

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

**Technical Programme
(2018-19 & 2019-20)**

Compiled and Edited by

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**ICAR-NATIONAL BUREAU OF AGRICULTURAL INSECT RESOURCES
BANGALORE 560024, KARNATAKA**

TECHNICAL PROGRAMME FOR 2018-19 & 2019-20

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 AICRP center.
Centre		Programme
NBAIR, KAU, CPCRI, OUAT, YSRHU, TNAU		<ul style="list-style-type: none"> Survey, surveillance and monitoring of rugose whitefly and their natural enemies on coconut
MPKV, PJTSAU, AAU-A, TNAU, IIVR		<ul style="list-style-type: none"> Survey and surveillance of natural enemies of pinworm, <i>Tuta absoluta</i> on tomato
AAU, Anand, MPKV and TNAU		<ul style="list-style-type: none"> Monitoring and record of incidence of papaya mealy bug and its natural enemies on papaya and other alternate hosts
AAU-A, MPKV, TNAU		<ul style="list-style-type: none"> Survey, surveillance and collection of natural enemies including spiders in different agro-ecological zones and on different crops.
AAU-J		<ul style="list-style-type: none"> Survey, surveillance and quantification of natural enemy complex including spiders in <i>kharif</i> and <i>rabi</i> rice and vegetables of Jorhat district
YSPUHF, Solan		<ul style="list-style-type: none"> Biodiversity of biocontrol agents from various agro ecological zones of Himachal Pradesh on fruit and vegetable crops.
PJTSAU, Hyderabad UAS (R)		<ul style="list-style-type: none"> Monitoring of sucking pest complex, Pink Boll Worm (PBW) and their natural enemies in cotton belt of Telangana state
PAU, Ludhiana		<ul style="list-style-type: none"> Mapping of microbials including EPNs from various agro-ecological zones of Punjab Diversity of insect pests and natural enemies on vegetables under poly house conditions in different agro ecological zones of Punjab Monitoring of whitefly and its natural enemies in cotton belt of Punjab
SKUAST, Srinagar		<ul style="list-style-type: none"> Biodiversity of natural enemies of pests of apple, apricot, plum, pear, peach, cherry walnut and almonds. Monitoring of apple codling moth from various agro-ecological zones of Kashmir to see its spread. Survey for the natural enemy complex associated with insect pests of vegetable, cereals and oil seed Survey of the insect pest complex of apricot in Ladakh and its ecofriendly management
TNAU, MPKV		<ul style="list-style-type: none"> Monitoring of sugarcane woolly aphid incidence and impact assessment of natural enemies on its bio suppression. Monitoring the diversity and outbreaks for invasive mealybug and other sap sucking pests on cotton.
KAU,OUAT, IIRR, AAU-A, AAU-J, PAU, UAS(R)	:	<ul style="list-style-type: none"> Seasonal abundance of spiders in rice ecosystem by general collection, pitfall trap and sweep net method (specimens to be sent to NBAIR for identification)
IGKV, Raipur		<ul style="list-style-type: none"> Biodiversity of various bio-agents with particular reference to

		<p><i>Trichogramma</i> spp. and <i>Bracon</i> spp.</p> <ul style="list-style-type: none"> • Biodiversity of coccinellid beetles in Chhattisgarh plains • Biodiversity of entomopathogenic nematodes in few districts of Chhattisgarh plains
MPUAT, Udaipur	:	<ul style="list-style-type: none"> • Biodiversity of natural enemies of pests of chickpea, tomato and maize.
IIHR, Bengaluru		<ul style="list-style-type: none"> • Survey, surveillance and monitoring of mealy bugs and their natural enemies on fruit crops
CISH, Lucknow		<ul style="list-style-type: none"> • Survey, surveillance and collection of natural enemies of major pests infesting mango
UBKV Pundibari		<ul style="list-style-type: none"> • Survey, surveillance and collection of natural enemies of major pests infesting tea, mustard and mungbean
Nagaland University, Medziphema		<ul style="list-style-type: none"> • Biodiversity of rice pests and their natural enemies.
NIPHM, Hyderabad		<ul style="list-style-type: none"> • Biodiversity of natural enemies of maize ecosystem
YSRHU, Tirupati		<ul style="list-style-type: none"> • Exploration and Collection of natural enemies associated with Citrus Psylla
Desirable important information		<p>Following Bioagents shall be collected as per the protocol given in earlier proceeding (<i>Ref. of Tech. Doc. No. 65</i>), and sent for identification to the NBAIR, Bangalore.</p> <p>The information should be collected on all aspects as given below</p> <ul style="list-style-type: none"> • Name of insect / microbial agent (including scientific name) • Geographical details • Location- village, taluka, district and agro-climatic zone • Date of survey • Host crop/ sole crop/ intercrop, etc. • Stage of the crop • Stage of the insect pest • Weather parameters (max. and min. temperature, rainfall, RH, No. of rainy days) • Pesticide usage pattern

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	:	1. Specific site & date visited-District, Mandal (Taluk),

information	<p>village (Give specific GPS coordinates, if available).</p> <p>2. Area covered in ha</p> <p>3. No. of crops specifically examined and Variety grown</p> <p>4. Major insects and disease (s) noticed and natural enemy occurrence</p> <p>5. Severity of damage (low, moderate, severe)</p> <p>6. Age of crop in severely damaged field(s) (in DAT/DAS and years for field and tree/ horticultural crops, respectively)</p> <p>7. Previous crop grown in the area</p> <p>8. Occurrence of the pest in weeds in surrounding area of the crop</p> <p>9. Plant protection measures adopted by the farmer prior to the visit</p> <p>10. Advice given to the farmer and follow up report if any</p>
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Crop Pest Outbreak Report Proforma

Name of Centre:

Date visited:

1.	Site details	Village(s) with GPS Co-ordinates (if available): 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, Nil report should be sent.**

III. BASIC WORK

New Experiment

(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

1. NIPHM-White Medium
2. 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
- LC₅₀ and LT₅₀

CROP WISE PROGRAMME

CEREALS

1. RICE

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

Variety	:	RGL 2537/BPT-5204
Layout	:	Randomized Block Design.
Plot size	:	1 x 5 cents for each treatment, 1 cent = 8x5 m
Treatments	:	Seven T1: <i>Steinernema carpocapsae</i> (NBAIR strain) @ 1.2x10 ⁹ IJs ha ⁻¹ T2: <i>Heterorhabditis indica</i> (NBAIR strain) @ 1.2x10 ⁹ IJs ha ⁻¹ T3: <i>Bt</i> (NBAIR strain) 2g/l twice at 10 and 25 DAT T4: <i>Beauveria bassiana</i> (NBAIR strain) @1x10 ⁸ spores/g-5g/l T5: <i>Metarhizium anisopliae</i> (NBAIR strain) @1X10 ⁸ spores/g-5g/l T6: Flubendiamide 25g.a.i.ha ⁻¹ T7: Untreated control
Replications	:	Three
Observations	:	<ul style="list-style-type: none"> • Mean No. of dead heart/white ear/sq. m. • Mean No. of rolled leaves per sq. m. • Yield kg/plot

1.2 Management of plant hoppers through BIPM approach in organic basmati rice (PAU) / rice (ANGRAU, PDKV)

Variety	:	Any recommended variety/For ANGRAU RGL 2537/BPT-5204
Layout	:	Randomized Block Design
Plot size	:	1x5 cents for each treatment, 1 cent = 8x5 m
Treatments	:	T1: BIPM <ul style="list-style-type: none"> • Recommended variety • Optimum time of sowing/transplanting • Green manuring or FYM • Optimum plant spacing • Alleyways of 30 cm after 2 m • Water management: Alternate wetting and drying • Increasing floral diversity through weeds, crops and flowers on bunds • Erection of straw bundles (spiders) @ 20/ha • Application of Azadirachtin 50000 ppm @ 200 ml/ha • Application of <i>Metarhizium anisopliae</i> 1x10⁸ spores/g-2.5 kg/ha T2: Farmers' practice (to be specified at the time of report)

		T3: Control
	:	Seven
Observations	:	<ul style="list-style-type: none"> • The population of plant hoppers will be recorded from 50 hills selected at random at weekly interval starting from 30 days after transplanting (DAT) from each plot and in light traps. • The population of predators like mirids, spiders, coccinellids, dragonflies and damselflies will be also recorded at weekly intervals. • Grain yield will be recorded at harvest

1.3 Large scale bio-intensive pest management on rice [ANGRAU (5 ha); PAU (25 ha); KAU (100 ha); AAU-A (2 ha); AAU-J (50 ha); OUAT (5 ha); IGKV (1 ha)]

Variety	:	Region specific popular rice variety
Treatments	:	<p>T1 = BIPM Package</p> <ol style="list-style-type: none"> 1. Seed bio-priming <i>Pseudomonas fluorescens</i>@ 10g/kg of seeds./<i>T. harzianum</i>@ 15g/kg of seeds (PAU) 2. Seedling dip with <i>Trichoderma harzianum</i> 15g/litre for few minutes (PAU) 3. Seedling dip with <i>Pseudomonas fluorescens</i> 2% solution. 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 <i>Pseudomonas fluorescens</i> @ 1.5 kg/ha against foliar diseases 7. Release of <i>Trichogramma japonicum</i> @ 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 <i>Trichogramma chilonis</i> and <i>Trichogramma japonicum</i> @ 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). <p>T2 = Farmers Practice (pesticides used by farmers' in respective centres to be mentioned)</p> <p>T3 = Untreated control</p>
Replications	:	Divide each block into 5 equal sized units, each unit to be considered as replication (each unit = one replication)
Observations	:	<ul style="list-style-type: none"> • Observations on pest incidence should be recorded on 10 randomly selected hills in each replication (50 hills/ each treatment), <i>i.e.</i>, 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

