

**PROCEEDINGS
OF
TWENTY-THIRD ANNUAL REVIEW MEETING OF ALL INDIA
NETWORK PROJECT ON SOIL ARTHROPOD PESTS
&
TECHNICAL PROGRAMME 2022-2024**



**ORGANIZED BY ICAR AND CSK-HPKVV, PALAMPUR,
HIMACHAL PRADESH DURING JULY 20-21, 2022
IN
HYBRID MODE**



**NETWORK UNIT
S.K.N. AGRICULTURE UNIVERSITY
RAJASTHAN AGRICULTURAL RESEARCH INSTITUTE, DURGAPURA,
JAIPUR 302018**

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Supervision and Guidance: Dr. A.S. Baloda, Network Coordinator

Compiled and Edited by: Dr. Seema Rani and Dr. Swati Bugalia

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I am obliged to Dr. T.R. Sharma, Deputy Director General (CS) ICAR for being the Inaugural session's Chief Guest and for his abundant encouragement and support. I am grateful to Prof. Harinder K Choudhary, Hon'ble VC, CSK HPKV, Palampur for his encouraging words and support from Leicester, UK. I am thankful to the Honorable Dr. Mandeep Sharma, Acting VC, CSK HPKV, Palampur for chairing the inaugural Session of the workshop and Dr. S.C. Dubey, ADG (PP & B) ICAR, New Delhi for his suggestions for strengthening the research work on soil arthropod pests under AINP on SAP. I am appreciative to Dr. S.P. Dixit, Director of Research, CSK HPKV, Palampur, for his welcome address and Dr. Ajay Sood, CSK HPKV, Palampur for delivering the vote of thanks.

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I placed on record my gratitude to Dr. T.R. Sharma, Deputy Director General (CS) ICAR, Dr. S.C. Dubey ADG (PP&B) ICAR, New Delhi, Dr. P. K. Metha, (Retd.) Dean, College of Agriculture and PS, Entomology, CSK HPKV Palampur, Himachal Pradesh, Dr. R. D. Gautam, Prof. & Retd. Head, Division of Entomology, IARI, New Delhi and Dr. G. K. Mahapatro, Head, ICAR-IARI Regional Station, Pune, National Fellow ICAR & Principal Scientist for Chairing and Co-Chairing different seasons.

I thank Dr. B.L. Jakhar, Associate Professor, RARI, Durgapura, Jaipur, K. S. Verma, Scientist, CSK HPKV, Palampur, Mr. Amit Paschapur, Scientist, Almora, Dr. Sudhanshu Bhagwati, Scientist & Dr. Kritideepan Sarmah, Junior Scientist, AAU, Jorhat, Assam, Dr. K. V. Prakash, Assistant Entomologist, GKVK, Bengaluru; rapporteurs' of different sessions for the presentation of recommendations.

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I also thank to Dr. Seema Rani and Dr. Swati Bugalia for compilation of the report, proceeding and technical programme for year 2022-2024.

Last, but not the least, we express our special indebtedness and obligation to all the participants, scientists and guests for attending the group meeting and making it a grand success.

Dr. A. S. Baloda

Director and Project Coordinator

Rajasthan Agricultural Research Institute, Durgapura, Jaipur 302018

WORKSHOP PROGRAMME

23rd Annual Review Meeting of All India Network Project on Soil Arthropods Pests at CSK-HPKV, Palampur, Himachal Pradesh

