall armyworm, *S. frugiperda* in Maize
Crop	:	Maize
Variety/ Hybrid	:	Rajarshi
Area	:	0.10
Treatments	:	3
Replication	:	8
Treatment Details		**T1: BIPM** • *Trichogramma preteosum* @ 1.0 lakh/acre at 10 and 20 DAS • *Metarhizium rileyi* 1×10^8 spores/g @ 2.0 gm/l at 30 DAS • *Heterorhabditis indica* NBAIIH38 @ 4 kg/acre at 40 and 50 DAS **T2: Farmers' practice** • Application of Emamectin benzoate 5 SG @ 0.2 G/lit at 20, 30 and 40 DAS

		T3: Control
Methodology	:	Number of larvae per plant/plot Number of damaged plants/plot Number of dead larvae (bacteria/virus/fungus) per plot Final yield

3. SORGHUM, FINGER, BARNYARD, FOXTAIL MILLETS

3.1 Evaluation of entomopathogenic fungi formulations against millet borers in Finger millet (IIMR, Hyderabad, Kharif, 2020, Kharif 2021) (ICAR-IIMR- Hyderabad)

No of Treatments : 6
Replications : 4
Plot size : 20 sqm
Finger millet Variety : 5614
Dose: 5 ml/liter (1×10^8 spores/ml)

Treatments:

T1 : Bb 23 spray at 20, 45 DAE
T2 : Bb 45 spray at 20, 45 DAE
T3 : Ma 35 spray at 20, 45 DAE
T4 : Strains of Bb
T5: Strains of Ma
T6: Strains of Ma
T7 : Basal application of Carbofuran 3G @ 20 kg /ha) at sowing + soil application of Carbofuran 3G at 30 DAE.
T8 : Untreated Control

Note: Strains of White and greem muscardine fungus for treatments T4, T5 and T6 to be suggested by NBAII

Observations:

- Lab studies on egg, larval mortalities after EPF spray at 2, 4th day after exposure
- Deadhearts (%) at 30, 60 DAE
- White earheads (%) at Harvest
- Yield/plot (kg)
- Cost benefit ratio

All sprayable formulations of Bioagents to be supplied by NBAIR, Bengaluru

3.2 Management of FAW in Sorghum using biocontrol agents (2 locations) (ICAR-IIMR-Hyderabad)

Plot size: 0.5 acre and Variety: CSH 16

T1 : Release of *Trichogramma chilonis* 1 card/acre (2 releases, first release one week of planting & second one after one week of release + spray of *Metarhizium anisopliae* Ma 35 0.5 % at 20, 30 DAE (need based when > 5% foliar damage is noticed)

T2: Control (Farmers practice)

Observations:

Egg patches/10 plants/ plot (nos)
Larvae/10 plants/plot (nos)
Per cent damaged plants/ plot (%)
Grain yield (kg/plot)

Oil based formulation of Ma 35 to be supplied by **NBAIR, Bengaluru**

PULSES

4. PIGEON PEA

4.1 Evaluation of NBAIR Bt formulation on pigeon pea against pod borer complex (PDKV, Akola)

Variety	:	PKV Tara
Treatments	:	Three **T1: Biocontrol** 3 sprays - NBAII BtG4 2% @ 2.0 ml/lt - at pre flowering, post Flowering and pod formation stage. **T2: Chemical control** 1st Spray – Thiodicarb 75 WP @ 625 ml/ha 2nd Spray – Chlorantraniliprole 18.5 SC @ 150 ml 3rd spray – Monocrotophos 36 SL @ 625 ml **T3: Control**
Replications	:	8 replications Divide each block into 8 equal sized units, each unit to be considered as replication (each unit = one replication)
Area	:	T1 – 1814 m^2 T2 – 1814 m^2 T3 – 1814 m^2
Observations	:	• No. of gram and legume/pod borer complex (spotted pod borer, plume moth, slug caterpillar*, etc) / plant • Pod borer complex (*Helicoverpa*, Plume moth, podfly) – commonly observed at this location • Per cent pod damage • Grain yield (kg/ha)
Product required		Bt – 0.7 to 1 Lt

5. COWPEA

5.1 Field evaluation of ICAR-NBAIR entomopathogenic strains against cowpea aphid (*Aphis craccivora*) (KAU-Thrissur and MPKV-Pune)

Variety	:	Phule vithai
Plot size	:	8 × 5m
Replications	:	04
Design	:	RBD
Treatments	:	1. Bb-5a isolate of *Beauveria bassiana* 1×10^8 cfu/ml @ 5ml/litre 2. Ma-6 isolate of *Metarhizium anisopliae* 1×10^8 cfu/ml @ 5ml/litre 3 Vl-8 isolate of *Lecanicillium lecanii* 1×10^8 cfu/ml @ 5ml/litre 4. Recommended Insecticide application 5. Control (Untreated)
Observations	:	Pre and post count of aphids (nymphs and adults) Grain yield/ha

5.2 Evaluation of oil formulation of *Lecanicillium* spp against sucking pests (aphids and pod bugs) of cowpea (KAU-Vellayani)

Treatments	:	T1 - Chitin enriched oil formulation of *L. lecanii* Vl 8 (NBAIR isolate) T2 - Chitin enriched oil formulation of *L. saksenae* (KAU isolate) T3 - Spore suspension of *L. lecanii* Vl 8 (NBAIR isolate) T4 - Spore suspension of *L. saksenae* (KAU isolate) T5 - Thiamethoxam 25 WDG 2g/10L T6 - Untreated check
No. of Replications	:	4
Unit plot size	:	10×10 m^2
Area	:	2400 m^2 (0.24 ha)

No. of sprayings: 3

Observations to be recorded:

1. Pre count of sucking pests
2. Post count of sucking pests
3. Precount of Predators
4. Post count of Predators
5. Yield per plot

5.3 Evaluation of entomopathogenic fungi aga**inst pod bug, *Riptortus pedestris* on cowpea *Vigna unguiculata* (KAU, Thrissur)**

Variety	:	Location specific recommended variety
Layout	:	Completely Randomized Design
Plot size		1x3 cents for each treatment, 1 cent = 8×5 m
Treatments	:	T1: *Beauveria bassiana* (NBAIR strain) @1×10^8 spores/g 5g/lt. at 10 days intervals T2: *M. anisopliae* (NBAIR strain) @1×10^8 spores/g 5g/lt. at 15 days intervals T3: Recommended insecticide application T4: Untreated control
Replications	:	Six
Observations	:	Pre and post treatment count of damaged pods /plant Yield (kg/plot)

5.4 Evaluation of entomopathogenic biopesticide against *Aphis craccivora* in cowpea (*Vigna unguiculata*) (AAU-Jorhat).

Target pests: *Aphis craccivora*
Location: Experimental farm, Dept. of Horticulture
Season: *Kharif*, 2020
Variety: Location specific recommended variety
Plot size: 3m × 3.5m
Experiment design: 4RBD
Treatments: 6

Treatments include:

1) *Beauveria bassiana* 1×10^8 cfu@ 5gm/lit
2) *Metarhizium anisopliae* 1×10^8 cfu@ 5gm/lit
3) *Verticilium lecanii* 1×10^8 cfu@5gm/lit.
4) Spinosad 45SC @ 0.3ml/lit.
5) Malathion 50EC @ 2ml/lit (standard check)
6) Untreated control

(Three rounds of spray will be made. The first spray to be given on initial occurance of aphid and rest will be based on abundance of pests.)

Observation to be recorded:

1. Aphid population in five randomly selected plants (terminal shoots) for each plot will be recorded before as well as 3, 7 day and 10 days after each treatment.
2. Yield at each harvest.

6. CHICKPEA

6.1 Evaluation of microbial biopesticides against wilt disease of chickpea in Bundelkhand region (ICAR-NCIPM)

Field Layout

Treatments: 8; Replications-3 Plot size: 5×4 m

1. Seed treatment with *Trichoderma harzianum*
2. Seed treatment with *Bacillus subtilis*
3. Seed treatment with *Pseudomonas fluorescens*
4. Combined seed treatment with *T. harzianum + B. subtilis + P. fluorescens*
5. Soil application of *T. harzianum* with FYM
6. Soil application + Seed treatment with *T. harzianum*
7. Seed treatment with Thiram + Carbendazim
8. Control

Observations to be recorded: Per cent disease incidence will be recorded at weekly interval

6.2 Evaluation of Biointensive Integrated Pest Management against pod borer in chickpea in Bundelkhand region (ICAR-NCIPM)

BIPM module: Area 1 acre

1. Deep summer ploughing and field sanitation
2. Timely sowing in the first fortnight of October
3. Selection of tolerant/resistant variety
4. Seed Treatment with *T. harzianum*
5. Intercropping with mustard
6. Installation of pheromone trap for monitoring 5/ha
7. Erection of bird perches 20/ha
8. Need based application of botanical neem and biopesticides Bt, *Ha*NPV

Observations to be recorded: on pest and disease incidence will be recorded at weekly interval, yield and economics will be workout. BIPM fields will be compared with Farmers practices field.

6.3 BIPM module for management of *Helicoverpa armigera* on chickpea (PAU, Ludhiana and TNAU)

Variety	:	Locally recommended variety
Treatments	:	**T1 = BIPM Package** 1. Seed bio-priming *T. harzianum* @ 10g/kg of seeds 2. Erection of bird perches @ 8/acre 3. Spray of *HaNPV* strain (1.5×10^{12} POBS/ha) @ 500 ml/ha twice at 15 days interval, first spray starting from pod initiation stage 4. Raising marigold as trap crop. 5. Use of pheromone traps @ 1 trap per plot. **T2 = BIPM Package** 1. Seed bio-priming *T. harzianum* @ 10g/kg of seeds 2. Erection of bird perches @ 8/acre 3. Sprays of *Bacillus thuriengiensis* @ 2 kg/ha twice at 15 days interval, first spray starting from pod initiation stage 4. Raising marigold as trap crop 5. Use of pheromone traps @ 1 trap per plot. **T3** = Chemical insecticide (recommended) **T4** = Untreated control
Replications	:	Divide each block into 6 equal sized units, each unit to be considered as replication (each unit = one replication)
Observations	:	• Number of larvae/ m row length before spray and 3, 7, 10 and 15 days after spray • Total and damaged pods at harvest. • Record natural enemies from 5 plants in each plot. • Pod yield will be recorded on whole plot basis.

6.4 Biological suppression of pod borer, *Helicoverpa armigera* infesting chickpea on-farm and farmers field (MPUAT-Udaipur and MPKV-Pune)

Variety	:	Location specific recommended variety
Layout	:	Randomized Block Design.
Plot size		8 ×5 m
Treatments		T1: *Beauveria bassiana* @ 1×10^8 conidia /gm @ 5 gm/l at 7 day interval, at pod initiation stage, 2 sprays T2: *Bacillus thuriengiensis* @ 1 Kg/ha at 7 day interval, at pod initiation stage, 2 sprays T3: • Spinosad 45SC @ 150ml/ha - 2 sprays/Azadirachtin 1500 ppm @ 500 ml/ha - 2 Sprays (MPKV) • Quinalphos 25EC @250g a.i/ha at pod initiation stage 2 sprays (MPUAT)

		T4: Spray of HaNPV (1.5×10^{12} POBS/ha) twice during the peak flowering and at pod initiation stage at 15 days interval T5: Untreated control
Replications	:	Five
Observations		• Number of larvae/ m row length before spray and 3, 7, 10 and 15 days after spray • Total and damaged pods at harvest. • Record natural enemies from 5 plants in each plot. • Pod yield will be recorded on whole plot basis.

6.5 Habitat manipulation / Bio-ecological engineering for the management of *Helicoverpa armigera* in chickpea (SKSUAT-Jammu)

Number of treatments : 12	**Number of replications : 3**
Design : RBD	**Plot size: 4.5 x 4.5 m^2**

Treatment details:

T1	Chickpea + Linseed (intercrop) + napier (border crop)
T2	Chickpea + Coriander (intercrop) + napier (border crop)
T3	Chickpea + Fenugreek (intercrop) + napier (border crop)
T4	Chickpea + Fennel (intercrop) + napier (border crop)
T5	Chickpea + Linseed (intercrop) + mustard (border crop)
T6	Chickpea + Corainder(intercrop) + mustard (border crop)
T7	Chickpea + Fenugreek (intercrop) + mustard (border crop)
T8	Chickpea + Fennel (intercrop) + mustard (border crop)
T9	Sole chickpea
T10	Sole chickpea + napier (border crop)
T11	Sole chickpea + mustard (border crop)
T12	Novaluron @ 25kg/ha (recommended check)

- A buffer distance of 15 m shall be maintained in between the treatments with Napier as trap crop and sorghum as border crop, so as to nullify their effect on each other.
- Twelve treatments will be imposed, taking mustard and Napier as border crops.
- Four intercrops (Linseed, Coriander, Fenugreek and Fennel) in additive series (1:1)
- Sole chickpea with and without insecticidal spray Novaluron @ 25 kg/ha recommended check.

Observations to be recorded

- No. of larvae / 5 plants
- Percent pod damage by *Helicoverpa* on chickpea, intercrops and border crops
- Natural Enemy abundance on chickpea, intercrops and border crops
- Grain yield
- Equivalent chickpea grain yield

6.6 Evaluation of bio-agent consortium in glasshouse (pot experiments) and in field for crop health management in chickpea (GBPUAT, Pantnagar)

Variety	:	PG-186
Plot size	:	3 × 2
Treatment	:	11
Replication	:	03
Glasshouse experiment	:	In pots (2 kg capacity) with same treatments and replications
Treatments	:	1. Th-17 + Psf-173 2. Th-17+ Psf-2 3. Th-17 + Th-14 4. Th-14+ Psf-2 5. Th-17 (positive control) 6. Th-14 (positive control) 7. Psf-2 (positive control) 8. Psf-173 (positive control) 9. Th-14 + Psf-173 (Standard check) 10. Carbendazim 11. Control (Negative control)
Methodology		• Seed bio-priming @ 10g/kg seed • In filed application of bioagents along with vermicompost (50g/500g) per plot. • In glasshouse soil will be pre inoculated with *Fusarium* (5g inoculum/pot) one week before sowing followed by bioagents along with vermicompost (10g/100g) per pot ❖ Three foliar sprays cum drench with bioagents (at 15 days interval) **Observations** **In glasshouse:** • Per cent seed germination 15 DAS • Plant stand at 30 and 45 DAS • Plant Growth at 45 DAS **In field** • Per cent seed germination 30 days after sowing • Plant stand at 60 and 90 days after sowing • Number of mature plant wilt at 90 DAS • Yield / plot and q/ha

6.7 Large Scale Demonstration of *Ha*NPV Kalaburgi strain against chickpea pod borer (UAS, Raichur)

Location	:	ARS, Kalaburgi (10 ha), ICAR-KVK, Kalaburgi (20 ha), ICAR-KVK, Raddewadagi (10 ha), ICAR- AICRP on Biocontrol, Raichur (10 ha)
Total Area	:	50 ha
Crop	:	Chick pea
Treatment Details		T_1: Application of ***Ha*NPV** @ 100 LE/acre, Installation of traps 10/acre T_2: Farmers' practice (as per sprays recommended insecticide at each place as per university recommendation or label claim). T_3: Untreated control
Replications	:	Divide each block into 8 equal sized units (each unit = one replication)
Methodology	:	Record the following observations • Number of larvae per meter row length • Per cent pod damage • Grain yield

7. GREEN GRAM

7.1 Integration of botanicals/microbials and insecticide spray schedule for the management of pod borer complex in Greengram (ANGRAU, Anakapalle)

Plot size	:	4×5 m^2
Replications	:	03
Design	:	RBD
Date of sowing	:	Rabi season
Treatments	:	T1: *Bacillus thuringiensis* @ 1.25 l/ha + Azadirachtin 1 % @ 1.25 l/ha T2: *Bacillus thuringiensis* @ 1.25 l/ha + *Bacillus thuringiensis* @ 1.25 l/ha T3: *Bacillus thuringiensis* @ 1.25 l/ha + Spinosad 45 SC@ 150 ml/ha T4: Azadirachtin 1% @ 1.25 l/ha +*Bacillus thuringiensis* @ 1.25 l/ha T5: Azadirachtin 1% @ 1.25 l/ha + Azadirachtin 1 % @ 1.25 l/ha T6: Azadirachtin 1% @ 1.25 l/ha + Spinosad 45 SC@ 150 ml/ha T7: Spinosad 45 SC@ 150 ml/ha + Azadirachtin 1 % @ 1.25 l/ha T8: Spinosad 45 SC@ 150 ml/ha + *Bacillus thuringiensis* @ 1.25 l/ha T9: Spinosad 45 SC@ 150 ml/ha + Spinosad 45 SC@ 150 ml/ha T10: Untreated Control First and second sprays at pod formation stage.
Observations	:	• Pod damage (%) recorded at 15 days after spraying

		• Yield (Q/ha)

COMMERCIAL CROPS

8. COTTON

8.1 Evaluation of entompthogenic fungi, *Beauveria bassiana* (NBAIR-Bb-5a) against sucking insect pests of cotton (UAS- Raichur)

Variety/ Hybrid	:	KCH-14K59 BG II (Jadoo)
Design	:	RBD
Treatments	:	8
Replication	:	3
Plot Size	:	54sqm
Treatment Details		T_1: *B.bassiana* @ 1×10^8 @ 5 gm/l (NBAIR-Bb-5a) @ 5.0 g/l T_2: *L. leccani* @ 1×10^8 @ 5 gm/l (NBAIR-VL-8) @ 5.0 g/l T_3: *L. leccani* @ 1×10^8 @ 5 gm/l (NBAIR-VL-15) @ 5.0 g/l T_4: *M. anisopliae* @ 1×10^8 @ 5 gm/l (NBAIR-Ma 4) @ 5.0 g/l T_5: *Isaria fumosorosea* (NBAIR strain) @ 1×10^8 @ 5.0 g/l T_6 : Azadirachtin 1500ppm @ 2 ml/lit T_7 : Fipronil 5 SC @ 1 ml/lit T_8: Untreated control
Methodology	:	• Average number of sucking pest population / 3 leaves, *viz.*, Aphids, Jassids, whiteflies and thrips will be counted and recorded. • Number of whitefly adults from 3 leaves (top, middle and lower canopy) of 5 randomly selected plants in each plot will be recorded before spray, 3 and 7 days after spray. • Cadavers without apparent sporulation along with leaves will be brought in the laboratory and incubated under optimal condition. After 5 days cadavers were observed for signs of fungal infection and sporulation. • The population of other sucking pests will also be recorded. • Yield (q/ha) to be recorded.