	<p>plant hoppers/ hill. Record the yield from 5 places of 5x5 m area from each replication.</p> <ul style="list-style-type: none"> • Cost-benefit ratio to be worked out.
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1.4 (i) Evaluation of bio-agent consortium in glasshouse (pot experiments) and in field for crop health management in rice (GBPUAT, Pantnagar)

Variety	: Pant Dhan 4
Plot size	: 3X2
Treatment	: 12
Replication	: 03
Glasshouse experiment	: In pots (2 kg capacity) with same treatments and replications
Treatments	: <ol style="list-style-type: none"> 1. Th-17 + Psf-173 2. Th-17+ Psf-2 3. Th-17 + Th-14 4. Th-14+ Psf-2 5. Th-14+ Th-17 6. Th-17 (positive control) 7. Th-14 (positive control) 8. Psf-2 (positive control) 9. Psf-173 (positive control) 10. Th-14 + Psf-173 (Standard check) 11. Carbendazim 12. Control (Negative control)
Methodology	<p>In field:</p> <ul style="list-style-type: none"> ❖ 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). <p>Observations :</p> <ul style="list-style-type: none"> ❖ Per cent seed germination 15 days after sowing. ❖ Plant stand at 60 and 120 days after sowing. ❖ Tiller/hills. ❖ Disease incidence and disease severity of different diseases at 90-100 DAT. ❖ Yield / plot and q/ha. <p>In glasshouse :</p> <ul style="list-style-type: none"> ❖ Soil will be pre inoculated with <i>Rhizoctonia</i> (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 (1st at 30 days after sowing and 2nd and 3rd at 45 days

	interval) Observations : ❖ Per cent seed germination 10 DAS ❖ Plant stand at 30 and 45 DAS ❖ Plant Growth at 45 DAS
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1.5 Bio-intensive pest management on rice at the Instructional Research Farm of IGKV, Raipur. (IGKV, Raipur).

Variety	:	Region specific popular rice variety
Treatments	:	<p>T1 = BIPM Package</p> <ol style="list-style-type: none"> 1. Seed bio-priming <i>Pseudomonas fluorescens</i>@ 10g/kg of seeds./<i>T. harzianum</i>@ 15g/kg of seeds 2. Seedling dip with <i>Trichoderma harzianum</i> 15g/litre for few minutes 3. Seedling dip with <i>Pseudomonas fluorescens</i> 2% solution. 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 <i>Pseudomonas fluorescens</i> @ 1.5 kg/ha against foliar diseases 7. Release of <i>Trichogramma japonicum</i> @ 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. <p>T2 = Farmers Practice (pesticides used by farmers' in respective centres to be mentioned)</p> <p>T3 = Untreated control</p>
Replications	:	Divide each block into 5 equal sized units, each unit to be considered as replication (each unit = one replication)
Observations	:	<ul style="list-style-type: none"> • Observations on pest incidence should be recorded on 10 randomly selected hills in each replication (50 hills/ each treatment), <i>i.e.</i>, 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.

1.6 Improved formulation of *B. bassiana* against Rice leaf roller *Cnaphalocrocis medinalis* (KAU, Vellayani)

Crop	:	Rice
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Major pest	:	Rice leaf roller, <i>Cnaphalocrocis medinalis</i>
Treatments	:	T1: <i>Beauveria bassiana</i> (KAU isolate) T2: <i>B.bassiana</i> Bb4 (NBAIR isolate) T3: Chitin enriched formulation of <i>B.bassiana</i> (KAU) T4: Chitin enriched formulation of <i>B. bassiana</i> (NBAIR isolate) T5: Flubendiamide T6: Untreated check
No. of Replications:	:	4
Unit plot size	:	5 x 5 m ²
Observation	:	Pre and post count natural enemies

1.7 Comparative efficacy of entomopathogenic fungi against sucking pests of rice, *Leptocorisa acuta* (KAU, Vellayani)

Crop	:	Rice
Major pest	:	Rice leaf roller, <i>Cnaphalocrocis medinalis</i>
Treatments	:	T1 <i>Beauveria bassiana</i> (KAU isolate) T2 <i>B.bassiana</i> Bb4 (NBAIR isolate) T3 Chitin enriched formulation of <i>B.bassiana</i> (KAU) T4 Chitin enriched formulation of <i>B. bassiana</i> (NBAIR isolate) T5 Flubendiamide T6 Untreated check
No. of Replications	:	4
Unit plot size	:	1 x 1 m ²

1.8 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 <i>Psuedomonas flourescens</i> (@ 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.

		<p>3. <i>Trichogramma japonicum</i> 5 cc egg cards/ha, six times weekly from first week after transplanting</p> <p>4. Need based application of neem formulations/ biopesticides for other defoliating pests</p> <p>5. Foliar spray of <i>P. fluorescens</i> on the foliage @ 20 g / litre of water. Spraying can be repeated depending on the disease severity.</p>
BIPM 2		Same as above in all respects except application of <i>Trichoderma</i> IIRR strain instead of <i>Psuedomonas</i>
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

2. MAIZE

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

Variety	:	Any susceptible high yielding variety
Layout	:	Randomized Block Design.
Plot size	:	1x5 cents for each treatment, 1 cent = 8x5 m
Variety	:	Recommended variety at each place
Treatments	:	<p>Seven</p> <p>T1: <i>Beauveria bassiana</i> (NBAIR Bb45) 1x 10⁸ spores /ml)-5 ml/lt.</p> <p>T2: <i>Metarhizium anisopliae</i> (NBAIR Ma4) 1x 10⁸ spores /ml)-5 ml/lt.</p> <p>T3: Two sprays of <i>Bt</i> formulation (commercial)@ 1250 ml/ha on 10 and 17 days old crop</p> <p>T4: Two sprays of <i>Bt</i> formulation (NBAIR formulation) @ 2% on 10 and 17 days old crop</p> <p>T5: Chemical control (region specific for maize crop as per university recommended / as per label claim)</p> <p>T6: Release of <i>T. chilonis</i> 1 lakhs/ha, 2 releases at weekly interval on 10 and 17 days after germination</p> <p>T7: Control</p>
Replications	:	Three
Observations	:	<ul style="list-style-type: none"> • 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. <ul style="list-style-type: none"> • Number of exit holes/plant. • Grain Yield at harvest
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2.2 Biological control of maize stem borer, *Chilo partellus* using *Trichogramma chilonis* [ANGRAU (5 ha); PAU (120 ha); MPUAT (1 acre)]

Variety	:	Location specific recommended variety
Treatments	:	Three T1: Three releases of <i>Trichogramma chilonis</i> @ 100,000/ha/release at 15, 22 and 29 days after crop germination. (For PAU only two releases of <i>Trichogramma chilonis</i> @ 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	:	<ul style="list-style-type: none"> • Dead hearts from 20 randomly selected plants at 30 DAS • Yield (t/ha) and incremental benefit cost ratio

New experiment

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

Number of treatments : 12	Number of replications : 3
Design : RBD	Plot size: 4.5 x 4.5 m²

Treatment	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

2.4 Field trial against Fall Armyworm in maize at AICRP-BC centres

(NBAIR, IIMR, Maize Hyderabad, IIMR Millets, Hyderabad, ANGRAU, PJTSAU, AAU-Anand, OUAT, UAS Raichur, MPKV and TNAU).

Treatments= 10

1. *Trichogramma pretiosum* 1 card per acre (2 releases, first release after one week of planting & second one after one week of first release) + NBAIR *Bt25* 2% (2-3 sprays depending on pest incidence, first spray after 20-25 days of planting & then the next sprays at 10 days intervals)
2. *Trichogramma pretiosum* 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)
3. *Trichogramma pretiosum* 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)
4. *Trichogramma pretiosum* 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* NBAIR H38 (1-2 whorl sprays @ 4kg/acre, first spray after 15 days of planting & then the next sprays at 10 days interval)
5. *Trichogramma pretiosum* 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 @ 20g/liter depending on pest incidence, first spray after 20-25 days of planting & then the next sprays at 10 days intervals)

6. *Trichogramma pretiosum* 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)
7. *Trichogramma pretiosum* alone (1 card per acre (2 releases, first release after one week of planting & then second one after one week of first release)
8. Pheromones @15 traps/acre (install one week after planting and the lures to be replaced once in 25-30 days)
9. Insecticidal check (Emamectin benzoate 0.4gm/lt)
10. Untreated check (control)

Plot size 8x5m, 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. pretiosum*, formulations of microbials, pheromone traps and lures will be supplied by NBAIR.

3. SORGHUM, FINGER, BARNYARD, FOXTAIL MILLET

3.1 Studies on abundance of natural enemies of borers in Millets, (Kharif, 2018, Rabi, 2018-19) (IIMR, Hyderabad)

- Field surveys, collection of various life stages of stem borers (*Chilo partellus*, *Sesamia inferens*) in Millets for recording the natural enemies (Kharif and Rabi 2018-19)
- Collection of natural enemies and identification.
- Quantification of natural parasitism/ predation / pathogenecity by various natural enemies (Parasites, predators, pathogens) in millet ecosystem

3.2 Evaluation of entomopathogenic fungi formulations against millet borers in Finger millet (IIMR, Hyderabad, Kharif, 2018)

No of Treatments:	8- Replications: 3-Plot size: 15 m ² ; Finger millet Variety: 5614
Dose:	5 ml/liter (1 x 10 ⁸ spores/ml)
Treatments	T1: Bb 23 spray at 20, 45 DAE

	<p>T2: Bb 45 spray at 20, 45 DAE T3: Bb 14 spray at 20, 45 DAE T4: Ma 35 spray at 20, 45 DAE T5: Ma 36 spray at 20, 45 DAE T6: Ma 52 spray at 20, 45 DAE T7: Basal application of Carbofuran 3G @ 20 kg /ha) at sowing + soil application of Carbofuran 3G at 30 DAE. T8: Untreated Control</p>
Observations:	<ul style="list-style-type: none"> • Lab studies on egg, larval mortalities after EPF spray at 2, 4th day after exposure • Deadhearts (%) at 30, 45 DAE • White earheads (%) at Harvest • No. of mycosed larvae • Yield/plot (kg)

Note: EPF sprayable formulations to be supplied by NBAIR

3.3 Field trial against Fall Armyworm in sorghum at AICRP-BC centres

(IIMR Millets, Hyderabad and UAS Raichur).