July 20, 2022 (Wednesday); 1 st day		
9:30-10:00AM, Registration		
I. Inaugural Session [10:00-11:00 AM]		
Chairman	Dr. T. R. Sharma, Deputy Director General (CS), ICAR, New Delhi	
Co-chairman	Dr. S. C. Dubey, Assistant Director General (PP&B), ICAR, New Delhi	
Rapporteurs	Dr. Sudhanshu Bhagwati, Scientist, AAU-J, Jorhat, Assam	
10:00-10:30 AM	<p>Welcome & Project Coordinator's Report by Network Coordinator, AINP on SAP & Director, RARI, (SKNAU, Jobner) Durgapura, Jaipur</p> <p>And Release of Folders, Bulletins, Technology folders, etc.</p>	Dr. Arjun Singh Baloda Director, RARI, Network Coordinator, AINP on Soil Arthropod Pests
10:30-10:40 AM	Remarks by Co-Chair	Dr. S. C. Dubey, Assistant Director General (PP& BS), ICAR, New Delhi
10:40-10:55 AM	Inaugural Address by Chairman	Dr. T. R. Sharma, Deputy Director General (CS), ICAR, New Delhi
10:55-11:00 AM	Vote of thanks	Dr. R.S. Chandel, PI, AINP on SAP, CSK HPKV, Palampur
11:00-11:15 AM Tea Break		
II. Panel discussion for collaboration between Institutes and AICRPs/AINP/NCIPM; ATR and Feedback [11:15-02:00 PM]		
Chair	Dr. T. R. Sharma, Deputy Director General (CS), ICAR, New Delhi	
Co-Chairs	Dr. S. C. Dubey, Assistant Director General (PP&B), ICAR, New Delhi	
Rapporteurs	Dr. Amit Paschapur, Scientist, Almora, Uttarakhand Dr. Sudhanshu Bhagwati, Scientist, AAU-J, Jorhat, Assam	
Speakers		
11:15-11:25 AM	Dr. A. S. Baloda, Network Coordinator, AINP on Soil Arthropod Pests	
11:25-11:35 AM	Dr. Subhash Chander, Director, NCIPM, New Delhi	
11:35-11:45 AM	Dr. M. Nagesh, Director, NBAIR, Bengaluru, Karnataka	
11:45-11:55 AM	Dr. H.V. Singh, Director, NBAIM, Mau	
11:55-12:05 PM	Dr. Vipin Chaudhary, Coordinator, AINP on Vertebrates Pest Management	
12:05-12:15 PM	Dr. Anil Sirohi, Project Coordinator, Nematodes	
12:15-12:25 PM	Dr. Balraj Singh, Project Coordinator, AICRP on Honey Bees and Pollinators	
12:25-12:35 PM	Dr. C. Chinmade Gowda, Network Coordinator, Acarology	
12:35-12:45 PM	Dr. Vandana Tripathi, Network Coordinator, AINP on Pesticide Residues	
Panellists		
12:45-12:55 PM	Dr. P. K. Mehta, (Red.) Dean College of Agriculture & PS, Entomology, CSKHPKV-Palampur, HP	

12:55-01:05 PM	Dr. G. K. Mahapatro, Head, ICAR-IARI, Regional Station, Pune, National Fellow, ICAR & Principal Scientist	
01:05-01:15 PM	Dr. R. D. Gautam, Professor & Head (Retd.), Entomology, IARI, New Delhi	
01:15-01:25 PM	Dr. V. V. Ramamurthy, Former Head, Division of Entomology, IARI, New Delhi	
01:25-01:35 PM	Other may be joined online	
Remark by Co-Chairman	Dr. S. C. Dubey, Assistant Director General (PP&B), ICAR, New Delhi	
Remark by Chairman	Dr. T. R. Sharma, Deputy Director General (CS), ICAR, New Delhi	
02:00-02:30 PM, Lunch break		
III. Presentation of Progress Reports and Technical Programme by Centres [02:30-06:00 PM]		
Chair	Dr. T. R. Sharma, Deputy Director General (CS), ICAR, New Delhi	
Co-Chair	Dr. S. C. Dubey, Assistant Director General (PP&B), ICAR, New Delhi	
Rapporteurs	Dr. Kritdeepan Sarmah, Junior Scientist, AAU-J, Jorhat, Assam Dr. K. S. Verma, Scientist, CSK-HPKV, Palampur, HP	
02:30-02:45 PM	Dr. Arup Kumar Sarma Principal Scientist	AINP on SAP, AAU-J, Jorhat, Assam
02:45-03:00 PM	Dr. D. Rajanna /Dr. Prakash Principal Scientist	AINP on SAP, University of Agricultural Sciences G.K.V.K, Bengaluru, Karnataka
03:00-03:15 PM	Dr. K.S. Verma, Principal Scientist	AINP on SAP, CSK HPKV, Palampur
03:15-03:30 PM	Dr. B. L. Jakhar, Associate Professor	AINP on SAP, RARI, Durgapura, Jaipur
03:30-03:45 PM	Dr. Amit Paschapur, Scientist	AINP on SAP, VPKAS, Almora
03:45-04:00 PM	Dr. U. B. Hole Professor of Entomology	AINP on SAP, RCSI College of Agriculture, MPKV, Rahuri, Kolhapur, Maharashtra
04:00-04:15 PM	Mr. J. P. Singh, Secretary/ Dr. Seema Rani, Research Associate	VC AINP on SAP, FARMER NGO, Ghaziabad, Uttar Pradesh
04:15-04:30 PM	Dr. Kolla Sreedevi Principal Scientist	NBAIR, Bengaluru, Karnataka
04:30-04:45 PM	Dr. A.K. Pandey Principal Scientist	G.B. Pant Agriculture University & Technology, Pantnagar
04:45-05:00PM Tea break		
05:00-05:15 PM	Dr. Deepa Bhagat Principal Scientist	NBAIR, Bengaluru, Karnataka
05:15-05:30 PM	Dr Sharad Mohan Principal Scientist	Division of Nematology, IARI, New Delhi
05:30-05:45 PM	Dr. Shankar Narayan Entomologist	Sugarcane Breeding Institute Regional Centre, Coimbatore
06:00-06:15 PM	Remark by Co-chair	Dr. S. C. Dubey, Assistant Director General (PP&BS), ICAR, New Delhi
06:15-06:30 PM	Remark by chair	Dr. T. R. Sharma, Deputy Director General (CS), ICAR, New Delhi