8.2 Biointensive management of pink bollworm on *Bt* cotton (PJTSAU; PDKV, Akola, TNAU)

Variety		Grow early maturing varieties recommended for each centre so that the cotton bolls mature before the heavy population of pink bollworm builds up.

Plot size		Three Each treatment consisting of 0.5 ha, except untreated control which can be of 5 cent size (1 cent = 8×5 m).
Layout	:	Randomised Block design
Treatments	:	Three Each treatment consisting of 0.5 ha, however, untreated control to be of 5 cent size (1 cent = 8×5 m). T1: Standard practice of plant protection till 55th day or appearance of PBW. The following inputs to be provided for PBW. I. Erection of pheromone traps (Funnel type) @ 10/ plot/PB Robe II. Releases of *Trichogrammatoidea bactrae* 100,000/ha/release, 6-8 releases starting from 55 days after germination. III. Application of azadirachtin 1500 ppm at ETL IV. Need based chemical insecticide based on label claim/university recommendation. T2: Spraying of insecticides as per label claim for PBW / SAUs at each centre during PBW infestation. Only for PDKV Akola 1st spray – Triazophos 40 EC @ 20 ml/10 Lt 2nd spray – Spinosad 45 SC @ 2.2 ml/10 Lt 3rd spray – B-cyfluthrin 2.5 %@10 ml/10 Lt 4th spray – Indoxacarb 14.5 SC @ 5 ml/10 Lt 5th spray – Fenvalerate 20 EC@ 6 ml/10 Lt T3: Control
Replications	:	Totally 8 quadrants will be made in 0.5 ha of land. Further each quadrant will serve as replications.
Methodology and observations:	:	• No. of good open bolls and bad open bolls (at least 100 balls to be observed & five observation/plot) and number of pink bollworm larvae. • No. of rosette flowers • No. of green bolls • No. of eggs recorded & no. of parasitized eggs (at least 20-50 eggs will collected in each observation) and yield at harvest.

PDKV-Akola: For sucking pest management – Spraying of Flonicamid 50 WG @ 2 g/ 10 Lt and Acetamiprid 20 % @ 15 g/10 Lt will be done.

8.6 Evaluation of entomofungal agents and botanicals for the management of sucking pests in cotton [PJTSAU & MPKV (for all sucking pests)]

Variety	:	Any recommended *Bt* cotton hybrid at each centre
Plot size	:	40 sq m x 4 for each treatment
Layout	:	Randomized Block Design
Treatments	:	Six

		T1: *Metarhizium anisopliae* ($1x10^8$ spores/g) @ 5 g /lit. T2: *Lecanicillium lecanii* ($1x10^8$ spores/g) @ 5g/lit. T3: *Beauveria bassiana* ($1 x 10^8$ spores/g) @ 5g/lit. T4: Azadirachtin 1500ppm @ 2 ml/lit. T5: As per label claim or as recommended by respective SAU T6: Untreated control
Replications	:	Four
observations:	:	• Average number of sucking pest population / 3 leaves, *viz.*, Aphids, Jassids, whiteflies and thrips will be counted and recorded. • Number of whitefly adults from 3 leaves (top, middle and lower canopy) of 5 randomly selected plants in each plot will be recorded before spray, 3 and 7 days after spray. • Cadavers without apparent sporulation along with leaves will be brought in the laboratory and incubated under optimal condition. After 5 days cadavers were observed for signs of fungal infection and sporulation. • The population of other sucking pests will also be recorded. • Yield (q/ha) to be recorded.

9. SUGARCANE

9.1 Field evaluation of ICAR-NBAIR endophytic entomopathogenic strains against shoot borers (*Chilo infuscatellus* and *Chilo sacchariphagus indicus*) in sugarcane (ANGRAU, Anakapalle)

Plot size	:	1 × 5 cents for each treatment, 1 cent = 8×5 m^2
Replications	:	03
Design	:	RBD
Date of sowing	:	Kharif season
Treatments	:	T1: NBAIR - *Beauveria bassiana* Bb-23@ 5 g/lt T2: NBAIR - *Beauveria bassiana* Bb-45@ 5 g/lt T3: NBAIR - *Metarhizium anisopliae* Ma-4@ 5 ml/lt T4: NBAIR - *Metarhizium anisopliae* Ma-35@ 5 ml/lt T5: Recommended Insecticide application (Chlorantraniliprole 18.5 SC @ 0.3 ml/lt) T7: Untreated Control Sett treatment at planting and spraying of endophytic entomopathogenic fungi 3 times at 14 days interval from 25 days after germination.
Observations	:	• Cumulative incidence of early shoot borer upto 120 days after planting • Internode borer incidence (%) in 50 canes

		• Internode borer intensity (%) i.e., number of bore holes per cane in 10 m row length • Cane yield data (t/ha) and single cane weight (kg/cane) • Sucrose (%) and incremental benefit cost ratio at harvest.

9.2 Field efficacy of EPN strains against white grubs in sugarcane (MPKV-Pune)

Experimental details:

Treatments: 6

T1: *Heterorhabditis indica* WP
T2: *H. bacteriophora* WP
T3: *Steinernema carpocapsae* WP
T4: *S. abbasi* WP
T5: Chemical (Chlorpyriphos/fipronil)
T6: Control

Replications: 4 and Design: RBD.

Plot size: 8 × 5 m^2 Spacing: 90 x 60 cm

Methodology:

The experiment will be conducted on the farmer's field, Sugarcane variety will be selected as per the university recommendation. The first application of entomo pathogenic nematode will be given after notice of white grub infestation

Observations:

1. No healthy tillers and dead tillers / 1 m row length before application of EPN Per cent reduction of white grub population;
2. Yield of sugarcane will be recorded at the time of harvesting (comparison with insecticides and control),
3. Cost benefit ratio.

9.3 Field efficacy of dose application of EPN against white grubs in sugarcane (MPKV-Pune)

Methodology:

The experiment will be conducted on the farmer's field, Sugarcane variety will be selected as per the university recommendation. Plot size: 8x5 m^2 (Spacing: 90 x 60 cm); No. of Replications: 4; Design: RBD.

The treatment details are as follows:

T1: *H. indica* @ 1.0 ×10^5/ m^2 (NBAIR WP formulation)

T2: *H. indica* @ 2.0×10^5/ m^2 (NBAIR WP formulation)

T3: *H. indica* @ 3.0×10^5/ m^2 (NBAIR WP formulation)

T4: *H. indica* @ 1.0×10^5/ m^2 (Commercial WP formulation)

T5: *H. indica* @ 2.0×10^5/ m^2 (Commercial WP formulation)

T6: *H. indica* @ 3.0×10^5/ m^2 (Commercial WP formulation)

T7: Chemical (Chlorpyriphos/fipronil)

T8: Control

Observations :

1. No healthy tillers and dead tillers / 1 m row length before application of EPN,
2. Per cent reduction of white grub population;
3. Yield of sugarcane will be recorded at the time of harvesting (comparison with insecticides and control),
4. Cost benefit ratio.

9.4 Efficacy of entomopathogenic fungi for the management of white grub in sugarcane ecosystem (ICAR-SBI)

Treatments:

T1: *B. brongniartii*
T2: *B. brongniartii* + Lasenta
T3: *M. anisopliae*
T4: *M. anisopliae* + Lasenta
T5: *M. anisopliae* + *B. brongniartii*
T6. *M. anisopliae*+ *B. brongniartii*
T7. *M. anisopliae* + *B. brongniartii* + Lasenta and
T8: untreated control.

Observations:

Pretreatment and post treatment observations after a month will be taken as grubs/ m^2. In addition, pot culture experiments to assess the persistence of the fungi and efficacy will be carried out.

9.5 Large Scale Demonstration of *Trichogramma chilonis* against sugarcane borers [PAU (4000 ha); OUAT (5 ha); MPKV (5 ha); UAS-R (50 ha); PJTSAU (5 ha); Sun Agro (5 ha), IISR, Lucknow]

Variety	:	Region specific popular variety
Treatments	:	T1: Releases of *T. chilonis* (**temperature tolerant strain of *T. chilonis* should be released**) @ 50,000/ha at 10 days

		intervals 10-12 releases will be made from mid 45 days old crop to 6 months old crop for early shoot borer/stalk borer/internode borer. In centres where only early shoot borer is problem, only 8 release to be made from April to June end. In centres where top shoot borer is problem, *T. japonicum* @ 50,000/ha at 10 days interval from 60 days old crop to 5 months crop. 8 releases to be made. T2: Farmers' practice (as per sprays recommended insecticide at each place as per university recommendation or label claim). T3: Untreated control
Replications	:	Divide each block into 8 equal sized units (each unit = one replication)
Observations	:	Record the following observations • Pre-release infestation, *i.e.*, per cent dead hearts / water shoots due to ESB and other borers • Post-release count of percent dead hearts at fortnight interval from initiation of parasitoid release up to 4 months • Per cent cane attacked at harvest • Cane yield data • Number of millable canes, juice quality and incremental benefit cost ratio estimated post harvest.

OILSEEDS

10. MUSTARD

10.1 Bio-efficacy of entomopathogenic fungus and neem against mustard aphid (UBKV-Pundibari)

Location	:	Instructional Farm, UBKV
Season	:	Rabi
Layout	:	Randomized Block Design
Plot Size		5 × 4m
Treatments	:	T1: *Beauveria bassiana* NBAIR Bb-5a @1×10^8 spore/g-5g/lit T2: *Metarhizium anisopliae* NBAIR Ma-4 @1×10^8 spore /g) @ 5g/lit T3: *Lecanicillium lecanii* NBAIR VI-8 (1×10^8 spore/g) @ 5g/lit T4*:* Azadirachtin 3000ppm @ 2.5ml/lit T5: Standard check (Any systemic insecticide) T6: Untreated control
Replications	:	Four

Observations	:	Counts of aphids to be made before treatment and 7 days after each treatment. 1. Aphid population at weekly interval on randomly selected 10 plants (terminal shoot) per plot up to maturity will be recorded from each plot. 2. Yield per plot

11. Ground nut

11.1 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 (UAS Raichur)

Crop	:	Ground nut
Variety/ Hybrid	:	R- 8808
Design	:	RBD
Treatments	:	7
Replication	:	3
Plot Size	:	54sqm
Treatment Details		T_1: *M. rileyi* 1×10^8 spores/g @ 5.0 g/l T_2: *M. rileyi* 1×10^8 spores/g @ Dharwad strain 5.0 g/l T_3: *B. bassiana*1×10^8 spores/g (NBAIR-Bb-5a) @ 5.0 g/l T_4: *M. anisopliae* 1×10^8 spores/g (NBAIR-Ma 4) @ 5.0 g/l T_5: NBAII BtG4 2% @ 2.0 ml/lt T_6: Emamectin benzoate 5 SG @ .02gm/lit T_7: Untreated control
Methodology	:	Number of active miner per 20 leaflet – Leaf miner Number of larvae per mrl - Spodoptera Number of dead larvae (bacteria/virus/fungus) per plot Pod and Halum yield

12. SOYBEAN

12.1 Large scale demonstration of entomopathogenic fungi, *Metarhizium rileyi* against soybean defoliators in Bidar district (UAS Raichur)

Crop	:	Soybean
Variety/ Hybrid	:	Dsb21
Area	:	50 ha
Treatment Details	:	T_1: *M. rileyi* 1×10^8 spores/g @ 2.0 g/l T_2: Farmers' practice (as per sprays recommended insecticide at each place as per university recommendation or label claim). T_3: Untreated control

Methodology	:	• Standard procedure will be followed to record the incidence of defoliators. • Cadavers without apparent sporulation along with leaves will be brought in the laboratory and incubated under optimal condition. After 5 days cadavers were observed for signs of fungal infection and sporulation. • Yield (q/ha) to be recorded.

FRUIT CROPS

13. BANANA

13.1 Bio-efficacy of entomopathogens against Banana fruit and leaf scaring beetles, *Nodostoma subcostatum* (AAU-J)

Variety	:	Cavendish (CV Jahaji)
Layout	:	Randomized Block Design.
Treatments	:	T1: Four spray of Neem product (Azadiractin 1500) @ 2ml/lt at 15 days interval. T2: Four time filling of Leaf axil with *Beauveria bassiana* (AAU J Culture) @1×10^8 spore / g at 15 days interval. T3: Four spray of *Beauveria bassiana* (AAU J Culture) @1×10^8 spore / g at 15 days interval. T4: Bunch covering with plastic bags. T5:Sprays of insecticides as per label claim or recommended by the University at 15 days interval T6: Untreated control (Spray will be imposed after bunch formation)
Replications	:	Five trees per treatment
Observations	:	• Number of *N. **subcostatum*** per plant will be recorded at 3 days after the treatment by counting on leaves including those hidden inside the crown leaves. • Number of leaf scares on leaf surface will be recorded from 5 sq. cm. on 3 different areas of the youngest leaves. • Observations on the number of healthy and infested fingers per bunch will be recorded and used for computing the mean finger infestation after harvesting the crop. • Influence of various treatments on finger weight of banana will be calculated after harvesting the crop. • Yield data from each treatment will be recorded

14. PAPAYA

14.1 Biological control of Papaya/mulberry mealybug/ complex with *Acerophagus papayae* & *Cryptolaemus montrouzieri* (NBAIR – 0.5 ha each)

Layout	:	Randomized Block Design.
Treatments	:	T1: Releases of *Acerophagus papayae* if incidence of PMB is observed. T2: Releases of *Cryptolaemus montrouzieri* grubs in 2nd instar @ 20 grubs / tree if incidence of other mealybugs is observed. T3: Natural control
Replications	:	Divide each block into 8 equal sized units (each unit = one replication)
Methodology and observations		i. The incidence of various species will be recorded. For identification of number of species, send specimens to NBAIR. i. Record natural enemies of mealybug complex on papaya at fortnightly interval and weather factors to work out correlation. • Mealy bug incidence will be recorded as percent incidence based on random selection of 25 plants from each orchards visited. • Pest intensity rating (1-5 scale) will be recorded from 5 plants/ orchard. • Record natural enemies species-wise from two leaves/ plant and 5 plants/ orchard.

15. APPLE

15.1 Validation and large scale field demonstration of IPM Technology of Codling moth, *Cydia pomonella* infesting apple in Ladakh (SKSUAT-Srinagar)

Crop	:	Apple
Variety	:	Red delicious and others
District	:	Kargil (Ladakh)
Specific villages	:	Trespone, Mingy, Slikchay and Bagh-e-Khomini
Area		2.0 ha.
Treatment	:	One chemical spray+ Light trap + Pheromone trapping + four releases of *T. cacoeciae*+ trunk banding + field sanitation
Observations	:	• Per cent fruit damage • Per cent reduction in damage over control • Yield

15.2 Evaluation of predatory bug, *Blaptostethus pallescens* against European Red mite *Panonychus ulmi* and two spotted spider mite *Tetranychus urticae* on apple (SKSUAT-Srinagar)

Variety	:	Red delicious
Plot size / No. of plants to be treated		10 per treatment
Layout	:	Randomized Block Design.
Treatments	:	T1: 200 nymphs/ tree @ two release /week T2: 400 nymphs/ tree @ two release /week T3: Chemical control with recommended insecticide as per university recommendation or label claim. T4: Control
Replications	:	Each tree to serve as replication
Methodology and observations	:	• Two field releases of anthocorid bugs @ 200 (T1) and 400 (T2) / plant when number of ERM crosses 10/leaf • *In situ* observations on population density of motile ERM/ leaf on 3rd and 7th day after the treatments • Comparison of the treatments for the efficacy of the bugs against Control(T4) • % Decline in mites' population • Effect of dosage on per cent reduction in motile stages of mites • Comparison of data with untreated check

15.3 Management of apple root borer using *Metarhizium anisopliae* (YSPUHF 10 orchards covering 5ha)

Variety	:	Apple variety in different orchards to be noted
Treatments	:	T1: *Metarhizium anisopliae* (NBAIR) 1×10^8 spores/g @ 30g per tree mixed with enriched FYM 1.5 kg /tree, as soil application during July- August i.e at the time of emergence of new grubs) T2: Farmers' practice (as per university recommendation or as per label claim).
Replications	:	Each orchard to serve as replication.

Observations	:	• Number of live and dead larvae will be counted at the time of basin preparation and percent mortality will be calculated

15.4 Evaluation of some biocontrol agents against leopard moth, *Zeuzera multistrigata* in apple (YSPUHF, Solan)

Treatments	T1: *Beauveria bassiana* (5g/L of 10^8 conidia/g; 10ml/gallery) T2: *Metarhizium anisopliae* (5g/L of 10^8 conidia/g; 10ml/gallery) T3: *Steinernemma feltiae* (2500IJs/gallery) T4: *Steinernemma feltiae* (5000IJs/gallery) T5: *Heterorhabditis bacteriophora* (2500IJs/gallery) T6: *Heterorhabditis bacteriophora* (5000IJs/gallery) T6: Azadiraditin (2ml/L of 1500ppm; 10ml/gallery) T7: Chlorpyriphos (0.04%; 10ml/gallery) T8: Control (water, 10ml/Gallery)
Replications	Three; 3 trees per replication The above treatment solutions will be injected in to the live insect galleries with the help of a syringe (without needle) during August-September. After treatment the galleries will be sealed with clay.
Observations	After 7-10 days the trees will be inspected and the opened galleries will be closed again. The data on live and dead galleries will be recorded after one month. The galleries reopened by the pest will be treated as live, while those not opened by the pest as dead. The data thus obtained will be used to calculate the per cent mortality and will be analysed as per RBD.