Treatments= 10

1. *Trichogramma pretiosum* 1 card per acre (2 releases, first release after one week of planting & second one after one week of first release)+ NBAIR *Bt25* 2% (2-3 sprays depending on pest incidence, first spray after 20-25 days of planting & then the next sprays at 10 days intervals)
2. *Trichogramma pretiosum* 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)
3. *Trichogramma pretiosum* 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)
4. *Trichogramma pretiosum* 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* NBAIR H38 (1-2 whorl sprays @ 4kg/acre, first spray after 15 days of planting & then the next sprays at 10 days interval)
5. *Trichogramma pretiosum* 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 @ 20g/liter depending on pest incidence, first spray after 20-25 days of planting & then the next sprays at 10 days intervals)
6. *Trichogramma pretiosum* 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)

7. *Trichogramma pretiosum* alone (1 card per acre (2 releases, first release after one week of planting & then second one after one week of first release)
8. Pheromones @15 traps/acre (install one week after planting and the lures to be replaced once in 25-30 days)
9. Insecticidal check (Emamectin benzoate 0.4gm/lt)
10. Untreated check (control)

Plot size 8x5m, 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. pretiosum*, formulations of microbials, pheromone traps and lures will be supplied by NBAIR.

PULSES

4. PIGEON PEA

4.1 Evaluation of NBAIR *Bt* formulation on pigeon pea against pod borer complex [PAU (2 ha); MPKV (2 ha); UAS-R (10 ha); PDKV, Akola (0.4 ha)]

Variety	:	Location specific recommended variety
Treatments	:	Three T1: NBAII <i>Bt</i> G4 2% @ 2.0 ml/lt - 3 sprays at pre flowering, post Flowering and pod formation stage. T2: Chemical control (as per recommendation of respective university) T3: Control
Replications	:	Divide each block into 8 equal sized units, each unit to be considered as replication (each unit = one replication)
Observations	:	<ul style="list-style-type: none"> • No. of gram and legume/pod borer complex(spotted pod borer, plume moth, slug caterpillar, etc) / plant • Per cent pod damage • Grain yield (kg/ha)

4.2 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 - <i>Trichoderma harzianum</i> @ 10g/ kg seeds Soil application of <i>Trichoderma harzianum</i> @ 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)

5. COWPEA

5.1 Evaluation of entomopathogenic fungi against 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 = 8x5 m
Treatments	:	T1: <i>Beauveria bassiana</i> (NBAIR strain) @ 1x10 ⁸ spores/g 5g/lt. at 10 days intervals T2: <i>M. anisopliae</i> (NBAIR strain) @ 1x10 ⁸ spores/g 5g/lt. at 15 days intervals T3: Thiacloprid 30 g a.i ha ⁻¹ at 10,15 and 20 days intervals T4: Untreated control
Replications	:	Six
Observations	:	Pre and post treatment count of damaged pods /plant Yield (kg/plot)

5.2 Field evaluation of ICAR-NBAIR entomopathogenic strains against cowpea aphid (*Aphis craccivora*) (KAU, Thrissur; IIVR, Varanasi)

Plot size	:	8x5m=40 m ²
Replications	:	03
Design	:	RBD
Plot size	:	200m ² (40x 5) for each centre
Date of sowing	:	As per the package of practice
Treatments	:	1. Bb-5a isolate of <i>Beauveria bassiana</i> 2. Ma-6 isolate of <i>Metarhizium anisopliae</i> 3. V1-8 isolate of <i>Lecanicillium lecanii</i> 4. Recommended Insecticide application 5. Control (Untreated)
Observations	:	<ul style="list-style-type: none"> Pre and post count of aphids (nymphs and adults)

		• Yield
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Note: 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

5.3 Screening of promising fungal and bacterial isolates for management of anthracnose disease in cowpea (*Vigna unguiculata* sub sp. *sesquipedalis*) (KAU, Kumarakom)

Variety	:	Location specific recommended variety
Layout	:	Randomized Block Design.
Plot size		8x5 m
Treatments	:	T1: <i>Pichia guilliermondi</i> (Y-12) @ 2×10^8 spores/ml – 10ml/lt T2: <i>Hanseniaspora uvarum</i> .(Y-73) 2×10^8 spores/ml – 10ml/lt T3: <i>Trichoderma harzianum</i> (Th-3) @ 2×10^8 spores/g – 10g/lt T4: <i>Trichoderma viride</i> (KAU strain) @ 2×10^8 spores/g – 10g/lt T5: <i>Pseudomonas fluorescens</i> (KAU strain) @ 1×10^8 spores/g - 20g/L T6: Carbendazim @ 2g/kg (seed treatment) and 2g/L spray T7: Untreated control
Replications		Four
Mode of application	:	Seed treatment with bioagents (10g or 10 ml/kg) followed by foliar spray @ 15, 30 and 45 DAS
Observations	:	Disease incidence, Yield (kg/plot)

6. CHICKPEA

6.1 Integration of botanicals, microbials and insecticide spray schedule for the management of *Helicoverpa armigera* on chickpea (PAU)

Variety	:	Location specific recommended variety
Layout	:	Randomized Block Design.
Plot size		1x3 cents for each treatment, 1 cent = 8x5 m
Replications	:	Three
Treatments		Eight (1 st & 2 nd Spray) T1: <i>Bt</i> (commercial formulation) @ 1.25 lt/ha & Azadirachtin 1500 ppm @ 500 ml/ha T2: <i>Bt</i> (commercial formulation) @ 1.25 lt/ha- 2 sprays T3: Azadirachtin 1500 ppm @ 500 ml/ha & <i>Bt</i> (commercial formulation) @ 1.25 lt/ha T4: Azadirachtin 1500 ppm @ 500 ml/ha - 2 Sprays T5: <i>Bt</i> (commercial formulation) @ 1.25 lt/ha & spinosad 45SC @ 150ml/ha T6: Azadirachtin 1500 ppm @ 500 ml/ha & spinosad 45SC @ 150ml/ha T7: Spinosad 45SC @ 150ml/ha - 2 sprays

		T8: Untreated control Spray schedule: Two sprays (1 st at initiation of pod formation & 2 nd at 15 days later)
Observations	:	<ul style="list-style-type: none"> • 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.

6.2 Biological suppression of pod borer, *Helicoverpa armigera* infesting chickpea (MPUAT)

Variety	:	Location specific recommended variety
Layout	:	Randomized Block Design.
Plot size	:	1 cent = 8x5 m
Treatments	:	T1: <i>Beauveria bassiana</i> @ 1x10 ⁸ conidia /gm @ 5 gm/l at 7 day interval, at pod initiation stage, 2 sprays T2: <i>Bacillus thuriangiensis</i> @ 1 Kg/ha at 7 day interval, at pod initiation stage, 2 sprays T3: Quinalphos 25 EC @ 250g a.i/ha, at pod initiation stage, 2 sprays T4: Untreated control
Replications	:	Five
Observations	:	<ul style="list-style-type: none"> • 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.

6.3 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	:	3X2
Treatment	:	10
Replication	:	03
Glasshouse experiment	:	In pots (2 kg capacity) with same treatments and replications
Treatments	:	13. Th-17 + Psf-173 14. Th-17+ Psf-2 15. Th-17 + Th-14 16. Th-14+ Psf-2 17. Th-14+ Th-17 18. Th-17 (positive control) 19. Th-14 (positive control) 20. Psf-2 (positive control)

	21. Psf-173 (positive control) 22. Th-14 + Psf-173 (Standard check) 23. Carbendazim 24. Control (Negative control)
Methodology	<ul style="list-style-type: none"> • 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 <i>Fusarium</i> (5g inoculum/pot) one week before sowing followed by bioagents along with vermicompost (10g/100g) per pot • Three foliar sprays cum drench with bioagents 1st at 30 days after sowing and 2nd and 3rd at 45 days interval <p>Observations</p> <p>In glasshouse:</p> <ul style="list-style-type: none"> • Per cent seed germination 10 DAS • Plant stand at 30 and 45 DAS • Plant Growth at 45 DAS <p>In field</p> <ul style="list-style-type: none"> • Per cent seed germination 15 days after sowing • Plant stand at 60 and 120 days after sowing • Number of mature plant wilt at 120 DAS • Yield / plot and q/ha

New experiment

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

Number of treatments : 12	Number of replications : 3
Design : RBD	Plot size: 4.5 x 4.5 m²

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 + Coriander (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)
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- 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

New experiment

6.5: BIPM module for management of *Helicoverpa armigera* on chickpea (PAU TNAU)

Variety	:	: Locally recommended variety
Treatments	:	<p>T1 :BIPM Package</p> <p>8. Seed bio-priming <i>T. harzianum</i> @ 10g/kg of seeds</p> <p>9. Erection of bird perches @8/ac</p> <p>10.Spray of Spray of HaNPV strain (1.5x10¹² POBS/ha) @ 500ml/ha twice during the early pod formation stage at 15 days interval</p> <p>11.Raising marigold as trap crop.</p> <p>12.Use of pheromone traps @ 1 trap per plot.</p> <p>T2 :BIPM Package</p> <p>1. Seed bio-priming <i>T. harzianum</i> @ 10g/kg of seeds</p> <p>2. Erection of bird perches @8/ac</p> <p>3. Spray of Spray of <i>Bacillus thuriangiensis</i> @ 2 Kg/ha at 7 day interval, at pod initiation stage, 2 sprays twice during the early pod formation stage at 15 days interval</p> <p>4. Raising marigold as trap crop.</p> <p>5. Use of pheromone traps @ 1 trap per plot.</p> <p>T3 = Chemical insecticide (recommended)</p> <p>T4 = Untreated control</p>
Replications	:	: Divide each block into 6 equal sized units, each unit to be considered as replication (each unit = one replication)
Observations	:	<ul style="list-style-type: none"> • 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.