July 21, 2022 (Thursday), 2nd day

SESSION IV: Technical programme for 2022-24 [9:30-11:30AM]		
Chair	Dr. S. C. Dubey, Assistant Director General (PP&B), ICAR, New Delhi	
Co-Chair	Dr. Arjun Singh Baloda, Network Coordinator, AINP on SAP & Director, RARI, (SKNAU, Jobner) Durgapura, Jaipur	
Rapporteurs	Dr. Amit Paschapur, Scientist, Almora Dr. Sudhanshu Bhagwati, Scientist, AAU-J, Jorhat	
	Discussion Regarding Technical Programme	
	Discussion with Panellists	
Remark by Co-Chair	Dr. Arjun Singh Baloda, Network Coordinator, AINP on SAP & Director, RARI, (SKNAU, Jobner) Durgapura, Jaipur	
Remark by chair	Dr. S. C. Dubey, Assistant Director General (PP&B), ICAR, New Delhi	
11:30-12:00PM Tea break		
SESSION V: Institute and industry interactions [12:00-02:00PM]		
Chair	Dr. S. C. Dubey, Assistant Director General (PP&B), ICAR, New Delhi	
Co chair	Dr. R. S. Chandel, Professor Entomology, CSK-HPKV, Palampur	
Rapporteurs	Dr. K.V. Prakash, Assistant Entomologist, GKVK, Bengaluru Dr. B. L. Jhakar, Associate Professor, RARI, Durgapura, Jaipur	
Speakers	Coordinators of different Plant Protection Groups Industrialists Expert Panellists	
Remark by Co-chair	Dr. R. S. Chandel, Professor, Department of Entomology, CSK-HPKV, Palampur	
Remark by chair	Dr. S. C. Dubey, Assistant Director General (PP&B), ICAR, New Delhi	
02:00-02:30 Lunch break		
SESSION VI: Valedictory and Plenary [02:30-05:00 PM]		
Chair	Dr. S. C. Dubey, Assistant Director General (PP&B), ICAR, New Delhi	
Co- Chair	Dr. R.D. Gautam, Professor & Head (Retd.), Entomology, IARI, New Delhi	
02:30-03:45PM	Presentation of recommendations by Rapporteurs of each sessions	Dr. K.V. Prakash, Entomologist, GKVK, Dr. Dharmrajsingh Jethva , Scientist, JAU, Dr. Amit Paschapur, Scientist, Almora Dr. Sudhanshu Bhagwati, Scientist, AAU-J Dr. Kritdeepan Sarmah, Junior Scientist, AAU-J Dr. K. S. Verma, Scientist, CSK-HPKV, Palampur Industrialist
03:45-04:45 PM	Remarks (Panellists)	Dr. R.D. Gautam
	Remarks (Panellists)	Dr. P. K. Mehta
	Remarks (Panellists)	Dr. G.K. Mahapatro
	Remarks (Panellists)	Dr. V.V. Ramamurthy
	Remarks by Chairman	Dr. S. C. Dubey
04:45-05:00 PM	Vote of Thanks	Dr. Arjun Singh Baloda, Network Coordinator, AINP on SAP & Director, RARI, (SKNAU, Jobner) Durgapura, Jaipur

PROCEEDINGS OF THE TECHNICAL SESSIONS

The Significant achievements and recommendations of the various sessions are as follows.