16. MANGO

16.1 Habitat manipulation for conservation of bioagents for management of mango insect pests (CISH-Lucknow)

Variety	:	Dashehari
No. of trees		10 trees per treatment
Layout	:	Randomized Block Design.
Treatments	:	T1: Mango intercropped with maize. T2: Mango intercropped with mustard T3: Mango intercropped with Coriander T4: Mango as sole.
Replications	:	Three
Methodology for imposing treatments		Crops will be sown during December or January, so that these crops comes flowering during the second fortnight of February and it will be synchronised with panicle emergence and flowering of mango
Methodology and observations	:	Observation will be taken at different intervals after application; Status of major pest of mango and Natural enemies, if any

16.2 Field evaluation of microbial biocontrol agents for the management of mango thrips (CISH-Lucknow)

Variety	:	Dashehari
No. of trees		3 trees per treatment
Layout	:	Randomized Block Design.
Treatments	:	T1: ICAR-NBAIR *Pseudomonas fluorescens* NBAIR PFDWD5 @20g/lit T2: *L. lecanii* NBAIR (VL8) @5g/lit T3: Chemical control with recommended insecticide as per CISH recommendation or label claim. T4: Control
Replications	:	Three
Methodology for imposing treatments		Soil application and Spray
Methodology and observations	:	Observation will be taken at different intervals after application; No of thrips/ tree; percent damage of fruits; Natural enemies, if any

16.3 Bioefficacy of entomopathogenic fungi formulations in suppression of mango tortricid borers (CISH-Lucknow).

Variety	:	Dashehari
No. of trees		5 trees per treatment
Layout	:	Randomized Block Design.
Treatments	:	T1: *Beauveria bassiana* (CISH culture) @1x10^8 spores/g @ 5g/lit T2: *Metarhizium anisopliae* (NBAIR culture) @1x10^8 spores/g @ 5g/lit T3: *Beauveria bassiana* (NBAIR culture) @1x10^8 spores/g @ 5g/lit T4: Dimethoate 30% EC 2 ml/lit (CISH POP) T5: Untreated control
Replications	:	Each tree to serve as replication
Methodology and observations	:	Observation will be taken at different intervals after application; percent damage by fruit borer, Natural enemies, if any

16.4 Management studies for inflorescence thrips on mango with bio-pesticides in field conditions. (DRYSRHU)

Experimental Details

Treatment details

Treatment	Dose	Source/ Strain name
T1- *Beauveria bassiana*	5 ml/l	Anand Agril. University (Source of Strain NBAIR Bb5a)
T2- *Metarhizium anisopliae*	5 ml/l	Anand Agril. University (Source of Strain NBAIR Ma4)
T3- *Verticillium lecanii*	5 ml/l	Anand Agril. University (Source of Strain NBAIR NBAIR VL15)
T4- Azadirachtin 10000 ppm	5 ml/l	Commercial
T5- Fipronil 5SC	2 ml/l	Commercial
T6- Untreated Control	-	-

Replications: 4

Location: Bavajipeta village, Gokavaram Mandal, East Godavari district

Frequency of spray: Weekly (a total of three/ four sprays) (with the incidence of thrips first generation)

Data to be recorded in the spraying experiment: Observations were taken on different intervals on thrips population (nymphs and adults) by counting single tap of shoot or panicle on whitepaper on 10 panicles per tree at standing height of tree on a day before spray and 7^{th}, 14^{th}, 21^{st} and 28^{th} day after spray.

16.5 Bio-intensive management of mango hopper (AAU-Anand)

	Year of commencement	**:**	2020-21
	Location	**:**	Farmers' fields, District –Valsad/Navsari & Talala, Dist. Sasan Gir
	Crop/variety	**:**	Mango
	Area	**:**	5 ha
	Treatments	**:**	02
	Repetition	**:**	10
	Design	**:**	Large plot sampling CRD
	Spacing	**:**	10 x 10 m
	Plot size	**:**	2.5ha for each treatment
Treatments			

T_1	BIPM module	• One spray of *Metarhizium anisopliae* (ICAR-NBAIR Ma-4) 1% WP (2×10^8 cfu/ g) @ 50 g/ 10 litre of water on tree trunk during the month of November • Three sprays of *Metarhizium anisopliae* (ICAR-NBAIR Ma-4)1% WP (2×10^8 cfu/ g) @ 50 g/ 10 litre of water on foliage during flowering at fifteen days interval with the initiation of pest
T_2	Chemical module/ Farmers' practice	-
	Methodology & Observations	• Total ten trees will be selected randomly in each treatment. Each tree will serve as one replication • **Number of hoppers/twig** • Five twigs-panicles (approx. 15 cm length) from each tree will be observed and number of hoppers per twig will be recorded • **Fruit yield - q/ha** • **C:B ratio**

17. GUAVA

17. 1 Evaluation of bio-agents against root-knot nematode and Fusarium wilt complex in guava under controlled conditions (CISH Lucknow)

Treatments:

1. *Purpureocillium lilacinum* @ 10^6 spores/cfu per kg of soil
2. *Pochonia chlamydosporia* @ 10^6 spores/cfu per kg of soil
3. *Trichoderma asperellum* @ 10^6 spores/cfu per kg of soil
4. *Bacillus* spp. @ 10^6 spores/cfu per kg of soil
5. ICAR-FUSICONT @ 20 g formulation per kg of soil
6. Vermi compost @ 100 g per kg of soil
7. T1 + T4
8. T2 + T4
9. T3 + T4
10. T1 + T6
11. T2 + T6
12. T3 + T6
13. T4 + T6
14. T5 + T6
15. Inoculated (nematode only) control
16. Inoculated (*Fusarium oxysporum* only) control
17. Inoculated (nematode + fungus) control
18. Uninoculated control

Nematode inoculums dose: 2000 J2 per kg soil mixture (8: 2 Soil: FYM)
Replicates: 5 per treatment

Methodology:

- Bio-agent inoculation : All the treatments (1-14) will be applied 7 days prior to transplantation of seedlings and treatment number 1-9 will be repeated 60 days after transplanting by scrapping top 2-3 mm soil followed by treatment application and replacement of same soil.
- Age of seedlings at transplanting : 45 days (after seed sowing)
- Nematode inoculation : Just after transplantation
- Termination of Experiment: 180 days after inoculation

Data to be recorded:

- Root-knot index (0-4 scale)
- Number of J2 in soil
- Colonization of roots by fungus
- Shoot height (cm)
- Shoot and root weight (g)

GD Comment: Occurrence of *Meloidogyne enterolobii* has to be confirmed. (CISH Lucknow)

The *Meloidogyne* females have been excised from infected roots taken from culture plants and from guava roots collected during survey and have been given for molecular characterization. This work will be continued at least for a year and results will be presented time to time.

17.2 Development of biocontrol based ipm module for the management of guava fruit borers (CISH-Lucknow)

Variety	:	Allahabad safeda
No. of trees		5 trees per treatment
Layout	:	Randomized Block Design.
Treatments	:	T1: *Beauveria bassiana* (CISH culture) @1x10^8 spores/g-5g/lit T2: *Metarhizium anisopliae* (NBAIR culture) @1x10^8 spores/g-5g/lit T3: *Beauveria bassiana* (NBAIR culture) @1x10^8 spores/g-5g/lit T4: Azadirachtin 1500 ppm @ 2ml/lt T5: Dimethoate 30% EC 2 ml/lit (CISH POP) T6: Untreated control
Replications	:	Each tree to serve as replication
Methodology for imposing treatments		Spray
Methodology and observations	:	Observation will be taken at different intervals after application; percent damage by fruit borer, Natural enemies, if any

17.3 Biological control of root knot nematode in guava (UAHS-Shivamogga)

Variety	Lucknow 49
No of trees	10 trees per treatment

Lay out	Randomized block design
Treatments	T_1 : *Purpureocillium lilacinum* (UAHS-15) @ 1×10^8 Cfu/ g @ - 30g/ plant multiplied in 3kg of FYM
	T_2 : *Trichoderma harzianum* (UAHS-3) @ 1×10^8 Cfu/ g - 30g/ plant multiplied in 3kg of FYM
	T_3 : *Pseudomonas fluorescens* (UAHS-56) @ 1×10^8 Cfu/ g - 30g/ plant multiplied in 3kg of FYM
	T_4 : *P. lilacinum* (UAHS-15) + *P. fluorescens* (UAHS-56) + *T. harzianum* (UAHS-3) @ 1×10^8 Cfu/ g - 10g each/ plant multiplied in 3kg of FYM
	T_5 : Carbofuran 10 G @ 25g per plant
	T_6 : Non-treated trees (check)
Replications	Each trees to serve as replication
Methodology and observations	Observations regarding plant growth parameters and galling on roots will be taken at different intervals after application

17.4 Biological control of guava mealy bug and scales using entomopathogens (SKUAST-Jammu)

Number of treatments: 5

Number of replications: 5

Design: RBD

Five trees per replication in Guava

Treatment details

T1	*B. Bassiana* (NBAIR-Bb-5a) @ 5 g/L
T2	*Metarhizium anisopliae* (NBAIR-Ma-4) @ 5 g/L
T3	*Lecanicillium lecanii* (NBAIR-VI-22) @ 5 g/L
T4	Azadirachtin 10000 ppm @ 1 ml/L
T5	Untreated Control

Observations to be recorded- Pre and post spray mealy bug and scales counts

17.5 Evaluation of entompthogenic fungi, *Beauveria bassiana* (NBAIR-Bb-5a) against mealy bug in guava ecosystem (UAS-Raichur)

Crop	:	Gauva
Variety/ Hybrid	:	Lucknow 49
Design	:	RBD
Treatments	:	8
Replication	:	3
No. of plants per treatment	:	05

Treatment Details		T_1: *B.bassiana* @ 1×10^8 @ 5 gm/l (NBAIR-Bb-5a) @ 5.0 g/l T_2: *L. leccani* @ 1×10^8 @ 5 gm/l (NBAIR-VL-8) @ 5.0 g/l T_3: *L. leccani* @ 1×10^8 @ 5 gm/l (NBAIR-VL-15) @ 5.0 g/l T_4: *M. anisopliae* @ 1×10^8 @ 5 gm/l (NBAIR-Ma 4) @ 5.0 g/l T_5: *Isaria fumosorosea* (NBAIR strain) @ 1×10^8 @ 5.0 g/l T_6 : Azadirachtin 1500ppm @ 2 ml/lit T_7 : Buprofeizn 25 SC @ 1 ml/lit T_8: Untreated control
Methodology	:	• Standard procedure will be followed to record the mealy bugs Number of whitefly adults from 3 leaves (top, middle and lower canopy) of 5 randomly selected plants in each plot will be recorded before spray, 3 and 7 days after spray. • Cadavers without apparent sporulation along with leaves will be brought in the laboratory and incubated under optimal condition. After 5 days cadavers were observed for signs of fungal infection and sporulation. • Yield (q/ha) to be recorded.

18. ANOLA

18.1 Biological control of anola mealy bug and scales using entomopathogens (SKAUST-Jammu)

Number of treatments: 5
Number of replications: 5
Design: RBD
Five trees per replication in Guava

Treatment details

T1	*B. Bassiana* (NBAIR-Bb-5a) @ 5 g/L
T2	*Metarhizium anisopliae* (NBAIR-Ma-4) @ 5 g/L
T3	*Lecanicillium lecanii* (NBAIR-VI-22) @ 5 g/L
T4	Azadirachtin 10000 ppm @ 1 ml/L
T5	Untreated Control

Observations to be recorded- Pre and post spray mealy bug and scales counts

19. CITRUS

19.1 Field evaluation of bio pesticides for the management of sucking pests of citrus (PDKV Akola)

Experimental Details:

Variety		**Nagpur mandarin/Acid lime**
Plot size		Each treatment consisting of two trees
Layout	:	Randomised Block design
Area	:	Citrus orchard of 12 years old having about 100 trees
Treatments	:	**T1:** *Beauveria bassiana* @ 5 g/lit (NBAIR-Bb-5 a) T2: *Metarhizium anisopliae* @ 5g/lit (NBAIR-Ma-4) T3: *Lecanicillium lecanii* @ 5 g/lit (NBAIR VI-8) T4: *Aschersonia aleyrodis* @ 5 ml/lit (source of strain Dr.PDKV, Akola) T5: Azadirachtin 10000 ppm @ 5 ml/lit T6: Imidacloprid 17.8 SL @ 0.25 ml/10 lit T7: Untreated control
Replications	:	3
Methodology and observations & frequency of spray	:	• Four shoot of 10 cm length will be selected in four directions at eye sight level on randomly selected observational trees to record the build of sucking pests population in citrus orchard • As soon as sucking pests incidence will be noticed treatment sprays will be initiated and subsequent sprays will be applied at 15 days interval. • Observations will be recorded on a day before spray and 3, 7 and 14 days after each spray.

19.2 Evaluation of potential isolates of microbials against citrus thrips (YSRHU, Tirupati)

Methodology:

Experimental material: Existing orchard with 6 x 6m spacing.

Age of plants: 8 years (Tirupati)

Treatment details:

T_1	*Beauveria bassiana* (NBAIR Bb-5a Strain) @ 5g/ Litre
T_2	*Metarhizium anisopliae* (NBAIR Ma-4 Strain) @ 5g/ Litre
T_3	*Lecanicium lecanii* (NBAIR Vl-8 Strain) @ 5g/ Litre
T4	*Pseudomonas fluorescens* (NBAIR-PFWD)20g/litre
T5	Chemical check (Acephate 75SP @ 0.1%)

T6	Control

Design: RBD; **Replications**: 5; **Plants/replication**: 3; **Variety**: Sathgudi

Observations: The per cent leaf infestation due to thrips on foliage at 0 days (pre count) and 3, 7 and 14 days after second spray and for fruits, the percent infested fruits will be counted. The observed data for per cent thrips infestation on leaf and fruits infestation will be analysed statistically and the values will be converted into arc sine transformed values. The yield data will be recorded and expressed into tonnes/ha.

Parameter	**SI unit**
Infestation of thrips on foliage/fruits,	%

Time of spray**:** First spray at the peak activity of the pest and second at 14 days after first spray for thrips damaging leaf and in case of thrips, treatments should be initiated immediately after fruit set (10 days after flowering)

19.3 Evaluation of potential isolates of microbials against citrus Rust and Green mites (YSRHU, Tirupati)

Methodology:

Experimental material: Existing orchard with 6 x 6m spacing

Treatment details:

T_1	:	*Beauveria bassiana* (NBAIR Bb-5a Strain) @ 5g/ Litre
T_2	:	*Metarhizium anisopliae* (NBAIR Ma-4 Strain) @ 5g/ Litre
T_3	:	*Lecanicium lecanii* (NBAIR Vl-8 Strain) @ 5g/ Litre
T4		*Pseudomonas fluorescens* (NBAIR-PFWD)20g/litre
T5	:	Local check (Propargite 57EC @0.0.057%)
T6	:	Control
Treatments should be given during active period of the pest twice at 15 days interval		

Design: RBD; **Replications**: 4; **Plant/replication**: 2; **Variety**: Sathgudi

Observations: The population counts of mites before and 3, 7 and 14 days after treatment will be recorded. In case of rust mites, observation on infested fruits (%) before harvest will be noted and the yield data will be recorded and expressed into tonnes/ha. The observed data for population counts on leaf and fruits infestation will be analysed statistically and the values will be converted into square root and arc sine transformed values, respectively.

20. Litchi

20.1 Bio-intensive management of litchi fruit borer, *Conopomorpha sinensis* (Bradley) in litchi (PAU, Ludhiana)

Variety	:	Region specific recommended variety
Treatments		Three 1. BIPM • Ploughing in orchard during March-April • Regular clean cultivation throughout the year • Regular collection and destruction of fallen infested fruits during May-June • Light trap @ 1 per acre during April • Releases of *T. embryophagum* @ 4000 parasitized eggs per tree 5-7 times at 7-10 days interval starting from initiation of flowering to colour break stage 2. Farmer's practice (chemical control) 3. Untreated control
Replications	:	Divide each block into 8 equal sized units (each unit = one replication)
Observations	:	Record the observations on total and infested fruits from 5 trees in each unit to work out per cent damage. Count total number of marketable fruits from 5 trees of each unit. After taking the average weight of 50 fruits, yield (kg/tree) of fruits will be calculated by dividing the number of fruits per tree with average weight of fruit and multiplying the value with 1000 to convert into kg per tree. Yield/acre (MT) will be calculated by multiplying fruit yield with number of trees/acre and dividing it by 1000 to convert to yield/acre in metric tons. Cost benefit ratio will also be calculated and per cent fruit infestation and yield loss on weight basis will be worked out.