	<ul style="list-style-type: none"> • Pod yield will be recorded on whole plot basis.
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Talc formulations of *Trichoderma harzianum*, *Trichoderma asperellum*, *Trichoderma virens*; Two invert formulations of *Trichoderma harzianum* i.e Th IE1 and Th IE2, chemical control (Ridomil gold @ 25g/10 liter water/ tree) and unsprayed control. The treatments were given as soil application (@100Kg of completely dried FYM enriched with 1 Kg talc formulation). The observation of number of foot rot infected plant and yield parameter were recorded.

COMMERCIAL CROPS

7. COTTON

7.1 Biointensive management of pink bollworm on *Bt* cotton (UAS-R; PJTSAU; NBAIR; 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 = 8x5 m).
Layout	:	Randomised Block design
Treatments	:	<p>Three Each treatment consisting of 0.5 ha, however, untreated control to be of 5 cent size (1 cent = 8x5 m).</p> <p>T1: Standard practice of plant protection till 55th day or appearance of PBW. The following inputs to be provided for PBW.</p> <p>i) Erection of pheromone traps (Funnel type) @ 10/plot/PB Robe</p> <p>ii) Releases of <i>Trichogrammatoidea bactrae</i> 100,000/ha/release, 6-8 releases starting from 55 days after germination.</p> <p>iii) Application of azadirachtin 1500 ppm at ETL</p> <p>iv) Need based chemical insecticide based on label claim/university recommendation.</p> <p>T2: Spraying of insecticides as per label claim for PBW / SAUs at each centre during PBW infestation.</p> <p>T3: Control</p>
Replications	:	Totally 8 quadrants will be made in 0.5 ha of land. Further each quadrant will serve as replications.
Methodology and observations:	:	<ul style="list-style-type: none"> • 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.
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7.2 Evaluation of entomofungal agents and botanicals for the management of sucking pests in cotton [PJ TSAU & MPKV (for all sucking pests)]

Variety	:	Any recommended <i>Bt</i> cotton hybrid at each centre
Plot size	:	40 sq m x 4 for each treatment
Layout	:	Randomized Block Design
Treatments	:	Six T1: <i>Metarhizium anisopliae</i> (1x10 ⁸ spores/g) @ 5 g /lit. T2: <i>Lecanicillium lecanii</i> (1x10 ⁸ spores/g) @ 5g/lit. T3: <i>Beauveria bassiana</i> (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:	:	<ul style="list-style-type: none"> • 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.

7.3 Bio-intensive pest management in *Bt* cotton [AAU-A (5 ha), UAS-R (2ha)]

Variety	:	Any recommended <i>Bt</i> cotton hybrid
Plot size	:	2 ha
Treatments	:	T1: BIPM package <ul style="list-style-type: none"> • Seed treatment with <i>Trichoderma harzianum</i> @ 10g/kg of seeds. • Maize as border crop • Pheromone traps @ 10/ha for bollworms. • Release of <i>Trichogrammatoidea bactrae</i> @ 100,000/ha (6-8 releases starting from 55th DAG or with appearance of PBW).

	<ul style="list-style-type: none"> • Application of Azadirachtin 1500 ppm @ 5 ml/ lit for sucking pests. • Spray of <i>Lecanicillium lecanii</i> (1x10⁸ spores/g) @ 5g/lit. • Spray of <i>Pseudomonas fluorescence</i> 2% solution against foliar diseases. <p>T2: Farmers' Practice (pesticides used by farmers to be mentioned both insect pests and diseases).</p>
Replications	: Totally 8 quadrants will be made of plot. Further each quadrant will serve as replications.
Observations	: <ul style="list-style-type: none"> • 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. • 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. • Disease incidence to be recorded. • Yield (q/ha) to be recorded. • Generate data on natural enemies and pest incidence in high density planting-UAS Raichur

7.4 Population dynamics of whitefly, *Bemisia tabaci* and its natural enemies in cotton: A study in farmers' field in North Zone ICAR-NCIPM, New Delhi

The present study will be conducted during 2018-19 in cotton growing area of Punjab and Haryana with following objectives.

Objectives

1. To study the seasonal dynamics of whitefly, its predators and parasitoids in cotton crop in different locations in farmers' fields in North Zone.
2. To study natural occurrence of entomopathogens associated with whitefly, *B. tabaci* in cotton crop ecosystem.

Methodology:

1- Roving survey of cotton fields will be conducted at fortnightly interval in whitefly hot spots of Punjab and Haryana during June to September. The observation on whitefly (per three leaves) and predators chrysopids, coccinelids and spiders (per plant) will be done by onsite count from five randomly selected plants per location. Whereas, for parasitoid cotton leaves infested with immature stages of whitefly will be brought into the laboratory. Observation on the parasitization of whitefly nymph/pupae will be taken under 3 D Digital stereomicroscope. The parasitization will be determined by counting number of healthy pupae (with red eye spot, and pupae with T shaped emergence hole) and parasitized pupae (black/brown colour or yellowish

opaque colour/ circular emergence hole). Insect samples will be sent to the NBAIR for further identification.

2- During roving survey diseased/infected whitefly samples will be collected for isolation of associated entomopathogens in the laboratory. Isolation will be done as per standard protocol. These isolated fungus will be send to NBAIR for further evaluation and characterization.

Expected outputs

Information about the dynamics of whitefly and its natural enemies in farmers' managed cotton crop ecosystem in different locations.

Expected outcomes

The information generated from the present study will be helpful in decision making for conservation and augmentation of natural enemies to promote natural biological control of whitefly in IPM program.

8. SUGARCANE

8.1 Efficacy of entomopathogenic nematodes and entomofungus for the management of white grub in sugarcane ecosystem [ANGRAU (5 ha); UAS-R (2 ha)].

Variety	:	Region specific popular sugarcane variety
Treatments	:	T1: <i>Heterorhabditis indica</i> WP (NBAIR) @12 kg/ha in 250 kg FYM per ha. Applied at the time of larval emergence T2: <i>Metarhizium anisopliae</i> (NBAIR) @2.5 kg/ ha in 250 kg FYM per ha. T3: Chemical control (Chlorantraniliprole 18.5SC @ 0.3 ml / lit) T4: Untreated control
Replications	:	Totally 8 quadrants will be made of plot. Further each quadrant will serve as replications.
Observations	:	<ul style="list-style-type: none"> Plant damage due to white grub was recorded for three rows of 10 meter length in each treatment at monthly interval till harvest and damage index was prepared. White grub population per 10 meter row in the root zone for three rows in each treatment was recorded by digging standard pit of 0.5x0.5x0.5 metre under clump in each damage category at monthly interval till harvest. Number of milialbe canes, cane yield and juice quality was recorded at harvest.

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

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

		<p>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.</p> <p>In centres where top shoot borer is problem, <i>T. japonicum</i> @ 50,000/ha at 10 days interval from 60 days old crop to 5 months crop. 8 releases to be made.</p> <p>T2: Farmers' practice (as per sprays recommended insecticide at each place as per university recommendation or label claim).</p> <p>T3: Untreated control</p>
Replications	:	Divide each block into 8 equal sized units (each unit = one replication)
Observations	:	<p>Record the following observations</p> <ul style="list-style-type: none"> • Pre-release infestation, <i>i.e.</i>, 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.

8.3 Demonstration of *Heterorhabditis indica* NBAIRH38 and *S. abbasi* NBAIISa01 WP formulation for management of sugarcane white grubs in Vijayapur and Bagalakot districts of Karnataka (NBAIR – 5 ha Jagadeesh Patil NBAIR)

Treatments: Two applications will be taken up and based on the pre sampling of the grub population EPN doses will be fixed and tested with recommended insecticide.

Observations: Percent reduction of white grub population, yield and comparison with insecticides spray and control.

OILSEEDS

9. MUSTARD

9.1 Bio-efficacy of entomopathogenic fungus and neem against mustard aphid (AAU-J)

Variety	:	Location specific variety
Layout	:	Randomized Block Design
Plot Size		8x5 m

Treatments	:	T1: <i>Beauveria bassiana</i> (AAU-J Culture) @1x10 ⁸ spore/g-5g/lit T2: <i>Metarhizium anisopliae</i> (AAU-J Culture) @1X10 ⁸ spore /g-5g/lit T3: <i>Lecanicillium lecanii</i> (AAU-J Culture) @1X10 ⁸ spore/g -5g/lit T4: <i>Lecanicillium lecanii</i> (NBAIR) @1X10 ⁸ spore/g-5g/lit T5: Azadirachtin 1500ppm @ 2ml/lit T6: Insecticide as per university recommendation at each centre T7: 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

10. Ground nut

10.1 Demonstration of *Heterorhabditis indica* NBAIRH38 and *S. abbasi* NBAIISa01 WP formulation for management of white grubs in ground nut in collaboration with AICRP-BC Anand centre, ground nut growing regions (**NBAIR – 5ha Jagadeesh Patil NBAIR**)

Treatments: Two applications will be taken up and based on the pre sampling of the grub population EPN doses will be fixed and tested with recommended insecticide.