PLANTATION CROPS

21. COCONUT

21.1 Surveillance of rugose whitefly in coconut and assessing the population of natural biocontrol agents [NBAIR, TNAU, AAU-J, KAU (all centers), DRYSRHU, CPCRI]

Methodology

- Observations on RSW incidence shall be made at monthly intervals from three pest infested gardens with varietal details, age of a and meteorological data
- Five palms shall be selected at random in each garden for observation
- Palm infestation should be recorded as

(i) Percentage of leaves infested/palm (no. of leaves infested by RSW /total leaf per palm)

(ii) Intensity of pest damage from four pest infested leaves per palm from the outer/middle whorl representing four directions (no. of leaflets infested by RSW/ total leaflets per leaf)

(iii) One leaflet from each observed sample leaf shall be collected and brought to laboratory for assessment live colonies, pest stages and natural enemies (total of 4 leaflet/palm) (20 leaflets/plot)

- The actual quantification (number/percentage) may be followed, than rating as low/ medium/high, for statistical analysis

21.2 Biological suppression of rugose spiralling whitefly in coconut (KAU- Kumarakom and Thrissur, DRYSRHU, CPCRI and TNAU)

Treatment details:

T1.	*Encarsia guadeloupae* natural conservation).
T2.	Foliar application of *Isaria fumosorosea* (pfu-5) @ 1×10^8 cfu/ml (Two sprays at 15 days intervals).
T3.	Foliar application of neem oil 0.5% (neem oil 5 ml + soap powder 10g /litre of water) (Two sprays at 15 days intervals).
T4.	Foliar water spray (2 sprays at 15 days intervals)

Ten palms per each treatment (palms with minimum 5-7 leaves infested with RSW with each leaf containing more than 10 live colonies with nymphs should be selected for experiment)

Observations:

Pre-treatment observations from all palms:

1. Total number of leaves/palm
2. Leaves infested with RSW/palm
3. Total leaflet and RSW infested leaflets /leaf (from 4 sample leaves/palm)
4. Collect 4 leaflets/palm & observation at laboratory for
   (i) number of live colonies/leaflet (live colony should be with either live eggs/nymphs/adults)
   (ii) number of healthy nymphs/leaflet
   (iii) number of parasitized nymphs (live & blackened) & nymphs with parasitoid emergence holes/leaflet

Post treatment observations (of all the parameters taken for pre-treatment) from all palms:

(1) 15 day after 1st spray
(2) 15 days after 2nd spray

Other observation

- Nut yield /palm (if treatment is imposed on yielding palms) at pre-treatment and at yearly interval
- Species of whitefly
- Variety of palm

Health management strategies adopted by farmer

21.3 Field evaluation of bio agents against rugose spiraling whitefly on coconut (UAHS-Shivamogga)

Variety	Local
Lay out	Randomized block design
Treatments	T_1 : *Isaria fumosorasea* (NBAIR) @ 5g /lt
	T_2 : *Encarsia guadeloupae* @ 600 adults per acre
	T_3 : *Beauveria bassiana* (UAHS-18) @ 1×10^8 Cfu/ ml - 3 ml /lt
	T_4 : *Metarhizium anisopliae* (UAHS-33) @ 1×10^8 Cfu/ ml - 3 ml /lt
	T_5 : *Lecanicillium lecanii* (UAHS-12) @ 1×10^8 Cfu/ ml - 3 ml /lt
	T_6 : Neem oil 1500 ppm @ 2 ml/litre of water
	T_7 : Untreated (check)
Replications	4
Methodology and observations	Number of sprays/ releases: 2- 3 sprays at weekly interval The pest population from randomly selected five plants before and after each spray / release of predator and yield / tree will be recorded

21.4 Management of Coconut Rugose spiralling whitefly using entomopathogenic fungi, *Isaria fumosorosea (*ANGRAU, Anakapalle)

Location	:	Farmers fields
Treatments	:	T1 : Spraying *Isaria fumosorosea* (pfu-5) @ 2×10^8 (5 ml /lt) oil formulation + field release of parasitoid *Encarsia guadeloupae* T2: Spraying *Isaria fumosorosea* (pfu-5) @ 2×10^8 (5 ml /lt) oil formulation + field release of predator, *Dichocrysa sp. nr. astur* @ 1000 eggs/ha T3: Spraying *Isaria fumosorosea* (pfu-5) @ 2×10^8 (5 g/lt) talc formulation + field release of parasitoid, *Encarsia guadeloupae* T4: Spraying *Isaria fumosorosea* (pfu-5) @ 5 g/lt @ 2×10^8 (5 g/lt) talc formulation + field release of predator, *Dichocrysa sp. nr. astur* @ 1000 eggs/ha T5: Spraying *Isaria fumosorosea* (pfu-5) @ 2×10^8 (5 g/lt) conidiated rice + field release of parasitoid *Encarsia guadeloupa* T6: Spraying *Isaria fumosorosea* (pfu-5) @ 2×10^8 (5 g/lt) conidiated rice + field release of predator, *Dichocrysa sp. nr. astur* @ 1000 eggs/ha T7 : Spraying Neem formulation 10000 ppm @ 1ml/lt Two- three sprays at 15 days interval covering the entire leaflet, fronds and directed lower side of leaves.
Replications	:	3

Design	:	Observational plot
Plot size		Separate blocks for each treatment with isolation distance
Observations	:	Palm infestation : Pre treatment count : 1. Percentage of leaves infested/palm (no. of leaves infested by RSW /total leaf per palm), 2. Intensity of pest damage from 10 pest infested leaflet/fronds per palm from the outer/middle whorl representing four directions (no. of leaflets infested by RSW/ total leaflets per leaf) 3. Ten leaflets from each palm for assessment live colonies (Low: 0-10 live egg spiral or adult/leaflet; Medium: 11-20 live egg spiral or adults/leaflet; Severe: more than 20 egg spirals or adults /leaflets), pest stages. Post treatment count on intensity of pest damage from four pest infested leaflet/fronds per palm from the outer/middle whorl representing four directions (no. of leaflets infested by RSW/ total leaflets per leaf) on 3, 7, 10 DAT. 10 leaflet from each palm for assessment live colonies. (Low: 0-10 live egg spiral or adult/leaflet; Medium: 11-20 live egg spiral or adults/leaflet; Severe: more than 20 egg spirals or adults /leaflets) on 3, 7, 10 DAT. *Isaria* infection can be observed on eggs, nymphs, adults: Mycelial growth on eggs (shrunken egg, dark brownish egg), nymphs (reddish spot, shrinken body, turn into pale yellowish brownish over the time), mummified adults (newly emerged adults unable to expand the wings, fly). Natural parasitism by *Encarsia guadeloupae*: 10 leaflet /per palm from lower fronts collected and maintained under laboratory conditions in the aerated contained with mesh or muslin cloth for 7-10 days. Natural parasitism may be determined by number pupae with circular exit holes/number of pupae without exit holes/100. Predation by *Dichocrysa sp. nr. astur*: Number of grubs , Number of eggs in10 leaflet/palm

21.5 Area-wide demonstration of biological suppression of black headed caterpillar using *Goniozus nephantidis* and *Bracon brevicornis* (ICAR-CPCRI, Kayamkulam)

Demonstration	**50 infested palms in endemic tracts**
Treatment	Augmentative release of *Goniozus nephantidis* and *Bracon brevicornis*

	@ 20 parasitoids/palm
observations	Pest incidence per leaflet, infested leaflets in a frond, parasitism percentage, pre-elease and post release data on pest incidence

21.6 Converging biological suppression approaches for area-wide management of coconut rhinoceros beetle (ICAR-CPCRI, Kayamkulam)

Village		Valiikunnan Panchayat, Mavelikara (1500 ha)
Technology intervention		✓ Delivery of *Metarhizium majus* for each members of Co-operative milk societies and *in situ* incorporation of *Clerodendron infortunatum* in the pest breeding sites ✓ Area-wide technology penetration through Farmer Field School ✓ Collaboration with local panchayat, State Department of Agricultural Development and Farmer's Welfare and Co-operative milk societies
Observations		Pre-treatment and post-treatment pest incidence level Palm health improvement

22. COCOA

22.1 *In vivo* evaluation of effective bio control agents against *Phytophthora* Pod rot management in cocoa (DRYSRHU, Ambajipeta)

a. Pod Rot:

Layout: RBD

Treatments: 4

T_1- Spraying of *Trichoderma reesei* spore suspension (2×10^6 cfu/ml) (2-3 sprays at 15 days intervals during monsoon period)

T_2 – Soil application of 50 g of *Trichoderma reesei* along with 5kg Neem cake (once before onset of monsoon)

T_3 – Spraying of copper oxychloride (3g/litre of water) (2-3 sprays at 15 days intervals during monsoon period)

T_4- Untreated Control

Replications: 6

Location: Avidi village , Kothapet Mandal, East Godavari district

Observations to be recorded: Number of healthy pods, Number of infected pods, Percent reduction of the infected pods & Yield.

b. Stem Canker

Layout: RBD

Treatments: 5

T_1- Chiselling of canker area on the stem and application of *Trichoderma reesei* Paste formulation (2×10^6 cfu/ml) on the chiselled area. Need based application at quarterly intervals

T2 - Chiselling of canker area on the stem and application of *Trichoderma reesei* coir pith cake (one cake per each canker spot) Need based application at quarterly intervals

T_3 - Soil application of 50 g of *Trichoderma reesei* along with 5kg Neem cake (once)

T_4- Chiselling of canker area on the stem and application Copper oxychloride paste formulation based on the lesion size

T_5- Untreated Control

Replications: 5

Location: HRS. Ambajipet, Mandal, East Godavari district

Observations to be recorded: Percent reduction in canker lesion size and Yield data

VEGETABLE CROPS

23. TOMATO

23.1 Role of Habitat manipulation for pest management in Tomato (CAU-Pashighat)

T1: Tomato intercropped with Carrot and Marigold as border crop

T2: Tomato intercropped with Lentil and Coriander as border crop

T3: Tomato intercropped with Chickpea and Mustard as border crop

T4: Tomato intercropped with Field bean and Fennel as border crop

T5: Tomato intercropped with Pea and Dill as border crop

T6: Tomato intercropped with Buckwheat and Maize as border crop

T7: Tomato as sole crop

Season: Winter

Replications: 03

Design: RBD

23.2 Bio-intensive pest management of *Helicoverpa armigera, Tuta absoluta* and sucking pests of tomato (PJTSAU, Sun Agro, IIHR – *Tuta absoluta*)

Variety	:	Location specific popular variety
Plot size	:	8×5 m^2
Layout	:	Randomized Block Design.
Treatments	:	**T1 = BIPM** Seed treatment with *Trichoderma harzianum* @ 10g/kg of

		seeds. Raising marigold as trap crop Use of NBAIR pheromone traps @ 1 trap per plot. *Trichogramma achaeae / Trichogramma pretiosum* @ 50,000 /ha per release (6 releases) Azadirachtin 1500 ppm @ 2 ml/lit. *Lecanicillium lecanii* (NBAIR) 1×10^8 spores/ g @ 5g/lt for sucking pests *Pochonia chlamydosporia* for root knot nematode **T2 = Chemical control** Chlorantraniliprole 18.5% SC for *Tuta* and indoxacarb 14.5 SC for other pests **T3**= Spinetoram 11.7% SC 0.25ml/L **(only for IIHR)** **T4 = Untreated Control**
Replications	:	Five
Methodology and observations	:	The treatment applications will be started at initial occurrence of American pin worm. Six releases of parasitoids at weekly interval and three sprays of biopesticides will be given during evening hours at fortnightly interval. • Randomly select 10 plants/40m^2 crop area and observe all the leaves for presence of leaf mine / sucking pests caused by the larva. • Randomly select 10 plants/ 40m^2 crop area and observe all the fruits for presence of holes/ damage caused by the larva. • Observations will be recorded at fortnightly interval from fruit formation to last harvest. • Fruit damage percentage and yield. • Cost-benefit ratio.

23.3 Large scale field trials for the management *Helicoverpa armigera* on tomato (MPUAT – 2 ha)

Variety	:	Location specific popular variety
Plot size	:	2 ha
Layout	:	Randomized Block Design.
Treatments	:	**T1 = BIPM** Seed treatment with *Trichoderma harzianum* @ 10g/kg of seeds. Azadirachtin 1500 ppm @ 2 ml/lit. *Beauveria bassiana* @ 1x10^8 conidia /gm, @ 5g/lt – 2 sprays at 15 days interval Spray of *HearNPV* (1.5×10^{12} POBS/ha) twice during the peak flowering and at fruit setting stage at 15 days interval. *Bacillus thuringiensis* @ 1kg/ha^{-1} two times during season at

		15 days interval **T2 = Chemical control** Spinosad 45 SC @ 0.25 ml/***l*** **T3 = Untreated Control**
Replications	:	Divide entire block into 8 equal sized units, each unit should further be divided into 8 units that serves as replications.
Methodology and observations	:	The treatment applications will be started at initial occurrence of *H. armigera* infestation sprays of biopesticides will be given during evening hours at fortnightly interval. • Randomly select 10 plants/ 40m^2 crop area and observe all the fruits for presence of holes/ damage caused by the larva. • Observations will be recorded at fortnightly interval from fruit formation to last harvest. • Fruit damage percentage and yield. • Cost-benefit ratio.

23.4 Demonstration on bio-intensive management of insect pests of tomato (0.5-1.0ha) (New experiment) (YSPUHF, Solan)

Variety	:	Location specific popular variety
Treatments	:	**T1 = BIPM** Seed treatment with *Trichoderma harzianum* @ 10g/kg of seeds. Raising marigold as trap crop Use of pheromone traps @ 30 traps/ha. *Trichogramma achaeae/ Trichogramma pretiosum* @ 50,000/ ha per release (6 releases) Azadirachtin 1500 ppm @ 2 ml/lit. *Lecanicillium lecanii* (NBAIR) 1 × 10^8 spores/ g @ 5g/lt for sucking pests **T2 = Farmers practice** Chlorantraniliprole 18.5% SC for *Tuta* and indoxacarb 14.5 SC for other pests
Replications	:	5
Methodology and observations	:	The treatment applications will be started at initial occurrence of American pin worm. Six releases of parasitoids at weekly interval and three sprays of biopesticides will be given during evening hours at fortnightly interval. • Randomly selected 100 plants/ plot will be observed for the presence of larvae, leaf mines/ sucking pests. • Randomly selected 100 fruits will be observed for the presence of holes/ damage caused by the larva. • Observations will be recorded at fortnightly interval from

		fruit formation to last harvest. • Fruit damage (%) and yield will be recorded. • Cost-benefit ratio.

24. BRINJAL

24.1 Development of biocontrol based IPM module for the management of fruit and shoot borer, *Leucinodes orbonalis* (Guenee) in brinjal (AAU-Anand)

	Year of commencement	:	2020-21 *Kharif*
	Location	:	Agronomy farm, AAU, Anand
	Crop/variety	:	Brinjal ABH-1
	Treatments	:	03
	Repetition	:	10
	Design	:	Large plot sampling CRD
	Spacing	:	90 × 60 cm
	Plot size	:	27 × 20 m

Treatments

T_1	BIPM module	1. Intercropping of brinjal with coriander (2:1 row) 2. Pheromone trap - Lucilure @ 40/ ha 3. *Trichogramma chilonis* @ 100000/ ha 4. Azadirachtin 10000 ppm (20ml/10 litre water) 5. *Bacillus thuringiensis* NBAIR BTG-1 (2×10^8 cfu/g) 1% WP (50g/ 10 litre water) 6. *Steinernema pakistanensis* AAU Strain @ 1.25×10^9 IJs ha
T_2	Chemical module/ Farmers' practice	Emamectin benzoate 5 SG (0.0025%) 5g/ 10 litre water - Three sprays at fifteen days interval with the initiation of pest.
T_3	Untreated control	-
	Methodology	• Pheromone trap will be installed from 30 DAT • Eight releases of *Trichogramma chilonis* @ 100000/ ha at weekly interval will be made with the initiation of pest • Three sprays of azadirachtin, two sprays of *Bt* and one spray of EPN will be carried out during the cropping season. **Spray schedule** **Bioagent/Biopesticide** | **Spray** | **DAT** Azadirachtin | First | 30

		Bt	Second	45	
		EPN	Third	60	
		Azadirachtin	Fourth	75	
		Bt	Fifth	90	
		Azadirachtin	Sixth	105	
	Observations	**Observations on catches of *Leucinodes orbonalis*** in pheromone trap will be recorded at weekly interval from the installation of pheromone trap **Shoot damage (%)** – Ten plants will be randomly selected from each subplot and observations on damages shoots will be recorded at weekly interval after 15 DAT **Fruit damage (%)** - The observations on fruit damage on number and weight basis will be recorded from net plot area from each treatment at each picking **Fruit yield** (healthy marketable fruit) - kg/plot **Natural enemies-** The observations of larval parasitoid Trathala flavorbitalis will be recorded from infested shoots and fruts of treated and untreated plants **C:B ratio** will be calculated			

24.2 Bio-intensive insect and nematode (RKN) management in brinjal (OUAT; IIHR; Sun Agro)

Variety	:	Variety will be selected as per the university recommendation
Plot size	:	8 × 5 m
Layout	:	Randomized Block Design.
Treatments	:	T1 = BIPM **For sucking pests** Azadirachtin 1500 ppm @ 2ml/lt *Lecanicillium lecanii* (NBAIR strain) 1 × 10^8 spores/ml @ 5g/lt **For BSFB** Mass trapping by all centres, traps by Sun Agro Release of *Trichogramma chilonis* multiple insecticide tolerant strain @100,000/ha, 8-10 releases at weekly interval from initiation of flowering. *Bacillus thuringiensis* NBAII BtG4 2% (not for AAU-J) **For Ash weevil** Entomopathogenic nematode (NBAIR) @ 2 billion IJs / ha, twice during season. **For mealybug** *Cryptolaemus montrouzieri* @ 5 grubs / plants or 1500/ha, twice at 15 days interval.

		T2 = Chemical Control Based on each university recommendation for insect pest on brinjal. 4-6 sprays depending upon pest species. T3: Untreated control
Replications	:	Eight
Methodology and observations	:	1. Pre-treatment incidence on shoot infestation and catches from pheromone traps. 2. Post treatment counts of infestation at shoot and fruit stage of crop at fortnightly interval. 3. Yield of healthy marketable fruits and cost-benefit ratio.