Observations: Percent reduction of white grub population, yield and comparison with insecticides spray and control.

10.2 Field efficacy of EPN strains against whitegrubs in groundnut (Trial by Dr. Nagesh in collaboration with AICRP-AAU, Anand; MPUAT, Udaipur); sugarcane (AICRP-MPKV, Rahuri).

T1: *H. indica* WP

T2: *H. bacteriophora* WP

T3: *S. carpocapsae* WP

T4: *S. abbasi* WP

T5: Chemical (Chlorpyrifos/fipronil)

T6: Control

Replications: 4

Plot size: 8x5m²

10.3 Field efficacy of dose application of EPN against whitegrubs in groundnut (Trial by Dr. Nagesh in collaboration with AICRP-AAU, Anand; sugarcane (AICRP-MPKV, Rahuri)

T1: *H. indica* @ 1.0×10^5 / m² (NBAIR WP formulation)
 T2: *H. indica* @ 2.0×10^5 / m² (NBAIR WP formulation)
 T3: *H. indica* @ 3.0×10^5 / m² (NBAIR WP formulation)
 T4: *H. indica* @ 1.0×10^5 / m² (Commercial WP formulation)
 T5: *H. indica* @ 2.0×10^5 / m² (Commercial WP formulation)
 T6: *H. indica* @ 3.0×10^5 / m² (Commercial WP formulation)
 T7: Chemical (Chlorpyrifos/fipronil)
 T8: Control
 Replications: 4;
 Plot size: 8×5m²

FRUIT CROPS

11. BANANA

11.1 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 <i>Beauveria bassiana</i> (AAU J Culture) @ 1×10^8 spore / g at 15 days interval. T3: Four spray of <i>Beauveria bassiana</i> (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	:	<ul style="list-style-type: none"> • Number of <i>N. subcostatum</i> 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.

	<ul style="list-style-type: none"> • Influence of various treatments on finger weight of banana will be calculated after harvesting the crop. • Yield data from each treatment will be recorded
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12. PAPAYA

12.1 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 <i>Acerophagus papayae</i> if incidence of PMB is observed. T2: Releases of <i>Cryptolaemus montrouzieri</i> grubs in 2 nd 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	:	<ol style="list-style-type: none"> The incidence of various species will be recorded. For identification of number of species, send specimens to NBAIR. Record natural enemies of mealybug complex on papaya at fortnightly interval and weather factors to work out correlation. <ul style="list-style-type: none"> • 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.

13. APPLE

13.1 Integrated Pest Management of apple Codling moth, *Cydia pomonella* (SKUAST)

Variety	:	Red delicious
Plot size / No. of plants to be treated	:	50 trees for MD traps 50 trees for T2, T3 & T4 in MD area
Layout	:	Randomized Block Design.
Treatments	:	T1: Installation of mating disruption traps T2: Release of <i>T. cacoeciae</i> @2.5 lakh/ha. (4 releases/ season) + Trunk banding + disposal of infested fruits + spray of <i>Heterorhabditis pakistanensis</i> (NBAIR) T3: Farmers practice of the region. T4: Control

Replications	:	Five, each set of ten trees as replication
Observations	:	<ul style="list-style-type: none"> • Per cent fruit damage • Per cent reduction in damage over control • Larval mortality caused by EPN. • Yield

13.2 Evaluation of predatory bug, *Blaptostethus pallescens* against European red mite, *Panonychus ulmi* and two spotted spider mite, *Tetranychus urticae* on apple (SKUAST)

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	:	<ul style="list-style-type: none"> • Two field releases of anthocorid bugs @ 200 (T1) and 400 (T2) / plant when number of ERM crosses 10/leaf • <i>In situ</i> 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

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

Variety	:	Apple variety in different orchards to be noted
Treatments	:	T1: <i>Metarhizium anisopliae</i> (NBAIR) 1x10 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	:	<ul style="list-style-type: none"> • Number of live and dead larvae will be counted at the time of basin preparation and percent mortality will be calculated

New experiment

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

Treatments	T1: <i>Beauveria bassiana</i> (5g/L of 10 ⁸ conidia/g; 10ml/gallery) T2: <i>Metarhizium anisopliae</i> (5g/L of 10 ⁸ conidia/g; 10ml/gallery) T3: <i>Steinernemma feltiae</i> (2500IJs/gallery) T4: <i>Steinernemma feltiae</i> (5000IJs/gallery) T5: <i>Heterorhabditis bacteriophora</i> (2500IJs/gallery) T6: <i>Heterorhabditis bacteriophora</i> (5000IJs/gallery) T6: Azadiraditin (2ml/L of 1500ppm; 10ml/gallery) T7: Chlorpyrifos (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.

14. MANGO

14.1 Effect of biopesticides for the management of mango hopper, *Idioscopus* spp. in field condition (DRYSRHU)

Variety	:	Popular variety
No. of trees	:	10 trees per treatment
Layout	:	Randomized Block Design.
Treatments	:	T1: <i>Beauveria bassiana</i> (commercial culture) @1x10 ⁸ spores/g-5g/lit T2: <i>Metarhizium anisopliae</i> (NBAIR culture Ma-4) @1x10 ⁸ spores/g-5g/lit T3: <i>Lecanicillium lecanii</i> (NBAIR / commercial culture) @1x10 ⁸ spores/g-5g/lit T4: Azadirachtin 10000 ppm @ 1ml/lt

		T5: Imidocloprid T6: Thrips specific fungal pathogen (IIHR strain supplied by NBAIR) T7: Untreated control
Replications	:	Each tree to serve as replication
Methodology and observations	:	Observation will be taken at different intervals after application; No of hoppers/ inflorescence; No of hoppers/ sweep net; Natural enemies, if any

14.2 Bio-efficacy of bio-pesticides for the management of mango hoppers (ICAR-CISH)

Variety	:	Dashehari
No. of trees	:	5 trees per treatment
Layout	:	Randomized Block Design.
Treatments	:	T1: <i>Beauveria bassiana</i> (CISH culture) @1x10 ⁸ spores/g @ 5g/lit T2: <i>Metarhizium anisopliae</i> (NBAIR culture) @1x10 ⁸ spores/g @ 5g/lit T3: Azadirachtin 1500 ppm @ 2ml/lt T4: Imidacloprid 0.005% (CISH POP) T5: Untreated control
Replications	:	Three
Methodology and observations	:	Observation will be taken at different intervals after application; No of hoppers/ inflorescence; No of hoppers/ sweep net; Natural enemies, if any

14.3 Bioefficacy of entomopathogenic fungi formulations in suppression of mango leaf webber (ICAR-CISH)

Variety	:	Dashehari
No. of trees	:	5 trees per treatment
Layout	:	Randomized Block Design.
Treatments	:	T1: <i>Beauveria bassiana</i> (CISH culture) @1x10 ⁸ spores/g-5g/lit T2: <i>Metarhizium anisopliae</i> (NBAIR culture) @1x10 ⁸ spores/g-5g/lit T3: Lamdacyahalotrin 0.01% (CISH POP) T4: Untreated control
Replications	:	Each tree to serve as replication
Methodology for imposing treatments	:	Soil application and Spray
Methodology and observations	:	Observation will be taken at different intervals after application; No of webs/ tree; No of larvae/ web; Natural

	enemies, if any
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14.4 Habitat manipulation for conservation of bioagents for management of mango insect pests

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

14.5 Field evaluation of microbial biocontrol agents for the management of mango thrips

Variety	:	Dashehari
No. of trees		3 trees per treatment
Layout	:	Randomized Block Design.
Treatments	:	T1: ICAR-NBAIR <i>Pseudomonas fluorescens</i> NBAIR PFDWD5 @20g/lit T2: <i>L. lecanii</i> 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

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

Variety	:	Popular variety
No. of trees		10 trees per treatment
Layout	:	Randomized Block Design.
Treatments	:	T1: <i>Beauveria bassiana</i> liquid formulation

		(commercial) @1x10 ⁸ spores/g - 5 ml /lit T2: <i>Metarhizium anisopliae</i> liquid formulation (commercial) @1x10 ⁸ spores/g-5 ml /lit T3: <i>Lecanicillium lecanii</i> (VL8) liquid formulation (commercial) @1x10 ⁸ spores/g-5 ml /lit T4:ICAR-NBAIR <i>Pseudomonas fluorescens</i> NBAIR PFDWD5 @20g/lit T5: Azadirachtin 10000 ppm @ 5ml/lt T6: Fipronil 5 % SC - 2ml/litre T7: Untreated control
Replications	:	Each tree to serve as replication
Methodology and observations	:	Observation will be taken at different intervals on Thrips population (nymph and adult) by counting single tap of shoot or panicle on white paper on fixed (tagged) 10 twig or panicles/tree at standing height of the tree one day before the treatment and 7, 14, 21 and 28 days after spray

15. GUAVA

15.1 Evaluation of bio-agents against root-knot nematode infection in guava under controlled conditions (CISH Lucknow)

Treatments:

1. *Purpuricillium lilacinus* @ 10⁶, 10⁷, 10⁸ spores/cfu per kg of soil
2. *Pochonia chlamydospora* @ 10⁶, 10⁷, 10⁸ spores/cfu per kg of soil
3. *Bacillus* sp. @ 10⁶, 10⁷, 10⁸ spores/cfu per kg of soil
4. Carbofuran 3G @ 200mg/ kg of soil
5. Inoculated control
6. Uninoculated control

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

Replicates: 9 per treatment

Methodology:

Bio-agent inoculation: 7 days prior to transplantation of seedlings

Age of seedlings at transplanting: 45 days (after seed sowing)

Nematode inoculation: Just after transplantation

Termination of Experiment: 45, 90 and 135 days after inoculation

Data to be recorded:

Root-knot index (0-4 scale)

Number of J2 in soil

Shoot height (cm)

Shoot and root weight (g)

New experiment

15.2 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	<i>B. Bassiana</i> (NBAIR-Bb-5a) @ 5 g/L
T2	<i>Metarhizium anisopliae</i> (NBAIR-Ma-4) @ 5 g/L
T3	<i>Lecanicillium lecanii</i> (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

16. ANOLA

New experiment

16.1 Biological control of anola 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	<i>B. Bassiana</i> (NBAIR-Bb-5a) @ 5 g/L
T2	<i>Metarhizium anisopliae</i> (NBAIR-Ma-4) @ 5 g/L
T3	<i>Lecanicillium lecanii</i> (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. CITRUS

New experiment

17.1 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: <i>Beauveria bassiana</i> @ 5 g/lit (NBAIR-Bb-5 a) T2: <i>Metarhizium anisopliae</i> @ 5g/lit (NBAIR-Ma-4) T3: <i>Lecanicillium lecanii</i> @ 5 g/lit (NBAIR VI-8) T4: <i>Aschersonia aleyrodis</i> @ 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	:	<ul style="list-style-type: none"> • 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.

New experiment

17.2 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:

T₁ *Beauveria bassiana* (NBAIR Bb-5a Strain) @ 5g/ Litre

T₂ *Metarhizium anisopliae* (NBAIR Ma-4 Strain) @ 5g/ Litre

T₃ *Lecanicium lecanii* (NBAIR VI-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)

New experiment

17.3 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:

T₁ : *Beauveria bassiana* (NBAIR Bb-5a Strain) @ 5g/ Litre

T₂ : *Metarhizium anisopliae* (NBAIR Ma-4 Strain) @ 5g/ Litre

T₃ : *Lecanicium lecanii* (NBAIR VI-8 Strain) @ 5g/ Litre

T₄ *Pseudomonas fluorescens* (NBAIR-PFWD)20g/litre

T₅ : Local check (Propargite 57EC @0.0057%)

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.

PLANTATION CROPS

18. COCONUT

18.1 Surveillance of rugose whitefly in coconut and assessing the population of natural biocontrol agents [NBAIR, TNAU, 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

Information on the management practices followed by the farmer and information on p

18.2 Management of Coconut black headed caterpillar using *Goniozus nephantidis* and *Bracon brevicornis* in endemic areas of Kerala (CPCRI)

Area/ location: Kannur/Kasaragod district

Treatments details:

S. No	Treatment details
1	Augmentative trunk release of <i>Bracon brevicornis</i> @30 per palm at monthly intervals
2	Augmentative trunk release of <i>Goniozus nephantidis</i> @20 per palm at monthly intervals

3	Release of <i>Goniozus nephantidis</i> @ 10 female parasitoids/palm and <i>Bracon brevicornis</i> @ 20 females parasitoids/palm
4	T4: Control (Farmers practice)

Variety: To be recorded

Replicates: Divide 5 ha block into 5 equal sized units, each unit should further be divided into 4 sub units that serves as replication.

Methodology:

- Trees of uniform height will be selected for the study.
- 10% of the total number of palms in 1 ha will be randomly selected for initial observation and pre treatment sampling.
- The pre release sampling will be done for each palm by collecting and examining 20 leaflets.
- The larvae, pupae and adult stages of the pest from each leaflet will be counted to arrive at the number of *Opisina arenosella* population per leaflet.
- Releases of the parasitoids will be made at monthly intervals depending on pest stage in the field.

Observation: Pre treatment and Post treatment data to be recorded on the no. of larva, pupa, and parasitoids / per 10 leaflets at monthly intervals.

18.3 Screening of coleopteran specific *Bt* formulation (NBAIR strains) against red palm weevil (*Rhynchophorus ferrugineus*) (CPCRI, DRYSRHU)

S. No	Treatment details
1	<i>Bt</i> isolate BTAN4, (ICAR-NBAIR)
2	Imidacloprid 1ml/lit
5	Control

Replicates: four (n=10)

Dosage: graded 10^{-1} to 10^{-4}

Observation: mortality of grubs at 24 hr interval till pupation, weight loss, external symptoms specific to *Bt* infection

New Experiment

18.4 Biological suppression of rugose spiralling whitefly in coconut. (ICAR-CPCRI, ICAR-NBAIR, ANGRAU, KAU-K, KAU-T, KAU-V, DRYSRHU, TNAU)

Treatment details:

T1.	<i>Encarsia guadeloupa</i> e natural conservation).
T2.	Foliar application of <i>Isaria fumosorosea</i> (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 2nd spray
- (2) 60 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

19. COCOA

19.1 Evaluation of microbial insecticides against bagworm, *Pteroma plagiophleps* in cocoa (DRYSRHU)

Variety	:	Local
Plot size / No. of plants to be treated	:	5 trees per treatment
Layout	:	Randomized Block Design.
Treatments	:	T1: <i>Beauveria bassiana</i> (NBAIR) 1x10 ⁸ spore/g @ 5 g/ L T2: <i>Metarrhizium. anisopliae</i> (NBAIR) 1x10 ⁸ spore/g @5 g /L T4: Azadirachtin 1500 ppm @ 3 ml/L T5: Lamada cyhalothrin 0.5ml/litre (chemical check) T6: Untreated control
Replications	:	Each tree to serve as replication
Methodology	and :	At 10 days interval after initial population is observed and

observations	number of sprays will be carried out as per the need. i. No. of bag worms/5 leaves before treatment ii. No. of bagworms/5 leaves /pods after every treatment
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19.2 Field evaluation of bioagents against pod rot and stem canker (*Phytophthora* sp.) in cocoa (Dr. YSRHU, Ambajipeta)

a. Pod Rot:

Layout: RBD

Treatments: 4

T₁- Spraying of *Trichoderma reesei* spore suspension (2×10^6 cfu/ml) (2-3 sprays at 15 days intervals during monsoon period)

T₂ – Soil application of 50 g of *Trichoderma reesei* along with 5kg Neem cake (once before onset of monsoon)

T₃ – Spraying of copper oxychloride (3g/litre of water) (2-3 sprays at 15 days intervals during monsoon period)

T₄- Untreated Control

Replications: 6

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

T₁- 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

T₃ - Soil application of 50 g of *Trichoderma reesei* along with 5kg Neem cake (once)

T₄- Chiselling of canker area on the stem and application Copper oxychloride paste formulation based on the lesion size

T₅- Untreated Control

Replications: 5

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

20. TEA

20.1 Field evaluation of bio-pesticides against red spider mites (UBKV, Pundibari)

Treatments	:	T1- <i>Lecanicillium lecanii</i> (NBAIR strain) @ 10 gm/lit. (10^8 spores/ml) T2- <i>Beauveria bassiana</i> (NBAIR strain) @ 10 gm/lit. (10^8 spores/ml) T3- Azadirachtin 10000 ppm @ 1ml/lit.
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		T4- Spiromesifen 240 SC @ 1 ml/lit. T5- Control
Layout	:	Randomized Block Design
Plot size	:	8 x 5m
Replication	:	Four blocks to be selected in the tea garden and each block to be divided into 5 equal sized units (each block= one replication and each unit = one treatment).
Spray schedule	:	Two sprays at 15 days interval after the new flush in tea
Observations	:	Observation on the pests and natural enemies incidence will be taken at fortnightly interval before and after spraying from the treated plants. Yield of tea leaf will also be recorded.

VEGETABLE CROPS

21 TOMATO

21.1 Bio-intensive pest management of *Helicoverpa armigera*, *Tuta absoluta* and sucking pests of tomato (YSPUHF, MPKV, PJTSAU, PAU, AAU-A, Sun Agro, IHR – *Tuta absoluta*)

Variety	:	Location specific popular variety
Plot size	:	8x5 m ²
Layout	:	Randomized Block Design.
Treatments	:	<p>T1 = BIPM Seed treatment with <i>Trichoderma harzianum</i> @ 10g/kg of seeds. Raising marigold as trap crop Use of NBAIR pheromone traps @ 1 trap per plot. <i>Trichogramma achaeae</i> / <i>Trichogramma pretiosum</i> @ 50,000 per release (6 releases) Azadirachtin 1500 ppm @ 2 ml/lit. <i>Lecanicillium lecanii</i> (NBAIR) 1x 10⁸ spores/ g @ 5g/lt for sucking pests <i>Pochonia chlamydosporia</i> for root knot nematode</p> <p>T2 = Chemical control Chlorantraniliprole 18.5% SC for <i>Tuta</i> and indoxacarb 14.5 SC for other pests</p> <p>T3= Spinetoram 11.7% SC 0.25ml/L (only for IHR) T4 = Untreated Control</p>
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

	<p>fortnightly interval.</p> <ul style="list-style-type: none"> • Randomly select 10 plants/40m² crop area and observe all the leaves for presence of leaf mine / sucking pests caused by the larva. • Randomly select 10 plants/ 40m² 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.
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21.2 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	:	<p>T1 = BIPM Seed treatment with <i>Trichoderma harzianum</i> @ 10g/kg of seeds. Azadirachtin 1500 ppm @ 2 ml/lit. <i>Beauveria bassiana</i> @ 1x10⁸ conidia /gm, @ 5g/lit – 2 sprays at 15 days interval Spray of HearNPV (1.5x10¹² POBS/ha) twice during the peak flowering and at fruit setting stage at 15 days interval. <i>Bacillus thuringiensis</i> @ 1kg/ha⁻¹ two times during season at 15 days interval</p> <p>T2 = Chemical control Spinosad 45 SC @ 0.25 ml/l</p> <p>T3 = Untreated Control</p>
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	:	<p>The treatment applications will be started at initial occurrence of <i>H. armigera</i> infestation sprays of biopesticides will be given during evening hours at fortnightly interval.</p> <ul style="list-style-type: none"> • Randomly select 10 plants/ 40m² 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.