24.3 Bio-efficacy of microbial agents against *Myllocerous subfasciatus* on brinjal (IIHR)

Variety	:	Variety will be selected as per the institute recommendation
Plot size	:	8x5 m
Layout	:	Randomized Block Design.
Treatments	:	Treatments T1: *Metarhizium anisopliae* (IIHR Strain) oil formulation @ 1ml/l T2: *Beauveria bassiana* (IIHR Strain) WP formulation 10g/l T2: *Metarhizium anisopliae* (Biometa, AAU strain) (1x108 spores /g) @ 5g/ litre T3: *Beauveria bassiana* (Biosona, AAU strain) (1x108 spores /g) @ 5g/ litre T4: *Metarhizium anisopliae* (Ma-4) NBAIR strain (1x108 spores /g) @ 5g/ litre T5: *Beauveria bassiana* (Bb-5a) NBAIR strain (1x108 spores /g) @ 5g/ litre T6: *Heterorhabditis indica* @ 2.5 10^9 IJs ha^{-1} T7: Imidacloprid @ 20 g ai/ha T8: Untreated control
Replications	:	Three
Methodology and observations	:	Pre and post treatment infestation at fortnightly interval. If possible destructive sampling may be done ro count the grubs Yield of healthy marketable fruits and cost-benefit ratio.

24.4 Bio-efficacy of microbial agents against leaf hopper in brinjal (UBKV-Pundibari)

Variety	:	Any recommended brinjal variety
Location	:	Instructional Farm, UBKV
Season	:	Pre-kharif
Plot size	:	6 × 5m
Layout	:	Randomized Block Design.
Treatments	:	T1: *Metarhizium anisopliae* NBAIR Ma-4 (1×10^8spores/g) @ 5 g /lit. T2: *Lecanicillium lecanii* NBAIR VL-8 (1×10^8spores/g) @ 5g/lit.

		T3: *Beauveria bassiana* NBAIR Bb-5a (1×10^8spores/g) @ 5g/lit. T4: Azadirachtin 3000ppm @ 2.5 ml/lit. T5: Standard check (Any systemic insecticide) T6: Untreated control
Replications	:	Four
Methodology and observations	:	• Population of leaf hoppers will be recorded from 3 leaves (top, middle and lower) of each plant of randomly selected 5 plants per plot at 1 day before spraying, 3 days and 7 days after spraying. • Yield (q/ha) to be recorded.

25. OKRA

25.1 Management of hoppers, aphids and Whitefly on Okra by oil based formulation of *Metarhiziumanisopliae* IIHR Strain (ICAR-IIHR)

T1	*M. anisopliae* (oil based formulation) @ 0.25ml /l
T2	*M. anisopliae* (oil based formulation)@ 0.5ml/l
T3	*M. anisopliae* (oil based formulation) @ 1ml/l
T4	Standard check – Imidacloprid @0.3ml/l
T5	Unsprayed (control)

Design: RBD, **Replication:** 4, **Plants/replication:** 10plants/replication: 10 sprays (entire crop duration) weekly

Observations:

1. Population of hoppers and thrips a day before application and 3rd, 7th day after application. (4 leaves/plant)
2. Record hopper damage symptoms and YVMV incidence.
3. Marketable Yield at harvest replication wise in each treatment

25.2 Evaluation of *Neoseiulus indicus* for the management of spider mites on okra (KAU, Thrissur)

Plot size	:	$8 \times 5m=40\ m^2$
Replications	:	03
Design	:	RBD
Date of sowing	:	As per the package of practice
Treatments*	:	T1: Release of predatory mites @10 mites/plant T2: Release of predatory mites @20 mites/plant T3: Release of predatory mites @30 mites/plant T4: Spiromesifen 100 g a.i/ha T5: Control
Observations	:	• Pre and post count of spider mite/cm^2 of leaf at three days interval

		• Number of arthropod natural enemies (all stages) from 5 randomly selected plants in each plot (Number/Plant). • Yield (kg/plot).

*No. of releases: Three, at ten days interval starting from first observation of mite infestation

25.3 Efficacy biocontrol agents for management of fruit borer, *Earias vittella* on bhendi (IIVR-Varanasi)

Variety	:	Variety will be selected as per the university recommendation
Plot size	:	8 x 5 m
Layout	:	Randomized Block Design.
Treatments	:	T1: *Metarhizium anisopliae* (NBAIR) 1×10^8 spores/ g @ 5g/lt T2: *Beauveria bassiana* (NBAIR) 1×10^8 spores/ g @ 5g/lt T3: *Trichogramma chilonis* @50,000 parasitoids/ha, 6 releases at weekly interval. T4: *Bacillus thuringiensis* @ 1 kg/ha T5: Azadirachtin 1500 ppm@ 2 ml/lit T6: University recommended insecticide, 2-4 sprays. T7: Untreated control
Replications	:	Three
Methodology and observations	:	Releases of parasitoids at weekly interval and three sprays of entomopathogens, and azadirachtin will be followed at fortnightly interval. The observations will be recorded on five randomly selected plants/ plot. 1. Pre and post- treatment counts on fruit infestation at weekly interval. 2. Yield of healthy marketable fruits at each picking.

25.4 Evaluation of biointensive IPM module against key pests of okra (AAU-J).

Target pests: Jassids/ Thrips/ Whiteflies/ shoot and fruit borer

Location: Neul Gaon, Jorhat (farmer's field).

Season: *Kharif*, 2020

Variety: Locally recommended variety

Area cover: 1ha (to be covered)

(The whole area will be divided into 10 sub plots to serve as 10 replication. A distance of at least 200m will be maintained in between IPM and farmer practice plots. Analysis will be done using 't'-test)

Treatment : 2 (BIPM and farmers practice)

a) BIPM treatments include:

- Yellow sticky traps @20/ha for maintaining of sucking pests.
- Rogue out the YVMV affected plant from time to time.
- Application of *Beauveria bassiana* @ 1×10^8 cfu/@5g/lit.
- Application of NSKE @ 5%
- Release of *Trichogramma chilonis* @ 100,000 per ha starting from 35 days after sowing 4-5 times at 10 days interval or coinciding with the emergence of *Earis* sp.
- Application of profenofos 50% EC @2ml/per lit.(at 2-3 sprays as need based)

b) Farmers practice

Alternate spray of cypermethrin 10EC @2ml/lit and lamda cyhalothrin 2.5%EC @ 1.5ml/lit.

Observations to be recorded:

- Record of sucking pest from 10 randomly selected plants on each leaves from top, middle and bottom before treatment and 7 and 10 days after treatment.
- Number of fruit borer larvae on 10 randomly selected plant before and 7 and 10 days after treatments.
- Per cent fruit damaged by borers.
- Yield at each harvest.

25.5 Bio-intensive pest management in okra (AAU-Anand)

	Year of commencement	**:**	2020-21 *Kharif*
	Location	**:**	Farmers' fields, Village - Umreth, District - Anand
	Crop/variety	**:**	Okra - Local/hybrid
	Area	**:**	10 ha
	Treatments	**:**	02
	Repetition	**:**	10
	Design	**:**	Large plot sampling CRD
	Spacing	**:**	60 x 30 cm
	Plot size	**:**	5 ha for each treatment
	Treatments		

T_1	BIPM module	1. Installation of pheromone trap for *Helicoverpa armigera* & *Earias vittella* @ 40 traps/ha at 30 DAS. 2. Six releases of *Trichogramma chilonis* @ 50000/ ha at weekly interval with the initiation of pest. 3. Two sprays of *Bacillus thuringiensis* NBAIR BTG4 ($2x10^8$ cfu/g) 1% WP (50g/ 10 litre water). First spray with the initiation of lepidopteran pest and subsequent spray at ten days interval 4. One spray of Azadirachtin 10000 ppm (1% EC) (20ml/ 10 litre water) with the initiation of sucking pest and subsequent spray with *Lecanicillium lecanii* NBAIR Vl-8 ($2x10^8$ cfu/g) 1% WP (50g/ 10 litre water) at ten days interval.
T_2	Chemical module/ Farmers' practice	-
	Methodology & Observations	Total 10 quadrates will be made in each treatment. Each quadrate will serve as one replication. **Observations on catches** of *Helicoverpa armigera* and *Earias vittella* in pheromone trap will be recorded at weekly interval from the installation of pheromone trap. The observations on **larval population** of *H. armigera* and *E. vittella* will be recorded from ten randomly selected plants per repetition at weekly interval with the initiation of pest. The observations on **sucking pest population** will be recorded from three leaves (upper, middle and lower) of ten randomly selected plants per repetition at weekly interval with the initiation of pest. Natural enemies: The population of natural enemies will be recorded from 10 plants of each quadrate at 15 days interval **Fruit damage (%)** - The observations on fruit damage on number and weight basis will be recorded from each treatment at each picking. **Fruit yield** (healthy marketable fruit) q/ha **C:B ratio**

26. CABBAGE

26.1 Influence of habitat manipulation on incidence and severity of pest damage on cabbage (AAU-Anand)

	Year of commencement	**:**	2020-21 *Rabi*

	Location	:	Agronomy farm, AAU, Anand
	Crop/variety	:	Cabbage - Sutton Express
	Treatments	:	05
	Replication	:	04
	Design	:	Randomized block design (RBD)
	Spacing	:	60 x 60 cm
	Plot size	:	Gross- 4.2 x 7.2 m Net-3.0 x 6.0 m
	Treatments		
T_1	Cabbage intercropped with mustard and cowpea		
T_2	Cabbage intercropped with mustard and oats as border crop		
T_3	Cabbage intercropped with cowpea and oats as border crop		
T_4	Cabbage with oats as border crop		
T_5	Cabbage as sole crop		
	Methodology and observations		Main crop, inter crop and border crop will be raised as per recommended agronomic practices. Five plants will be randomly selected from each subplot and observations will be recorded at weekly interval after 25 DAT. 1. Larval population/ plant 2. Aphid population/plant 3. Aphid parasitization (%) by *Diaeretiella* sp. 4. Natural enemies/plant (coccinellids and syrphid fly) 5. Yield (healthy marketable cabbage heads) - kg/plot 6. C:B ratio will be calculated

26.2 Field evaluation of ICAR-NBAIR entomopathogenic strains against cabbage aphid (*Brevicoryne/Myzus*) and *Plutella xylostella* (DBM) (IIVR), AAU- Jorhat, MPKV and CAU Pashighat

Plot size 8x5m=40 m^2
Rep 03
Design: RBD
Treatments=6
Total area required = 240m^2 (40x 6) for each centre
Date of sowing: As per the package of practice

Treatments

1. Bb-5a isolate of *Beauveria bassiana*
2. Bb-45 isolate of *Beauveria bassiana*
3. Ma-4 isolate of *Metarhizium anisopliae*
4. Vl-8 isolate of *Lecanicillium lecanii*
5. Recommended Insecticide application
6. Control (Untreated)

Four rounds of foliar sprays of oil formulations of entomopathogenic fungi at the spore dose of 1×10^8 cfu/ml (5ml/liter) has to be given at 15 days interval

Observations:

- Pre and post count of aphids (nymphs and adults)
- Yield

26.3 Bio-intensive pest management in cabbage (AAU-Anand)

	Year of commencement	**:**	2020-21 *Rabi*
	Location	**:**	Farmers' fields, Village -Navli, District – Anand// Village Prantij, Dist. Sabarkantha
	Crop/variety	**:**	Cabbage - Local/hybrid
	Area	**:**	10 ha
	Treatments	**:**	02
	Repetition	**:**	10
	Design	**:**	Large plot sampling method (CRD)
	Spacing	**:**	60 × 60 cm
	Plot size	**:**	5 ha for each treatment
	Treatments		
T_1	BIPM module		1. Installation of pheromone trap for *Plutella xylostella* @ 12 traps/ha at 30 DAT 2. Eight releases of *Trichogramma chilonis* @ 100000/ ha at weekly interval with the initiation of pest 3. Two sprays of *Bacillus thuringiensis* NBAIR BTG4 ($2x10^8$ cfu/g) 1% WP (50g/ 10 litre water). First spray with the initiation of lepidopteran pest and subsequent spray at ten days interval 4. One spray of Azadirachtin 10000 ppm (1%EC) (20ml/ 10 litre water) with the initiation of sucking pest/aphid and subsequent spray with *Lecanicillium lecanii* NBAIR Vl-8 ($2x10^8$ cfu/g) 1% WP (50g/ 10 litre water) at ten days interval.

T_2	Chemical module/ Farmers' practice	-
	Methodology & Observations	Total 10 quadrates will be made in each treatment. Each quadrate will serve as one replication. **Observations on catches** of *Plutella xylostella* in pheromone trap will be recorded at weekly interval from the installation of pheromone trap. The observations on **larval population/plant** of lepidopteran pest will be recorded from ten randomly selected plants per repetition at weekly interval with the initiation of pest. The observations on **aphid population/plant** will be recorded from ten randomly selected plants per repetition at weekly interval with the initiation of pest. **Fruit damage (%) -** The observations on fruit damage on number basis will be recorded from each treatment at each picking. Natrual enemies-per plant parasitization by *Diaeretiella* sp. and other natural enemies viz., coccinellid and syrphid fly will be recorded from each treatment at 15 days interval **Yield** (healthy marketable cabbage heads) **q/ha** **C:B ratio**

27. CHILLI

27.1 Management of thrips, aphids and Whitefly on chilli by oil based formulation of *Metarhizium anisopliae (IIHR Strain) (ICAR-IIHR)*

T1	*M. anisopliae* (oil based formulation) @ 0.25ml /l
T2	*M. anisopliae* (oil based formulation)@ 0.5ml/l
T3	*M. anisopliae* (oil based formulation) @ 1ml/l
T4	Standard check – Imidacloprid @0.3ml/l
T5	Unsprayed (control)

Design:RBD , Replication: 4, Plants/replication: 10plants/replication

Observations:

1. Population of white fly, aphids and thrips a day before application and 3rd, 7th day after application. (4 leaves/plant)

2. Record hopper damage symptoms and ChLCVincidence.

3. Marketable Yield at harvest replication wise in each treatment

27.2 Screening of promising isolates of entomopathogenic fungi for management of mites in chillies (continuing experiment) (KAU- Kumarakom)

Variety	:	Location specific recommended variety
Layout	:	Randomized Block Design.
Treatments	:	T1: NBAIR Bb-5a isolate of *Beauveria bassiana* T2: NBAIR Ma-4 isolate of *Metarhizium anisopliae* T3: NBAIR Ma-6 isolate of *Metarhizium anisopliae* T4: NBAIR Vl-8 isolate of *Lecanicillium lecanii* T5: Spiromesifen 22.9SC@ 96 g ai ha^{-1} T6: Untreated control
Replications		Four
Mode of application	:	Four rounds of foliar sprays of oil formulations of entomopathogenic fungi at the spore dose of $1x10^8$cfu/ml (5ml/liter) to be given at 15 days interval
Observations	:	➢ Pre and post count of whiteflies ➢ Yield

28. CUCUMBER

28.1 Evaluation of BIPM against fruit flies *Deccaus bactrocera* sp. against cucumber (AAU-Jorhat)

Location: Experimental farm, Dept. of Horticulture

Plot size: 400m^2 (Whole plot will be divide into8 sub plots, represents as individual replication)

Season: *Kharif*, 2020

Variety: locally recommended

Treatments: 3 (BIPM, conventional and farmer practices)

1) **BIPM practices**
   - Good agricultural practices (racking, weeding)
   - Installation of cue lure @ 15/ha for monitoring
   - Destruction of damaged fruits
   - Spray of neem based insecticides
   - Spray of spinosad 45SC @ 0.3ml/lit
2) **Conventional practices**

- Jaggary 1% + malathion 50 EC@2ml per litre of water

3) **Farmers practice**
   - Untreated control practice

Application of treatments

- The botanical treatment, NSKE5% and spinosad will be sprayed during evening hours.
- Untreated control plots will be maintained 200m away from BIPM plots.
- First spray of will be started when fruit flies be trapped in pheromone traps.
- No management practices will be followed in case of untreated control plots except water spray.

Observation to be recorded

- For pre and post treatment observation 5 plants will be selected randomly from each sub plots and per cent damaged fruits will be recorded after imposing each treatment at 7 and 10 day interval.
- Epilachna bettle, flea beetle red pumpkin beetle will be observed in each sub plot considering randomly selected 5 plants.
- Both nymphs and adult of aphid will also be collected on the basis of number of population per leaf.
- Natural enemy complex will also be recorded per plant basis.
- Yields of marketable fruits at each harvest will be pooled together to get the average yield.

29. Onion

29.1 Efficacy of different biocontrol agents against onion thrips (*Thrips tabaci* L.) (AAU-Anand)

	Year of commencement	**:**	2020-21 *Rabi*
	Location	**:**	Agronomy farm, AAU, Anand
	Crop/variety	**:**	Onion - Talaja local
	Treatments	**:**	08
	Replication	**:**	03
	Design	**:**	Randomized block design (RBD)
	Spacing	**:**	60 x 60 cm
	Plot size	**:**	Gross - 3.0 x 4.8 m Net - 1.8 x 3.6 m

Treatments

Treatments	Concentration	Dosage/

			10 litre water	
T_1	*Lecanicillium lecanii* NBAIR Vl8 – 1%WP	$2x10^8$ cfu/g	50 g	
T_2	*Beauveria bassiana* NBAIR Bb5a - 1%WP	$2x10^8$ cfu/g	50 g	
T_3	*Metarhizium anisopliae* NBAIR Ma4 - 1%WP	$2x10^8$ cfu/g	50 g	
T_4	*Steinernema carpocapsae* NBAIR strain - 1%WP	-	80 g	
T_5	*Pseudomonas fluorescens* NBAIR *Pf*DwD-1%WP	$2x10^8$ cfu/g	50 g	
T_6	Azadirachtin 10000	0.2 %	20 ml	
T_7	Dimethoate 30 EC	0.003	10 ml	
T_8	Untreated control	-	-	

	Methodology and observations	First spray will be carried out with the initiation of pest and subsequent two sprays will be carried out at ten days interval. Five plants will be randomly selected from net plot area and observations will be recorded. Number of thrips per plant will be recorded before treatment application and at 3rd, 7th and 10th day after each spray. 1. No. of thrips/ plant 2. Bulb yield - kg/plot 3. C;B ration will be calculated

30. Capsicum

30.1 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 (UAS Raichur)**

Objectives	:	To generate the specific data on bioefficacy of *Beauveria bassiana* (NBAIR-Bb-5a) against sucking pests of capsicum under open condition (CIB and RC registration).
Location	:	Biocontrol Field, MARS, Raichur
Crop	:	Capsicum
Variety/ Hybrid	:	Indra
Design	:	RBD
Treatments	:	7
Replication	:	3
Plot Size	:	54sqm
Treatment Details		T_1: *B.bassiana* @ 1×10^8 @ 5 gm/l (NBAIR-Bb-5a) @ 5.0 g/l T_2: *L. leccani* @ 1×10^8 @ 5 gm/l (NBAIR-VL-8) @ 5.0 g/l

		T_3: *L. leccani* @ 1×10^8 @ 5 gm/l (NBAIR-VL-15) @ 5.0 g/l T_4: *M. anisopliae* @ 1×10^8 @ 5 gm/l (NBAIR-Ma 4) @ 5.0 g/l T_5: *Isaria fumosorosea* (NBAIR strain) @ 1×10^8 @ 5.0 g/l T_6 : Azadirachtin 1500ppm @ 2 ml/lit T_7 : Untreated control
Methodology	:	• Average number of sucking pest population / 3 leaves, *viz.*, thrips, aphids, mites and whiteflies will be counted and recorded. • Cadavers without apparent sporulation along with leaves will be brought in the laboratory and incubated under optimal condition. After 5 days cadavers were observed for signs of fungal infection and sporulation. • The population of other sucking pests will also be recorded. • Yield (q/ha) to be recorded.

31. Amaranthus

31.1 Efficacy of capsule formulations of *Beauveria bassiana* in managing amaranthus leaf webber *Hymenia recurvalis* (KAU- Vellayani)

Technical Programme:

Crop	:	Amaranthus
Major Pest	:	Amaranthus leaf webber, *Hymenia recurvalis*
Treatments	:	T1 - Capsule formulation of *B. bassiana* KAU isolate T2 - Capsule formulation of *B. bassiana* NBAIR isolate (Bb5) T3 - Talc formulation of *B.bassiana* (NBAIR isolate) T4 - Talc formulation of *B.bassiana* (KAU isolate) T5 – Spore suspension of KAU isolate @10^8 spores mL-1 T6- Spore suspension of NBAIR isolate @10^8 spores mL-1 T7- Untreated check
No. of Replications	:	3
Unit plot size	:	5 x 5 m^2
Area	:	525 m^2

No. of sprayings: 3

Observations to be recorded

1. Pre count of leaf webber
2. Post count of leaf webber

3. Precount of Predators
4. Post count of Predators
5. Yield per plot

SPICE CROPS

32. GINGER

32.1 To test the *Trichoderma* formulation developed as a component of integrated management of ginger rhizome rot under field condition (Nagaland University, Medziphema)

Crop	:	Ginger
Variety	:	Nadia
Layout of plots	:	Randomized Block Design (RBD)
Plot size	:	1 x 2m sq.
Replications	:	03
Treatments	T_1	Seed rhizome treatment with *Trichoderma* formulation and planting
	T_2	Field soil treatment with *Trichoderma* formulation and planting
	T_3	Hot water treatment of seed rhizomes at 51°C for 10 mnts and planting
	T_4	Hot water treatment as above + *Trichoderma* treatment and planting
	T_5	Field soil solarization for 4 weeks and seed rhizome planting
	T_6	Field soil solarization as above + seed rhizome treatment with *Trichoderma* and planting
	T_7	Soil solarization as above + Trichoderma soil treatment and planting
	T_8	Seed rhizome treatment with Copper oxychloride (COC) @ 3g/kg seed rhizomes and planting (for comparison)
	T_9	Seed rhizome planting without any treatment (Control)

33. POLYHOUSE INSECT PESTS

33.1 Management of sucking pests on cucumber using anthocorid predator, *Blaptostethus pallescens* under polyhouse condition (KAU-Thrissur)

Variety	:	Any recommended variety
Plot size in polyhouse	:	2x2 m
Layout	:	Randomized Block Design.

Treatments	:	T1: *Blastostethus pallescens* @ 10 nymphs/m row twice at 15 days interval T2: *Blastostethus pallescens* @ 20 nymphs/ m row twice at 15 days interval T3: Spiromesifen 45SC @100g.a.i ha^{-1} twice at 15 days interval or recommended insecticide for use in polyhouse T4: Control
Replications	:	Five
Observations	:	1. Pre treatment count of thrips and mites 2. Post treatment count of thrips and mites at 7 and 14 DAT 3. Number of leaves with symptoms of infestation 4. Yield

33.2 Management of sucking pests in Tomato under polyhouse condition (PAU, Ludhiana

Variety		Variety will be selected as per the university recommendation Plot
Plot size		2x2m
Layout		RBD
Treatments		T1 • Spray of Azadiractin5%@ 2ml/L • Yellow sticky trap @4/250 sq.m T 2 • *Lecanicillium lecanii* $1X10^8$ spore/ g @ 10g/lt • Yellow sticky trap @4/250 sq.m T 3 • *Chrysoperla zastrowi sillemi* @ 4 larvae / plant, 2-3 releases (weekly) to be made. • Yellow sticky trap @4/250 sq.m T4. Chemical control T5. Untreated control 2-3 sprays will be made at 10 days interval on appearance of pest
observations		• Population of sucking pests from 10 randomly selected will be recorded at weekly interval • Marketable yield

33.3 Evaluation of biocontrol agents for the control of sucking pests in capsicum under polyhouse (IIHR)

Variety	:	Variety will be selected as per the university recommendation
Plot size	:	2x2 m
Layout	:	Randomized Block Design.
Treatments	:	T1: *Metarhizium anisopliae* (NBAIR) $1X10^8$ spore/ g @ 5g/lt T2: *Metarhizium anisopliae* (IIHR) oil based formulation @ 1ml/1L for only IIHR T3: *Lecanicillium lecanii* (NBAIR) $1X10^8$ spore/ g @ 5g/lt T4: *Beauveria bassiana* (NBAIR) $1X10^8$ spore/ g @ 5g/lt T5: *Chrysoperla zastrowi sillemi* @ 4 larvae / plant, 2-3 releases(weekly) to be made. T6: Five (weekly) releases of *Blaptostethus pallescens* @ 30 nymphs/ m row length T7: Azadirachtin @ 2ml/L of 1500ppm T8: Insecticide as per label claim / University recommendation T9: Control
Replications	:	Three
Observations	:	2-3 sprays will be made at 10 days interval on appearance of pest Population of sucking pests from 10 randomly selected plants before spray / release of predator, 5, 7 and 10 days after spray / release of predator. Marketable yield

33.4 Management of phytophagous mites on cucumber using *Blaptostethus pallescens* and *Neoseiulus longispinosus* under polyhouse condition (New experiment) (YSPUHF, Solan)

Variety	:	University recommended variety
Plot size in polyhouse	:	3x2 m
Layout	:	Randomized Block Design.
Treatments	:	T1: *Blastostethus pallescens* @ 10 nymphs/m row twice at 15 days interval T2: *Blastostethus pallescens* @ 20 nymphs/ m row twice at 15 days interval T3: *Neoseiulus longispinosus* @ 1:30 (predator: prey) twice at 15 days interval T4: *Neoseiulus longispinosus* @ 1:20 (predator: prey) twice

		at 15 days interval T5: Spiromesifen 45SC @100g.a.i ha^{-1} twice at 15 days interval or recommended insecticide for use in polyhouse T6: Control
Replications	:	Five
Observations	:	5. Pre-treatment count of mites 6. Post treatment count of mites at 7 and 14 DAT 7. Yield

33.5 Field evaluation of anthocorid bug, *Blaptostethus pallescens* against spider mite, *Tetranychus urticae* infesting carnation in Kashmir (Poly house) (SKSUAT-Srinagar)

Crop	:	Carnation (*Dianthus caryophyllus* L.)
Variety	:	Canadian Red & Dark Dona
Location	:	Shalimar campus
Treatments	:	04 (08 weekly releases) T1 = @25 bugs/plant/release T2= @50 bugs/plant/release T3= @100 bugs/plant/release T4= Hexythiazox 5.45 EC @0.4ml/ litre of water (2prays) T5= Untreated check
Replications	:	05 (Each replication will consist of 10 plants)
Experimental Design	:	RBD
Area to be covered	:	Poly house
Likely duration	:	03 years
Methodology		Laboratory reared 8- days old nymphs of *Blaptostethus pallescens* will be released twice/ week @ 25,50 and 100 bugs/ plant on carnation in the poly house of SKUAST-K. A total of eight releases will be made from June- July' 2019. Prior to first release pretreatment data on average population of mites /leaf will be recorded. After every treatment similar observations shall be made every week.
Observations	:	➢ Average mite population/leaf/flower

		➢ Crop damage or petal distortion ➢ Effect of weather parameter on mites' population ➢ % Decline in mites' population in response to treatment ➢ Comparison of data with untreated check ➢ C: B ratio

33.6 Evaluation of biocontrol agents for the control of sucking pests in capsicum under protected cultivation (UAHS-Shivamogga)

Variety	Indra
Lay out	Randomized block design
	T_1 : *Metarhizium anisopliae* (UAHS-33) @ 1 x 10^8 Cfu/ ml - 3 ml /lt
	T_2 : *Lecanicillium lecanii* (UAHS-12) @ 1 x 10^8 Cfu/ ml- 3 ml /lt
	T_3 : *Beauveria bassiana* (UAHS-18)@ 1 x 10^8 Cfu/ ml- 3 ml /lt
	T_4 : Azadirachtin 1500 ppm @ 2 ml/litre of water
	T_5 : Chemical control (malathion 50EC @ 4 ml/litre of water)
	T_6 : Untreated (check)
Replications	4
Methodology and observations	Number of sprays/ releases: 2-3sprays at weekly interval The aphid population from randomly selected five plants before and after each spray and yield will be recorded

33.7 Biological control of bacterial wilt of capsicum under protected cultivation (UAHS-Shivamogga)

Variety	Indra
Lay out	Randomized block design
	T_1 : *Trichoderma harzianum* (UAHS-3) @ 1 x 10^8 Cfu/ g @ 10 kg/ha multiplied in 250 kg FYM 10 days prior to its application and apply at the time of sowing
	T_2 : *Bacillus subtilis* (UAHS-147) @ 1 x 10^8 Cfu/ g @ 10 kg/ha multiplied in 250 kg FYM 10 days prior to its application and apply at the time of sowing
	T_3 : *Pseudomonas fluorescens* (UAHS-56) @ 1 x 10^8 Cfu/ g @ 10 kg/ha multiplied in 250 kg FYM 10 days prior to its application and apply at the time of sowing
	T_4 : *B. subtilis* (UAHS-147) + *P. fluorescens*(UAHS-56) + *T. harzianum* (UAHS-3) @ 1 x 10^8 Cfu/ g @ 3kg each /ha multiplied in 250 kg FYM 10 days prior to its application and apply at the time of sowing

	T_5 : chemical control
	T_6 : Untreated (check)
Replications	4
Methodology and observations	• Observations regarding plant growth parameters and disease incidence will be taken at different intervals after application • Yield will be recorded

34. Casava KAU all the centres, TNAU, NBAIR New

1. **Survey for incidence of *Phenacoccus manihoti*- the recent invasive mealybug on cassava**
2. **Host range of *P. manihoti* across agricultural and horticultural crops**
3. **Survey and utilization of natural enemies of *P. manihoti*- including possible classical biological control using *Anagyrus lopezi***

35. Large scale field demonstration trials (GBPUAT, Pantnagar)

Rice-100 acre
Tomato-20 acre
Pea- 25 acre

Location: Farmers fields of District Nainital of Uttarakhand.
Methodology:
Step 1. Plastic mulching (soil solarization) of nursery beds and fields: It is a low-cost technique to reduce losses due to soil borne insect pests and diseases of the nursery. Under the technique, nursery beds are prepared 5-8 weeks in advance of seed sowing, irrigated and covered with a transparent polythene sheet (50-100 u thick) which is removed 3-4 days ahead of the seed sowing.
Step 2. Use of bioagents:

i. Seed treatment through biopriming: Seeds are mixed with the formulated BCAs @ 8-10g/kg and incubate under moist conditions for 24 to 48h before sowing.
ii. Rhizome treatment: Rhizomes dipped in solution of bioagent (@ 8-10 gram/ liter water) for 30 minutes, dried in shade and planted.
iii. Seedling treatment: Before transplanting roots of seedlings dipped in solution of bioagents @ 8-10 g/ liter for about 30 minutes.
iv. Spray: @ 8-10 g/ liter on standing crop at 10-12 days intervals
v. Drench: @ 8-10 g/ liter in soil in the nurseries from time to time.

Step 3. Bio-composting including vermi composting: Vermicompost is more nutritious than traditionally used undecomposed FYM and gets ready in lesser time. It reduces the cost of production, increases plant health and improves fertility and water holding capacity of the soil. Cattle dung, crop residue, green manure and other farm wastes are used by the earthworms to convert these to nutritious compost. It can be prepared in pits (with variable dimensions as per

convenience and use) filled with animal dung and other waste material available on farm. Thereafter, earthworms are released in the pits where they increase in population and convert the waste material to 'nutritious vermicompost' in about 3 months.

Step 4. Value addition of vermicompost and FYM: Before use vermicompost is supplemented with bioagents @ 1Kg/q. This increases the nutritive value of the compost and provides opportunity to the bioagent to grow faster on the compost so that it can compete well with plant pathogens in the soil. Further, it facilitates rapid spread of bioagents in the soil.

Step 5. Need based use of safe chemicals for the control of insect pest.

36. PLANT DISEASES EXPERIMENTS

36.1 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

Treatments (6) and replications (4):

1. NBAIR-PFDWD isolate of *Pseudomonas fluorescens*
2. NBAIR-PEOWN isolate of *Pseudomonas entomophila*
3. NBAIR-BATP isolate of *Bacillus albus*
4. NBAIR-BtoyPS isolate of *Lysinibacillus sphaericus*
5. NBAIR-TATP isolate of *Trichoderma asperellum*
6. Recommended Fungicide application
7. Control (Untreated)

Data parameters:

- Lesion Number: The lesion number will be recorded 21 days after inoculation of different isolates of *Rhizoctonia solani* on the rice cultivar.
- Lesion Height: The lesion height will be recorded 21 days after inoculation of different isolates of *Rhizoctonia solani* on the rice cultivar.
- Relative Lesion Height: RLH = Maximum height at which lesion appear/plant height x100.
- Percent Disease Index (PDI) - PDI will be calculated 21 days after inoculation by the formula given by Wheeler.
- PDI = (Sum of all ratings ×100)/ (Total no. of observations × Maximum rating scale)
- Disease severity% = [Σ (Disease index × number of plants)/ (total number of plants × highest disease index)] × 100%
- Bio-control efficacy% = [(Disease severity of control − disease severity of treatment)/disease severity of control] × 100% will be calculated.

36.2 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

Disease Assessment

- Five leaves from top of each culm will be taken for observation. Now the disease area will be calculated and scoring done according to the rating scale of 0-9 developed by International Rice Research Institute and then it will be converted into per cent disease intensity by using formula
- Disease intensity (%) = (Area of disease score/9) × 100
- Disease scoring area (%) = (Area of leaf affected/Total leaf area) × 100

36.3 Field evaluation of ICAR-NBAIR strains against Rice Blast (*Magnaporthe oryzae*), Brown spot (*Bipolaris oryzae*) and sheath blight (*Rhizoctonia solani*) (ICAR-NRRI, Cuttack).

Plot size: 20-25 Sq.m.
Replications: 04
Design: RBD
Date of sowing: As per the package of practice

Treatments:
1. NBAIR-PEOWN isolate of *Pseudomonas entomophila*
2. NBAIR-BATP isolate of *Bacillus albus*
3. NBAIR-BtoyPS isolate of *Lysinibacillus sphaericus*
4. NBAIR-PFDWD isolate of *Pseudomonas fluorescens*
5. NBAIR-TATP isolate of *Trichoderma asperellum*
6. Recommended fungicide application
7. Control (Untreated)

Observations:
- Scoring and calculation of Percent disease index (Rice blast -7 days interval, brown spot - 7 days interval, sheath blight - 7 days interval).
- Growth promotion character viz., plant height (cm), biomass (gm)
- Yield (kg/plot)

Note: Four rounds of foliar sprays of talc and liquid formulations of entomopathogenic fungi and bacteria at the dosage of 10^8 cfu/ml has to be given at 14 days interval.

36.4 Evaluation of bio-agents consortia in glasshouse and in field for crop health management in rice (GBPUAT-Pantnagar).