22. BRINJAL

22.1 Bio-intensive insect and nematode (RKN) management in brinjal (MPKV; TNAU; AAU-J; OUAT; IIHR; Sun Agro, CAU and IIVR)

Variety	:	Variety will be selected as per the university recommendation
Plot size	:	8x5 m
Layout	:	Randomized Block Design.
Treatments	:	<p>T1 = BIPM</p> <p>For sucking pests Azadirachtin 1500 ppm @ 2ml/lt <i>Lecanicillium lecanii</i> (NBAIR strain) 1×10^8 spores/ml @ 5g/lt</p> <p>For BSFB Mass trapping by all centres, traps by Sun Agro Release of <i>Trichogramma chilonis</i> multiple insecticide tolerant strain @100,000/ha, 8-10 releases at weekly interval from initiation of flowering. <i>Bacillus thuringiensis</i> NBAII BtG4 2% (not for AAU-J)</p> <p>For Ash weevil Entomopathogenic nematode (NBAIR) @ 2 billion IJs / ha, twice during season.</p> <p>For mealybug <i>Cryptolaemus montrouzieri</i> @ 5 grubs / plants or 1500/ha, twice at 15 days interval.</p> <p>T2 = Chemical Control Based on each university recommendation for insect pest on brinjal. 4-6 sprays depending upon pest species.</p> <p>T3: Untreated control</p>
Replications	:	Eight
Methodology and observations	:	<ol style="list-style-type: none"> 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.

* TNAU to use cowpea as border crop

22.2 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	:	<p>Treatments</p> <p>T1: <i>Metarhizium anisopliae</i> (IIHR Strain) oil formulation @ 1ml/l</p> <p>T2: <i>Beauveria bassiana</i> (IIHR Strain) WP formulation 10g/l</p>

		T2: <i>Metarhizium anisopliae</i> (Biometra, AAU strain) (1x10 ⁸ spores /g) @ 5g/ litre T3: <i>Beauveria bassiana</i> (Biosona, AAU strain) (1x10 ⁸ spores /g) @ 5g/ litre T4: <i>Metarhizium anisopliae</i> (Ma-4) NBAIR strain (1x10 ⁸ spores /g) @ 5g/ litre T5: <i>Beauveria bassiana</i> (Bb-5a) NBAIR strain (1x10 ⁸ spores /g) @ 5g/ litre T6: <i>Heterorhabditis indica</i> @ 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 to count the grubs Yield of healthy marketable fruits and cost-benefit ratio.

22.3 Bio-intensive pest management of brinjal fruit and shoot borer and whitefly on brinjal (KAU, Thrissur)

Treatment:

T₁– Release of *Trichogramma chilonis* @ 100,000/release against brinjal fruit and shoot borer, 10-12 releases to be made at 30 days after transplanting & need based spray of *Bacillus thuringiensis* (NBAIRBtG4) liquid formulation for BFSB and *Lecanicillium lecanii*, *Metarhizium anisopliae* and *Beauveria bassiana* (1 × 10⁸ spores/g @ 5g/l) for whitefly.

T₂– Farmers practices

Observation:

For BSLB:

- Pre- release observation –No. of shoot damage, such 10 spot will be selected for observation including 10 plants each spot, observation will be taken at 15 days interval
- To check percent field parasitization sentinel cards will be placed in field.

For whitefly:

- Pre-treatment observations on no. of nymphs and adults of whitefly per leaf will be taken before each application of fungi, and post-treatment observations will be taken at 3, 7, 10 and 15 days after each treatment (DAT). Observations of the whitefly populations (no. of nymphs and adults per leaf) will be recorded on leaves from the top, middle and bottom of 10 randomly selected plants per treatment.
- Yield of healthy marketable fruits and cost benefit ratio will be worked out.

23. OKRA

23.1 Efficacy biocontrol agents for management of fruit borer, *Earias vittella* on bhendi (AAU-A)

Variety	:	Variety will be selected as per the university recommendation
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Plot size	:	8 x 5 m
Layout	:	Randomized Block Design.
Treatments	:	T1: <i>Metarhizium anisopliae</i> (NBAIR) 1x10 ⁸ spores/ g @ 5g/lt T2: <i>Beauveria bassiana</i> (NBAIR) 1x10 ⁸ spores/ g @ 5g/lt T3: <i>Trichogramma chilonis</i> @50,000 parasitoids/ha, 6 releases at weekly interval. T4: <i>Bacillus thuringiensis</i> @ 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.

New experiment

23.2 Management of *Tetranychus truncatus* using *Neoseiulus indicus* on Okra (SKUAST-Jammu)

Design: RBD

Treatments:

T1: Release of 10 predatory mites/plant

T2: Release of 20 predatory mites/plant

T3: Release of 30 predatory mites/plant

T4: Spiromesifen 100 g a.i/ha

T5: Control

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

No. of replications: 4

Area per replication: 1 cent (open field)

Observations: Pre and post count of prey mite/ cm² leaf area at three days interval as well as mean yield/plant

Adequate population of predatory mites to be provided by NBAIR

24. CABBAGE

24.1 Evaluation of *Steinernema carpocapsae* and *Heterorhabditis indica* (NBAIR strain) against lepidopteran pest complex (SKUAST)

Variety	:	Local variety
Plot	:	8x5 m
Layout	:	Randomized Block Design
Treatments	:	T1: <i>S. carpocapsae</i> @ 2.5 lakh IJs/sq. mt. 2-3 sprays depending on pest infestation. T2: <i>H. pakestanansis</i> @ 2.5 lakh IJs/sq.mt 2-3 sprays depending on pest infestation. T3: Insecticide as per label claim / University recommendation T4: Control
Replications	:	Four
Observations	:	<ul style="list-style-type: none"> Average population of active IJs/ plant after 24 hours Larval mortality after 72 and 96 hrs of each treatment Yield (Average yield of IJs from 1st, 2nd, 3rd and 4th larva) Crop yield in treated and untreated micro plot

24.2 Biological control of lepidopteran pest complex and aphid on cabbage (CAU 0.1 ha)

Crop/Variety	:	Local popular variety
Area	:	0.4 to 1.0 ha
Layout	:	Randomized Block Design
Treatments	:	T1: Raising of mustard as intercrop (TNAU & CAU), Release of MITS of <i>Trichogramma chilonis</i> @ 100,000/release against <i>Plutella xylostella</i> , 6 releases to be made at 30 days after transplanting, release of <i>Chrysoperla zastrowi sillemi</i> @ 2000/ release, 2 releases to be made at 15 days interval against cabbage aphid, <i>L. lecani</i> -1x10 ⁸ spore/ ml @ 5ml/lt and <i>Bt</i> (NBAIR) three sprays and <i>Bacillus thuringiensis</i> NBAII <i>BtG4</i> 2%. T2 : Farmers practices (to be specified by each centre)
Replications	:	Divide block into 5 equal sized units, each unit should serve as replication.
Observations	:	<ul style="list-style-type: none"> Pre- release observation – No. of holes on the leaves, No. of larvae, such 5 spot to be selected for observation including 10 plants each spot, observation will be taken 4 times at 15 days interval Collection of eggs, about 100 eggs to be collected to check parasitisation, observation will be recorded 4

	<p>times.</p> <ul style="list-style-type: none"> • Aphid – observation to be recorded in 5 random spots including 10 plant each spot for aphid infestation and total number of infested plant to be counted. Five observation to be taken on the aphid colony infesting leaves by using the 1cm window, • Yield data
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24.3 Field evaluation of ICAR-NBAIR entomopathogenic strains against cabbage aphid (*Brevicoryne/Myzus*) and *Plutella xylostella* (DBM) (IIVR), AAU- Jorhat

Plot size 8x5m=40 m²

Rep 03

Design: RBD

Treatments=6

Total area required = 240m² (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 1x10⁸cfu/ml (5ml/liter) has to be given at 15 days interval

Observations:

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

New experiment

24.4 Management of cabbage pest, *Plutella xylostella* through biological control agents (in farmer field, 1 ha) (NBAIR, Dr. Omprakash and Dr. Jagadeesh Patil)

Treatment details:

Variety	:	Variety will be selected based as grown in farmers' field
Area	:	1 ha
Layout	:	Randomized Block Design
Treatments	:	T1- <i>Trichogramma</i> (targeting eggs stage)

		T2 - <i>Heterorhabditis indica</i> (targeting larval stage)
		T3 - <i>Steinernema abbasi</i> (targeting larval stage)
		T4 - <i>Bacillus thuringiensis</i> (NBAIR Bt) (targeting larval stage)
Replications	:	6
Observations	:	i. Number larvae/ plants ii. Number of parasitized eggs and per cent parasitism and recovery by sentinel trap cards iii. Number of holes/ plants iv. Percentage head damage v. Yield and economic analysis