Variety	:	Pant Dhan 4
Plot size	:	4 × 2.5 m^2
Treatment	:	11
Replication	:	03
Glasshouse experiment	:	In pots (2 kg capacity) with same treatments and replications
Treatments	:	1. Th-17 + Psf-173 2. Th-17+ Psf-2 3. Th-17 + Th-14 4. Th-14+ Psf-2

		5. Th-17 (positive control) 6. Th-14 (positive control) 7. Psf-2 (positive control) 8. Psf-173 (positive control) 9. Th-14 + Psf-173 (Standard check) 10. Carbendazim 11. Control (Negative control)
Methodology		**In field:** ❖ Bioagents along with vermicompost (50g/500g) before sowing in the nursery. ❖ Seed bio-priming @ 10g/kg seed. ❖ Seedling dip treatment (10g/lit) for 20-30 min. before transplanting. ❖ Three foliar sprays along with drenching with bioagents @ 10g/l (1st at 30 days after sowing and 2nd and 3rd at 45 days interval). **Observations :** ❖ Tiller/hills. ❖ Disease incidence and disease severity of different diseases at 90-100 DAT. ❖ Yield / plot and q/ha. **In glasshouse :** ❖ Soil will be pre inoculated with *Rhizoctonia* (5g inoculum/pot) one week before sowing followed by bioagents along with vermicompost (10g/100g) per pot ❖ Three foliar sprays along with drenching with bioagents (at 15 days interval) **Observations :** ❖ Per cent seed germination 10 DAS ❖ Plant stand at 30 and 45 DAS ❖ Plant Growth at 45 DAS

36.5 Demonstration of *Trichoderma* spp for the management of *Fusarium* wilt in pigeon pea (1 ha) (AAU-Anand)

Variety	:	Location specific variety
Treatments	:	T1: Seed treatment - *Trichoderma harzianum* @ 10g/ kg seeds Soil application of *Trichoderma harzianum* @ 10 kg/ha multiplied in 250 kg FYM 10 days prior to its application and apply at the time of sowing T2: Chemical Control T3: Control
Replications	:	Divide each block into 8 equal sized units, each unit to be considered as replication (each unit= one replication)

Observations	:	Disease incidence (%)/Plant stand (%) at 30, 45, 60 DAS Yield (q/ha)

36.6 Biological control of plant disease using antagonistic organisms in brinjal (UBKV-Pundibari)

Crop	Recommended variety of Brinjal of the zone
Location	Instructional Farm, UBKV
Season	Pre-kharif
Layout	Randomized Block Design
Plot size	5 m × 4m
Treatments	Seven T1: Seed treatment of *Trichoderma* sp. (UBKV culture) T2: Soil treatment of *Trichoderma* sp. (UBKV culture) T3: Seed treatment of Flurorescent pseudomonad (UBKV culture) T4:Soil treatment of Flurorescent pseudomonad (UBKV culture) T5: Seed treatment of *Trichoderma* sp. + Flurorescent pseudomonad T6: Soil treatment *Trichoderma* sp. + Flurorescent pseudomonads T7: Control
Replication	3
Mode of application	Seed treatment with bioagents. Five grams of talc formulation of bioagents with 1 kg of seeds Soil treatment with bioagents. Five grams of talc formulation of bioagents with 1 kg of vermicompost, incubate for 7-15 days and application in field
Observations	• Shoot and root growth • Soil borne disease • Yield • Population of the bioagent before and after application

36.7 Large Scale Demonstration of biocontrol technologies against the soft rot of ginger (UAHS-Shivamogga)

Large scale demonstrations of biocontrol technologies using bioagents, *Trichoderma harzianum , Bacillus subtilis,* and *Pseudomonas fluorescens* for the management of soft rot of ginger will be conducted over an area of 200 acres of farmer fields of malnad and region of Karnataka in collaboration with KVK and different NGO's operating in that area.

Location	Shikaripura, Sagara and Soraba talluk of Shivamogga district of Karnataka
Area	200 acres
Methodology	Ginger blocks where soft rot is a problem will be selected • T_1: Enrichment of FYM with bioagents *Trichoderma harzianum* (UAHS-25) *Bacillus subtilis* (UAHS-72) and *Pseudomonas fluorescens* (UAHS-8) @ 4 kg each / ha (10 days prior to its application)

	• T_2: Rhizome treatment with 10 g of *Trichoderma harzianum*, (UAHS-25) 10g of *Bacillus subtilis*, (UAHS-72) and 10g of *Pseudomonas fluorescens* (UAHS-8) during the planting • T_3 : Farmers' practice (as per sprays recommended insecticide at each place as per university recommendation or label claim).
Replication	Divide each block into 8 equal sized units (each unit = one replication)
Observations	Germination %, Disease incidence (%), Plant stand (%) and Yield (q/ha) will be recorded.
Collaboration	• KVK University of agriculture and horticulture sciences Shivamogga. • Active NGO's of the region.

36.8 Field efficacy of different combinations of *Trichoderma harzianum* and *Pseudomonas fluorescens* against the early blight of tomato (AAU-Anand)

Year of commencement	**:**	2020-21 *Kharif*
Location	**:**	Agronomy Farm, AAU, Anand
Crop & Variety	**:**	Tomato, AT-3
Treatments	**:**	08
Replications	**:**	03
Design	**:**	Randomized Block Design
Spacing	**:**	90 x 60 cm
Plot size	**:**	Gross : 5.4 x 6.0 m Net : 3.6 x 4.8 m

Treatments:

1. Th (SA + RD + FS)
2. Pf (SA + RD + FS)
3. Th + Pf (SA + RD + FS)
4. Th (SA + RD) + Azoxystrobin 23% SC (FS)
5. Pf (SA + RD) + Azoxystrobin 23% SC (FS)
6. Th+ Pf (SA + RD) + Azoxystrobin 23% SC (FS)
7. Azoxystrobin 23% SC (RD) + Azoxystrobin 23% SC (FS)
8. Untreated control

Note:

Th = *Trichoderma harzianum* (AAUBC- Th1)
Pf = *Pseudomonas fluorescence* (NBAIR strain PfDWD)
SA = Soil application, RD = Root dip treatment FS = Foliar spray

Methodology:

Soil application (SA)

Standard protocol will be followed for enriching biopesticides. *T. harzianum* (2×10^6 cfu/g) and *P. fluorescens* (2×10^8 cfu/g) will be enriched in vermicompost separately and in combination as per the treatments. The formulation (2.5 kg) will be mixed with 100 kg vemicompost for enrichment and applied in 1 ha area. The enriched biopesticide will be applied based on plot size of each treatment.

Root dip treatment (RD)

The seedling roots will be dipped in the suspension of Th (10 g/litre), Pf (10 g/litre), and Th + Pf (5 g each/litre) for 30 min just before transplanting in the field.

Foliar spray (FS)

Th (5 g/litre), Pf (5 g/litre), Th + Pf (each with 5 g/litre) and Azoxystrobin 23% SC (1.0 ml/litre) will be applied as foliar sprays.

Observations

1. Germination%
2. Per cent disease intensity (PDI)
3. Ancillary observations on plant growth parameters (Plant height, Number of branches/ plant, Fruit weight/ plant)
4. Marketable fruit yield (kg/plot)
5. C:B ratio

Note:

The percent disease intensity (PDI) will be calculated by using 0–5 disease rating scale given by Pandey et al. (2002)

$$PDI = \frac{\text{Sum of all disease ratings}}{\text{Total no. of observations (sample)} \times 5} \times 100$$

Scale	Description
0	No symptoms on the leaf
1	0-5 percent leaf area infected and covered by spot
2	6-20 percent leaf area infected and covered by spot, some spots on petiole
3	21-40 percent leaf area infected and covered by spot, spots also seen on petiole, branches
4	41-70 percent leaf area infected and covered by spot, spots also seen on petiole, branches, stem
5	>71 percent leaf area infected and covered by spot, spots also seen on petiole, branch,

	stem, fruits

36.9 Field efficacy of different combinations of *Trichoderma harzianum* and *Pseudomonas fluorescens* against the early blight of potato (AAU-Anand)

Year of commencement	**:**	2020-21 *Rabi*
Location	**:**	Agronomy Farm, AAU, Anand
Crop & Variety	**:**	Potato, Kufri Badshah
Treatments	**:**	08
Replications	**:**	03
Design	**:**	Randomized Block Design
Spacing	**:**	45 x 15 cm
Plot size	**:**	Gross : 2.70 x 3.00 m Net : 1.80 x 2.70 m

Treatments:

1. Th (SA + ST + FS)
2. Pf (SA + ST + FS)
3. Th + Pf (SA + ST + FS)
4. Th (SA + ST) + Kresoxim-methyl 44.3% SC (FS)
5. Pf (SA + ST) + Kresoxim-methyl 44.3% SC (FS)
6. Th+ Pf (SA + ST) + Kresoxim-methyl 44.3% SC (FS)
7. Kresoxim-methyl 44.3% SC (ST) + Kresoxim-methyl 44.3% SC (FS)
8. Untreated control

Note:

Th = *Trichoderma harzianum* (AAUBC- Th1)
Pf = *Pseudomonas fluorescence* (NBAIR strain PfDWD)
SA = Soil application, ST = Seed treatment FS = Foliar spray

Methodology:

Soil application (SA)

Standard protocol will be followed for enriching biopesticides. *T. harzianum* (2×10^6 cfu/g) and *P. fluorescens* (2×10^8 cfu/g) will be enriched in vermicompost separately and in combination as per the treatments. The formulation (2.5 kg) will be mixed with 100 kg vemicompost for enrichment and applied in 1 ha area. The enriched biopesticide will be applied based on plot size of each treatment.

Seed treatment (ST)

The seeds will be dipped in the suspension of Th (10 g/litre), Pf (10 g/litre), and Th + Pf (5 g each/litre) for 30 min just before planting in the field.

Foliar spray (FS)

Th (5 g/litre), Pf (5 g/litre), Th + Pf (each with 5 g/litre) and Azoxystrobin 23% SC (1.0 ml/litre) will be applied as foliar sprays.

Observations

1. Germination%
2. Per cent disease intensity (PDI)
3. Ancillary observations on plant growth parameters (Plant height, Number of branches/ plant, Number of tubers/ plant, Tuber weight/ plant)
4. Marketable tuber yield (kg/ plot)
5. C:B ratio

Note:

The percent disease intensity (PDI) for early blight of potato crop will be recorded based on the leaf parts affected at 0–5 scale (Granovsky and Peterson, 1954)

0 = Disease free
1 = up to 10%
2 = 11–25%
3 = 26–50%
4 = 51–75%
5 = > 75% leaf area affected

$$PDI = \frac{\text{Sum of all disease ratings}}{\text{Total no. of observations (sample)} \times 5} \times 100$$

36.10 Evaluation of microbial antagonist for the management of ginger rot disease AAU, Jorhat

Target pests: *Ralstonia solanacearum* and *Pythium aphanidermatum*

Location: Dergaon, Golaghat (farmer's field).

Season: *Kharif*, 2020

Variety: Locally recommended variety

Area cover: 1ha (to be covered)

Treatment: 7

Replication: 3

T_1: Seed treatment with *Pseudomonas fluorescens* (AAU Culture)@ $1x10^8$ cfu/ml (5g/ltr)

T_2: T_1 + spraying of *Trichoderma asperellum* (AAU Culture)@ $1x10^8$ cfu/ml (5g/ltr)

T_3: T_1 + spraying of *Trichoderma harzianum* (AAU Culture)@ $1x10^8$ cfu/ml (5g/ltr)

T_4: T_1 + spraying of *Trichoderma asperellum* (Commercial formulation)@ $1x10^8$ cfu/ml (5g/ltr)

T_5: T_1 + spraying of *Trichoderma harzianum* (Commercial formulation)@ $1x10^8$ cfu/ml (5g/ltr)

T_6: Soil drenching of Copper hydroxide 2g/L @6 litres/m2

T_7: Untreated check

Mode of application: Seed treatment with biopesticide followed by foliar application at @15, 30, 45, 60 days after sowing

Observations to be recorded:

- Record of infected plant during vegetative stage
- Estimation of disease intensity
- Record of infected ginger after harvest
- Yield data.

Note: Experiment will be conducted with collaboration Department of Plant Pathology, AAU, Jorhat

36.11 Ecofriendly management of stem rot, *Macrophomina phaseolina* in sesame using biocontrol agents (ANGRAU, Anakapalle)

Name of the PI & Co PI	:	Dr.M.Visalakshi, Principal Scientist (Entomology) Mrs. Shaik Haseena, Scientist (Plant pathology)
Location	:	Agricultural Research Station, Yelamanchili , Visakhapatnam district
Plot size	:	6x4.5 m
Replications	:	03
Design	:	RBD

Date of sowing	:	Kharif season, 2020
Treatments	:	T1: NBAIR - *Trichoderma asperillum* seed treatment @ 10 g/kg seed + *Trichoderma asperillum* soil drenching @ 5kg/ha T2: NBAIR - *Pseudomonas fluorescence* seed treatment @ 10 g/kg seed + *Pseudomonas fluorescence* soil drenching @ 5kg/ha T3: NBAIR - *Trichoderma asperillum* seed treatment @ 10g/kg seed + *Pseudomonas fluorescence* soil drenching @ 5kg/ha T4: NBAIR - *Pseudomonas fluorescence* seed treatment @10 g/kg seed+ *Trichoderma asperillum* soil drenching @ 5kg/ha T5: NBAIR -*Trichoderma harzianum* seed treatment @ 10g/kg seed+ *Trichoderma harzianum* soil drenching @ 5kg/ha T6: NBAIR - *Trichoderma harzianum* seed treatment @ 10g/kg seed T7: NBAIR - *Trichoderma asperillum* soil drenching @ 5kg/ha T8: NBAIR - *Pseudomonas fluorescence* soil drenching @ 5kg/ha T9: Carbendazim seed treatment @1g/kg seed + carbendazim soil drenching @ 5kg/ha T10: Untreated Control Soil drenching at 30 and 60 days after sowing
Observations	:	Germination (%) Root and shoot length (cm) Stem rot incidence (%) at 30 and 60 days after sowing Grain yield (kg/ha)

36.12 Development of IPM module for the management of rhizome rot (Fungi and bacteria) and shoot borer in Ginger (CAU, Pasighat)

T1: Microbials based pest management: Trichoderma seed treatment (0.1%), Trichoderma soil application (5%), *Pseudomonas putida* soil application (5%) and *Beauveria bassiana* shoot borer management (0.05%)

T2: Plant products based pest management: Biofumigation with cabbage/mustard crop residues, Neem cake (0.8t/acre), mulching with *Vitex negundo* green leaves (4t/acre) and Neem oil (0.5%) for shoot borer management

T3: Cow byproducts based pest management: Soil application of Ghanajeevamruta (400 kg/acre), Seed treatment with Beejamruta, Soil drenching with Jeevamruta (200L/acre), Agniastra (5%) for shoot borer management

T4: Conventional pest management: Soil solarization, hot water treatment, Mancozeb rhizome treatment @240g/acre and soil drenching @0.3%, and Dimethoate @0.02% for shoot borer management

T5: Untreated control

Season: Summer

Replications: 04

Design: RBD

36.13 Management of *Phytophthora* disease in black pepper nursery using biocontrol agents (KAU, Thrissur)

Design: CRD Variety: Panniyur -1
Treatments: 7 Replications: 3

T1	*Trichoderma viride* (KAU strain) @ 1g/ kg of potting mixture
T2	Soil drenching of PGPR consortium (KAU) @ 2 %
T3	Soil drenching at the time of planting + Foliar application of *Pseudomonas fluorescens* (KAU strain) at 15 days interval (2%)
T4	*Trichoderma viride* @ 1g/ kg of potting mixture + Foliar application of *Pseudomonas fluorescens* (KAU strain) at 15 days interval (2%)
T5	Soil drenching of PGPR consortium at the time of planting + Foliar application of PGPR at 15 days interval (2%)
T6	Soil application of COC at the time of planting + Foliar application at 15 days interval (0.2%)
T7	Untreated control

Observations: Per cent survival of plants

36.14 Management of *Fusarium* wilt in vegetable cowpea using microbial agents (KAU-Vellayani)

Crop	:	Cowpea
Disease	:	Fusarium wilt
Treatments	:	T1 - Seed treatment with *P.flourescence* (KAU srain)@ 10g /kg + Soil drenching @ fortnightly intervals + foliar drenching @fortnightly intervals T2 – Basal application of *Trichoderma sp.* KAU starin (multiplied in cowdung + neemcake 9:1 ratio) @ 250 g /plant + monthy soil application T3 – TI + T2 T4 – IDM – T3 + need based application of copper oxy chloride @ 2g/L foliar spray / 4g/ L soil drenching T5 – Chemical fungicide Carbendazim @ 2g/L –need based T6 - Untreated check

No. of Replications	:	3
Unit plot size	:	10 x 10 m^2
Area	:	2400 m^2(0.24 ha)

No. of sprayings: 5 No.of soil drenching - 3 No. of basal applications – 3

Observations to be recorded

1. No.of plants infested with Fusarium wilt
2. Degree of infection (low, moderate, severe)
3. Incidence of other diseases and pests
4. Yield per plot

36.15 Screening of promising isolates antagonistic fungi and bacteria against bacterial wilt of Tomato (*Ralstonia solanacearum*) (KAU- Kumarakom)

Sl. No.	Treatments	Dose (ml/L)

Variety	:	Akshay
Plot size	:	4x5m=20 m^2
Replications	:	Seven
Design	:	RBD
Treatments	:	1. NBAIR-PFDWD isolate of *Pseudomonas fluorescens* 2. KAU strain of *P. fluorescens* 3. Soil drenching of Copper hydroxide 2g/L @6 litres/m^2 4. Control (Untreated)
Method of application of bioagents	:	Talc based formulations of the bioagents 2×10^8 c.f.u./g will be applied as seed treatment @5g/kg of seed, seedling dip (2%) at the time of transplanting and soil drenching (2%) at 30 DAP.
Observations	:	● Per cent wilt incidence at 15,30,45,60,75 DAP ● Growth promotion characters *viz*., plant height (cm), biomass (g) ● Yield (kg/ha)

36.16 Management of Powdery mildew (*Uncinula necator*) of Grape by using Biocontrol agents (MPKV)

Design of Experiment: RBD, Replication Three with 4 plants in each replications, Treatment 8, Variety: Thompson seedless, Spacing: 3.0 m x 1.5 m

Methodology and Observations:

T_1	*Trichoderma harzianum*	5 g or lml/L
T_2	*Bacillus subtilis*	5 ml/L
T_3	*Ampelomyces quisqualis*	1.0 g or lml /L
T_4	*Trichoderma harzianum + Bacillus subtilis*	5 g or lml/L + 5 lml L
T_5	*Trichoderma harzianum + Ampelomyces quisqualis*	5 g or lml/L + 1.0 g or lml /L
T_6	*Bacillus subtilis + Ampelomyces quisqualis*	5 ml/L+ 1.0 g or lml /L
T_7	Sulphur	2.0 g/L
T_8	Untreated control	-

Observations recorded:

a. Percent disease index on leaves and berries 15 days interval
b. Per cent disease over control
c. Yield

Method of recording observation:

All the treatments were applied into three replications at the appearance of disease symptoms. All the agronomical practices were followed as and when required. Four fungicidal sprays were given at an interval of 15-days, by using knapsack sprayer with hollow cone nozzle with water 1000 l/ha. For recording observations on disease incidence, 10 canes per vine were selected and on each cane 10 leaves starting from the bottom were observed in respect of disease on leaves by following 0-4 scale as given below:

Scale	Incidence of disease (%)
0	No disease
1	1-25
2	26-49
3	50-75
4	More than 75

PDI was calculated as follows with help of 0-4 scale:

Percent disease index (PDI) =

$$\frac{\text{Sum of numerical rating}}{\text{.}} \times \frac{100}{\text{.}}$$

Total No. of leaves observed Maxi Grade(s) (4)

Disease incidence was monitored regularly 15 days after each spray by using the above mentioned scale and finally means of observations on PDI (Percent Disease Index) were statistically analysed.