25. CHILLIES

25.1 Screening of promising isolates of entomopathogenic fungi for management of white flies in chillies (KAU- Kumarakom)

Variety	:	Location specific recommended variety
Layout	:	Randomized Block Design.
Plot size	:	8×5 M
Treatments	:	T1: Bb-5a isolate of <i>Beauveria bassiana</i> T2: Ma-4 isolate of <i>Metarhizium anisopliae</i> T3: Ma-6 isolate of <i>Metarhizium anisopliae</i> T4: Vl-8 isolate of <i>Lecanicillium lecanii</i> 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	:	<ul style="list-style-type: none"> ➤ Pre and post count of whiteflies ➤ Yield

25.2 Evaluation of fungal pathogens against chilli yellow mite, *Polyphagotarsonemus latus* on chili (UBKV, Pundibari)

Treatments	:	T1: <i>Metarhizium anisopliae</i> (NBAIR Ma-4) 1×10 ⁸ cfu @ 6g/lit T2: <i>Beauveria bassiana</i> (NBAIR Bb-5a) 1×10 ⁸ cfu @ 6g/lit T3: <i>Lecanicillium lecani</i> (NBAIR VL 8) 1×10 ⁸ cfu @ 6g/lit T4: Pyridaben 20% WP @ 1g/lit T5: Control
Layout	:	Randomized Block Design
Variety	:	Akashi
Plot size	:	6x 5m
Replication	:	4

Spray schedule	:	Two sprays at an interval of 15 days.
Observations	:	Results of first year spray shows that the talc formulation of EPFs provided by NBAIR has given better result on mite control (25-40% mortality) as compared to the market available products (20-25% mortality). However acaricide Pyridaben 20% WP has given best result with maximum mortality of mite (>80%). 2 nd year trial will be continued in this year and the crop is still in the field.

26. CUCUMBER

26.1 Bio-efficacy of some bio-pesticides against sucking pests (Whiteflies and Jassids) in cucumber (UBKV, Pundibari)

Treatments	:	T1- <i>Lecanicillium lecanii</i> (NBAIR VL8) @ 10 gm/lit. (10 ⁸ spores/ml) T2- <i>Beauveria bassiana</i> (NBAIR BB-5a) @ 10 gm/lit. (10 ⁸ spores/ml) T3- Azadirachtin 10000 ppm @ 1ml/lit. T4- Buprofezin 25 SC @ 1.5 ml/lit. T5- Control
Layout	:	Randomized Block Design
Variety	:	Malini
Plot size	:	6x 5m
Replication	:	4
Spray schedule	:	Two sprays at an interval of 15 days.
Observations	:	Observation on the pests and natural enemies incidence will be taken at before and 1, 3and 7 days after spraying from the treated plants. Yield of cucumber will also be recorded for benefit: cost ratio.

SPICE CROPS

27. GINGER

27.1 Biological control of ginger rhizome rot (Nagaland University, Medziphema)

1. Isolation of local strains of antagonistic organisms
2. In vitro evaluation of local & NBAIR strains of antagonistic organisms against ginger rhizome rot pathogen.

28. POLYHOUSE INSECT PESTS

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

Variety	:	Any recommended variety
Plot size in polyhouse	:	2x2 m
Layout	:	Randomized Block Design.
Treatments	:	T1: <i>Blastostethus pallescens</i> @ 10 nymphs/m row twice at 15 days interval T2: <i>Blastostethus pallescens</i> @ 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

28.2 Management of red spider mite, *Tetranychus urticae* infesting rose in polyhouse conditions (MPKV)

Variety	:	Variety will be selected as per the university recommendation
Micro Plot size	:	2x2 m
Layout	:	Randomized Block Design.
Treatments	:	T1: <i>Lecanicillium lecanii</i> (NBAIR VL8) 1x10 ⁸ spores/ g @ 5g/lt T2: <i>Beauveria bassiana</i> (NBAIR Bb-5a) 1x10 ⁸ spores/ g @ 5g/lt T3: <i>Metarhizium anisopliae</i> (NBAIR Ma4) 1x10 ⁸ spores/ g @ 5g/lt T4: Predatory mites <i>Neoseelus</i> sp. @ 20 per plant T5: Insecticide as per label claim / University recommendation T6: Untreated control
Replications	:	Four
Methodology and observations	:	Planting of seedlings in raised beds/plastic pots. Apply organic manure as per recommendations. Initial mite population /plant on 3 leaves from 10 plants. Record mite population 7 days after each spray. Yield parameters.

28.3 Evaluation of biocontrol agents for the control of sucking pests in capsicum under polyhouse (YSPUHF, PAU, IIHR)

Variety	:	Variety will be selected as per the university recommendation
Plot size	:	2x2 m
Layout	:	Randomized Block Design.
Treatments	:	T1: <i>Metarhizium anisopliae</i> (NBAIR) 1X10 ⁸ spore/ g @ 5g/lt T2: <i>Metarhizium anisopliae</i> (IIHR) oil based formulation @ 1ml/1L for only IIHR T3: <i>Lecanicillium lecanii</i> (NBAIR) 1X10 ⁸ spore/ g @ 5g/lt T4: <i>Beauveria bassiana</i> (NBAIR) 1X10 ⁸ spore/ g @ 5g/lt T5: <i>Chrysoperla zastrowi sillemi</i> @ 4 larvae / plant, 2-3 releases(weekly) to be made. T6: Five (weekly) releases of <i>Blaptostethus pallescens</i> @ 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

28.4 Integrated management of root-knot nematodes in polyhouses using *Pochonia chlamydosporia* (DRYSRHU (cucumber), NBAIR (capsicum))

(Biocontrol agents supplied by NBAIR)

Root knot nematode in cucumber: DRYSRHU, Ambajipeta (Biocontrol agents supplied by NBAIR)

Crops: Polyhouses in Bangalore

Area: Farmers polyhouses, 0.5-1ha/treatment.

Observations: Plant mortality/recovery; gall index; yield parameters; benefit-cost ratio.

Treatments:

T1: *P. chlamydosporia* (NBAIR) 10⁶⁻⁷ cfu/m²

T2: PGPR bacterium (NBAIR) 10⁶⁻⁷ cfu/m²

T3: *P. chlamydosporia* (commercial) 10⁶⁻⁷ cfu/m²

T4: PGPR bacterium (commercial) 10⁶⁻⁷ cfu/ m²

T5: T1+T2

T6: T3+T4

T7: Carbofuran

T8: Control; Replications: 4; Plot size: 2x2m² or 4x1m²

29. TOBACCO

29.1 Evaluation of bio-pesticides in suppressing tobacco stemborer, *Scrobipalpa heliopa* on tobacco

Crop	:	Tobacco
Plot size	:	5 x 5 m
Design		Randomized Block Design
Treatments		T1: <i>Beauveria bassiana</i> T2: <i>Metarhizium anisopliae</i> . T3: <i>Bt</i> formulation T4: <i>Nomuraea rileyi</i> T5: Chlorantraniliprole T6: Untreated Control
Replications		Four replications
Seasons		Rabi, 2018-2019 and 2019-2020
Observations		<ul style="list-style-type: none"> • Percent infestation • No of larvae and pupae/ plant Weekly observations from 10 DAP

29.2 Impact of contaminated prey on life parameters of insect predators

Design: Complete Randomized Design (CRD)

Treatments : T1= Aphids (Imidacloprid treated),
T2= Aphids (Thiamethoxam treated)
T3 = Aphids (Pymetrozine treated)
T4= Aphids (Flonicamid treated)
T5= Aphids (control)

Replications : Four replications.

Observations : To study the fecundity, longevity and % mortality of Coccinellids.

30 FLOWER CROPS

CARNATION

New experiment

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

Crop	:	Carnation (<i>Dianthus caryophyllus</i> 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)
Design	:	RBD
Area to be covered	:	Poly house
Likely duration	:	03 years
Methodology		Laboratory reared 8- days old nymphs of <i>Blaptostethus pallelescens</i> 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	:	<ul style="list-style-type: none"> ➤ 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

31 CROP DISEASE MANAGEMENT

31.1 Large scale field demonstration trials (GBPUAT),

Rice-100 ha

Tomato-20 ha

Peas 25ha

30.2 Large scale demonstration of bioagents based IPM module for whitegrub in groundnut

Year of commencement: AAU, Anand

Location: Farmers fields of Mahuva and Una taluk, Bhavnagar District. Gujarat

Area: 400 acres

Methodology:

1. Groundnut block (400 acres) will be adopted. Selection of block will be as per NGO choice.
2. Farmers will do the following operations on their own cost/ subsidized by NGO
 - Deep summer ploughing and heavy pruning of trees before onset of monsoon
 - On the onset of monsoon border trees of the field will be sprayed with imidacloprid (7ml/10 lit water) and chlorpyrifos (20 ml/ 10lit water)
3. Enrichment of FYM with biopesticides
Metarhizium anisopliae 6 kg each/ha
4. Seed treatment with chlorpyrifos @ 5%/ kg of seeds
5. All bio-pesticides will be applied as soil application prior sowing.

Observations to be recorded

1. Adults count (50 trees/block will be observed continuously for three days)

2. Larval populations/ meter length row near root zone in treated blocks and untreated blocks (entire block will be divided into 50 sub blocks and from each block 2 samples will be collected)
3. Yield/ha (will be collected same as above)

Collaboration:

NGO – Gram Nirman Samaj (Devaliya)
TKF (Triveni Kalyan Foundation) Mahuva
APMC, Mahuva. Bhavnagar District, Gujarat