36.17 Screening of promising isolates of antagonistic fungi and bacteria against bacterial wilt of Tomato (*Ralstonia solanacearum*) under field conditions (ICAR-NBAIR)

Variety	:	Akshay
Plot size	:	4x5m=20 m^2
Replications	:	5
Design	:	RBD
Treatments	:	1. NBAIR-PFDWD strain of *Pseudomonas fluorescens* (2%) 2. NBAII63 strain of *Bacillus megaterium* (1%) 3. NBAIR-TATP isolate of *Trichoderma asperellum* (2%) 4. Soil drenching of Copper hydroxide 2g/L @ 6 litres/m^2 5. Control (Untreated)
Method of application of bioagents	:	Talc based formulations of the bioagents 2×10^8 c.f.u./g will be applied as seed treatment, seedling dip at the time of transplanting and foliar spray (2%) at 20 DAP, 35 DAP, 50 DAP and soil drenching (2%) at 30 DAP, 45 DAP, 60 DAP
Observations	:	• Per cent wilt incidence at 15, 30, 45, 60, 75 DAP • Growth promotion characters *viz*., plant height (cm), number and weight of fruits/plant (gm) • Yield (kg/ha)

36.18 Evaluation of microbial antagonists for the management of diseases (Powdery mildew/Ascochyta blight/Rust) in pea (PAU-Ludhiana)

Variety; Recommended variety

Treatments

1 *Pseudomonas flouresecence* (NBAIR formulation)
2. *Trichoderma harzanium* (NBAIR formulation)
3. *Pseudomonas flouresecence* (local if available)
4. *Trichoderma asperellum* (Commercial formulation)
5. *Pseudomonas fluorescence* (Commercial formulation)
6. Chemical control (Seed Treatment with 3g /kg of seed and spray the crop thrice with 200g Sulfex and 400g Indofil M45 per acre at an interval of 10 days.)
7. Untreated control

Replications: Four

Mode of application Seed Treatment: @ 10g/kg,

Soil Treatment: mix formulation @1 kg with 100kg FYM per acre and broadcast uniformly in one a acre of land

Foliar spray: Three foliar sprays @ 10g/litre at 10 days interval

Observation to be recorded: 1) Disease incidence to be recorded per square meter per replication

2) Disease severity

3) Yield

36.19 Evaluation of microbial antagonists for the management of foot rot of kinnow caused by *Phytophthora* spp. (2nd year) (PAU-Ludhiana)

1. *Pseudomonas fluorescence* (NBAII- Pf DWD) (Talc formulation)
2. *Pseudomonas fluorescence* Commercial (Talc formulation)
3. *Trichoderm aviride* Commercial (Talc formulation)
4. *Trichoderma harzianum* Commercial (Liquid formulation)
5. Chemical control (Curzate M-8 @ 25g/10 litre water/ tree)
6. Untreated control.

Replication : Four with three trees per replica

Soil application @ 2.5 kg completely dried FYM enriched with 100 g of formulation per tree

Observation: Number of foot rot tree and yield parameters

36.20 Evaluation of effective fungal and bacterial antagonists, fungicide and their integration against sugarcane red rot (ICAR-SBI, Coimbatore)

Variety	:	CoC 671
Plot size	:	4 x 6m=24 m^2
Replications	:	4
Design	:	RBD
Treatments	:	1. SBI strain of *Trichoderma harzianum* (1%) 2. SBI strain of *Paenibacillus alvei* (1%) 3. *Trichoderma harzianum* (0.5%) + *Paenibacillus alvei* (0.5%) 4. Thiophanate methyl/ Azole (0.05%) + *Paenibacillus alvei* (0.5%) 5. Thiophanate methyl/ Azole (0.1%) 6. Inoculated control (Untreated) 7. Uninoculated control (Untreated)
Method of treatment	:	• Liquid formulations of the bioagents 1-2×10^8 c.f.u./ml and fungicide will be applied as sett treatment using Sett Treatment Device developed at Plant Pathology Lab, Sugarcane Breeding Institute

		• Secondary application will be done on 60 and 120 DAP with their respective bioagents and fungicide invidually/ alternatively/ in combination.
Observations	:	• Per cent germination (30DAP) • Per cent Disease incidence (45DAP, 60DAP, 90DAP) • No. of healthy shoots/ stalks (120DAP, 180DAP, 240DAP) • Yield (kg/ha)
Location	:	Endemic fields in sugar factory areas

36.21 Management of *Fusarium* wilt/ root rot of pea through biological control agents (YSPUHF, Solan)

Variety	:	Pb-89 or other university recommended variety
Plot size	:	3 × 2 m
Layout	:	Randomized Block Design.
Treatments	:	1. Seed treatment with *Pseudomonas flouresecence* @ 10g/kg seed 2. Seed treatment with *Trichoderma asperellum* @10g/kg seed 3. Seed treatment with *Pseudomonas flouresecence* @ 10g/kg seed + soil application of *Trichoderma asperellum* after mixing with FYM (10g/Kg FYM) @40g/m^2 4. Seed treatment with *Trichoderma asperellum* @10g/kg seed+ soil application of *Trichoderma asperellum* after mixing with FYM (10g/Kg FYM) @40g/m^2 5. Seed treatment with *Pseudomonas flouresecence* @ 10g/kg seed + soil application of *Pseudomonas flouresecence* after mixing with FYM (10g/Kg FYM) @40g/m^2 6. Seed treatment (2g/ kg of seed) + soil drenching (2g/ L) with carbendazim Control (no treatment)
Replications	:	Three
Observations	:	i) Disease incidence (%) ii) Pod yield (kg/plot) iii) C:B ratio

36.22 Management of major diseases of rice with *Bacillus subtilis* (TNAU strain) (TNAU-Coimbatore)

Treatments

T1 – Soil application of *Bacillus subtilis* (TNAU strain) @2.5Kg/ha
T2 – Seed treatment of *Bacillus subtilis* (TNAU strain) @10gm/Kg of seed
T3 - Seedling dip of *Bacillus subtilis* (TNAU strain) @2.5Kg/seedlings required for one ha
T4 – Foliar spraying of *Bacillus subtilis* (TNAU strain) @20gm/lit on 45th and 60th days after transplanting
T5 – T1+T2+T3+T4
T6 – Azoxystrobin @0.1% (1ml/lit.)
T7 – Control

Replications -3
TNAU strain of *Bacillus subtilis* available in Department of Plant Pathology, TNAU, Coimbatore will be used in the field trial

Observations to be recorded:
Severities (PDI) of the following disease of rice

i. Blast
ii. Sheath blight
iii. Brown spot
iv. Sheath rot
v. Grain discoloration

36.23 Experiment No. 14 Bio-intensive management of wilt and dry root rot complex in chickpea (UAS-Raichur)

Treatment Details		**T1** : Seed treatment with local strain *Trichoderma viride* (10 g/kg) + soil application of FYM (250 kg/ha) enriched with local strain *T. viride* (2.5 kg)
		T2: Seed treatment with talc based formulation of local strain *Pseudomonas fluorescence* (10 g/kg of seeds) + soil application of FYM (250 kg /ha) enriched with local strain *P. fluorescens* (2.5 kg/ha)
		T3: Seed treatment with *P. fluorescens (*NBAIR-PFDWD) (10 g/kg) + soil application of FYM (250 kg/ha) enriched with *P. fluorescens (*NBAIR-PFDWD) (2.5 kg)

		T4: Carbendazim @ 1gm/lit
		T5: Control
Replications		4
Methodology		Per cent disease incidence and grain yield will be recorded and analysed statistically.

36.24 Experiment No. 15 Bio-intensive management of chilli wilt and powdery mildew (UAS-Raichur)

Crop	:	Chilli
Treatment Details		**T1** : Seed treatment with local strain *Trichoderma viride* (10 g/kg) + soil application of FYM (250 kg/ha) enriched with local strain *T. viride* (2.5 kg)
		T2: Seed treatment with talc based formulation of local strain *Pseudomonas fluorescence* (10 g/kg of seeds) + soil application of FYM (250 kg /ha) enriched with local strain *P. fluorescens* (2.5 kg/ha)
		T3: Seed treatment with *P. fluorescens (*NBAIR-PFDWD) (10 g/kg) + soil application of FYM (250 kg/ha) enriched with *P. fluorescens (*NBAIR-PFDWD) (2.5 kg)
		T4: Carbendazim @ 1gm/lit
		T5: Control
Replications		4
Methodology		Per cent disease incidence will be recorded and dry chilli yield will be recorded.

36.25 Field evaluation of ICAR-NBAIR antagonistic organisms against Maize Turcicum leaf blight (*Exserohilum turcicum*) (SKUAST-Jammu)

Plot size	:	1 x 5 cents for each treatment, 1 cent = 8x5 m^2
Replications	:	04

Design	:	RBD
Date of sowing	:	As per the package of practice
Variety		High yielding variety susceptible to Turcicum leaf blight
Treatments	:	1. NBAIR-PFDWD strain *Pseudomonas fluorescens* 2. BC1 strain *Trichoderma asperellum* (Local strain, Jammu) 3. BC2 strain *Pseudomonas fluorescens* (Local strain, Jammu) 4. Recommended fungicide application 5. Control (Untreated)
Observations	:	**Turcicum leaf blight** ● Scoring and calculation of Percent disease index (for maize turcicum leaf blight) at 3 and 7 Days After Spray ● Growth promotion character viz., plant height (cm), biomass (gm) ● Yield (q/ha)

Note: Four rounds of foliar sprays of talc and liquid formulations antagonistic organisms at the 10^8 cfu/ml has to be given at 14 days interval starting from 25 Days after Sowing.

36.26 Field evaluation of ICAR-NBAIR antagonistic organisms against Wheat Yellow rust (*Puccinia striiformis* f. sp. *tritici*) (SKUAST-Jammu)

Plot size	:	8x5m=40 m^2
Replications	:	04
Design	:	RBD
Date of sowing	:	As per the package of practice
Treatments	:	1. NBAIR-PFDWD strain *Pseudomonas fluorescens* 2. BC1 strain *Trichoderma asperellum* (Local strain, Jammu) 3. BC2 strain *Pseudomonas fluorescens* (Local strain, Jammu) 4. Recommended fungicide application 5. Control (Untreated)
Observations	:	**Wheat Yellow Rust** ● Scoring and calculation of Percent disease index (for wheat yellow rust) at 3 and 7 Days After Spray ● Growth promotion character viz., plant height (cm), biomass (gm) ● Yield (q/ha)

Note: Four rounds of foliar sprays of talc and liquid formulations antagonistic organisms at the 10^8 cfu/ml has to be given at 14 days interval starting from 75 Days after Sowing.

36.27 Field evaluation of ICAR-NBAIR antagonistic organisms against Chick pea Fusarium wilt (*Fusarium oxysporum f. sp. ciceris*) (SKUAST-Jammu)

Plot size	:	1 x 5 cents for each treatment, 1 cent = 8x5 m^2
Replications	:	04
Design	:	RBD

Date of sowing	:	As per the package of practice
Variety		High yielding variety susceptible to pod borer
Treatments	:	1. NBAIR-PFDWD strain *Pseudomonas fluorescens* 2. BC1 strain *Trichoderma asperellum* (Local strain, Jammu) 3. BC2 strain *Pseudomonas fluorescens* (Local strain, Jammu) 4. Recommended fungicide application 5. Control (Untreated)
Observations	:	**Chick pea Fusarium wilt** ● Scoring and calculation of Percent disease index (for Chick pea Fusarium wilt) at 3 and 7 Days After Spray ● Growth promotion character viz., plant height (cm), biomass (gm) ● Yield (q/ha)

Note: Four rounds of foliar sprays of talc and liquid formulations antagonistic organisms at the 10^8 cfu/ml has to be given at 14 days interval starting from 75 Days after Sowing.

36.28 Field evaluation of ICAR-NBAIR antagonistic organisms against Mustard White rust (*Albugo candida*) (SKUAST-Jammu)

Plot size	:	8x5m=40 m^2
Replications	:	04
Design	:	RBD
Date of sowing	:	As per the package of practice
Treatments	:	1. NBAIR-PFDWD strain *Pseudomonas fluorescens* 2. BC1 strain *Trichoderma asperellum* (Local strain, Jammu) 3. BC2 strain *Pseudomonas fluorescens* (Local strain, Jammu) 4. Recommended fungicide application 5. Control (Untreated)
Observations	:	**White rust** ● Scoring and calculation of Percent disease index (for Mustard White rust) at 3 and 7 Days After Spray ● Growth promotion character viz., plant height (cm), biomass (gm) ● Yield (q/ha)

Note: Four rounds of foliar sprays of talc and liquid formulations of antagonistic organisms at the 10^8 cfu/ml has to be given at 14 days interval starting from 75 Days after Sowing.

36.29 Field evaluation of ICAR-NBAIR entomopathogenic strains against field Pea Rust (*Uromyces viciae-fabae*) (SKUAST-Jammu)

Plot size	:	8x5m=40 m^2
Replications	:	07

Design	:	RBD
Date of sowing	:	As per the package of practice
Treatments	:	1. NBAIR-PFDWD isolate of *Pseudomonas fluorescens* 2. Recommended fungicide application 3. Control (Untreated)
Observations	:	**Field Pea Rust** ● Scoring and calculation of Percent disease index (for Field pea rust) at 3 and 7 Days After Spray ● Growth promotion character viz., plant height (cm), biomass (gm) ● Yield (q/ha)

Note: Four rounds of foliar sprays of talc and liquid formulations of entomopathogenic bacteria at the **Three spore dosages of 10^6, 10^8, 10^{10} cfu/ml** has to be given at 14 days interval starting from 75 Days after Sowing.

37. Frontline Demonstrations (CAU-Pasighat)

Location: East Siang district, Arunachal Pradesh

Area to be covered: 2 hectares

No. of demonstrations: 4 (one each on Maize, Mustard, Cabbage and Tomato)

Technology to be demonstrated:

1. Biointensive pest management in Cabbage
2. Biocontrol based pest management in Tomato
3. Management of major pest in Maize by using effective bio-control agents
4. Biological control of insect pest of Mustard

Details of Technology:

1. **Biointensive pest management in Cabbage**

Raising of mustard as trap crop, 5 releases of *Trichogramma chilonis*@ 100,000/release against *Plutella xylostella*, at 30 days after transplanting, spraying of *L. lecanii*-1×108 spore/ ml @ 5ml/lt against cabbage aphid and three sprays NBAII BtG4 2% against lepidopteron pests or *Beauveria bassiana*/*Metarhizium anisopliae* @0.05% and alternative sprays with Neem oil (1500 ppm) @2 ml/lt water based on availability of bioagents.

2. **Biocontrol based pest management in Tomato**

Seed treatment with *Trichoderma harzianum@* 10g/kg of seeds; raising marigold as trap crop; inoculative sixrelease of *T. pretiosum@* 50,000 / release, alternative application of *Beauveria bassiana*/*Metarhizium anisopliae* @0.05% or NBAII BtG4 2% against fruit borers and spraying of azadirachtin 1500 ppm @ 2 ml/lit; and *L. lecanii* (NBAIR) 1×108 spores/ g @ 5g/lit for sucking pests.

3. **Management of major pest in Maize by using effective bio-control agents**

Spraying of *Beauveria bassiana*/*Metarhizium anisopliae* @0.05%, Bt 2%, Neem oil 1500 ppm @2 ml/lt water and *Steinerema carpocapsae*/*Heterorhabditis bacteriophora* NBAIR strain on alternate basis for the management of fall army worm in maize.

4. **Biological control of insect pest of Mustard**

Spraying of Neem oil 1500 ppm @ 2 ml/lit; and *L. lecanii* (NBAIR) 1×108 spores/ g @ 5g/lit against aphids and application of *Beauveria bassiana/Metarhizium anisopliae* @0.05% and Bt 2% for defoliators.

Source of Technology:

1. Biointensive pest management in Cabbage: NBAIR Bengaluru, TNAU Coimbatore and AAU Jorhat

2. Biocontrol based pest management in Tomato: NBAIR Bengaluru and IIVR Varanasi

3. Management of major pest in Maize by using effective biocontrol agents: NBAIR Bengaluru

4. Biological control of insect pest of Mustard: NBAIR Bengaluru

Observations to be recorded:

1. Survey and surveillance of major and minor pest complex
2. Seasonal abundance of natural enemies
3. Percent incidence of major crop pests
4. Percent damage by major crop pests
5. Crop yield
6. Cost benefit ratio
7. Farmers feed back

Expected outcome

Front line demonstrations on bio-intensive pest management in major crops will helps the farmers to understand about the importance of biological control of crop pests and that knowledge is much needed by the farmers for the eco-friendly pest management and to produce pesticide residue free food from potential North eastern region of India. Through farmers capacity building training programmes they will gain the first hand knowledge on how to differentiate between crop pests and natural enemies, also mass production, field release, conservation and encouragement of the latter in different agricultural and horticultural crop ecosystems. By adopting the demonstrated FLD's the cost of cultivation reduces and thereby farmers' income and livelihood status could be improved. Besides this, the technology may be transferred to the other farmers directly and also helps in increasing the awareness among the farmers.