SESSION I: INAUGURAL SESSION

The 23rd AINP on SAP Annual Review Meeting was organized under the aegis of the Indian Council of Agricultural Research, New Delhi at Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishvavidyalaya (CSK-HPKV), Palampur, Himachal Pradesh during July 20-21, 2022 in hybrid mode. The inaugural session was started with the playing of university song followed by lighting of lamp by Dr. Mandeep Sharma, Acting Hon'ble Vice Chancellor, CSK HPKV, Palampur, Dr. T. R. Sharma, DDG (Crop Sciences), ICAR, New Delhi, Dr. S. C. Dubey, ADG (PP&B), ICAR, New Delhi and Dr. S. P. Dixit, Director of Research, CSK-HPKV, Palampur. The delegates and the dignitaries were welcomed in Himachal's traditional culture. The invited experts Dr. P. K. Mehta, (Retd.) Dean College of Agriculture & PS, Entomology, CSK-HPKV, Palampur, Dr. R. D. Gautum (Retd.) Head, Entomology, IARI, New Delhi, and Dr. G.K. Mahapatro, Head, ICAR-IARI, Regional Station, Pune, National Fellow ICAR & Principal Scientist gave their introductory remarks. The delegates and invitees from AINP on SAP Centres, ICAR Institutes, Agricultural Universities, Representatives of Private Commercial Production Units, farmers and Staff of Department of Entomology of Palampur, attended the Inaugural Session.

The programme was as follows:

Welcome Address	: Dr. Mandeep Sharma, Acting Hon'ble Vice Chancellor, CSK HPKV, Palampur
Project Coordinator's Report	: Dr. A. S. Baloda, Network Coordinator AINP on SAP & Director, RARI, (SKNAU, Jobner) Durgapura, Jaipur
Inaugural Address by Chairman	: Dr. T. R. Sharma, DDG (CS), ICAR, New Delhi
Remarks by Co-Chair	: Dr. S. C. Dubey, ADG (PP&B), ICAR, New Delhi
Vote of Thanks	: Dr. R. S. Chandel, PI, AINP on SAP, CSK HPKV, Palampur, HP

Dr. A.S. Baloda, Network Coordinator AINP on SAP & Director, RARI, (SKNAU, Jobner) Durgapura, Jaipur, presented the salient achievements of the AINP on SAP for the year 2021-22. Dr. S. C. Dubey, ADG (PP&B), ICAR in his address valued the accomplishment of team work of AINP on SAP; he emphasized to cover soil arthropod pest survey with GPS based technology and make country wise mapping of major soil arthropod pests. He highlighted to increase

ecofriendly pest management approaches by demonstrating biocontrol technologies at large scale and by coordination between SAUs and ICAR. He also emphasized the role of label clam pesticides, quality biocontrol agents, light traps and pheromone traps in managing the soil arthropod pests and importance of uniform field experiments methodology at each climatic zone of country, evaluation of entomopathogenic fungi with entomopathogenic nematodes against soil arthropod pests, DNA based taxonomic identification, Nutritional profiling of soil arthropod pests and more research work on slugs infestation in country. He also suggested compiling them vise data in upcoming annual report.

Dr. T. R. Sharma, DDG (CS), ICAR, New Delhi counseled to prepare the technical program for the upcoming two years for the management of eight major soil arthropod pests by conducting an online meeting. He advised the constitution of the Expert Committee for reviewing the project's progress annually. He emphasized on providing more effort to an assessment of accurate crop losses due to soil insect pests. He suggested studying the reasons for changes in soil pests population and genetic variability in different climates and host plant assessments. He also suggested the evaluation of the effectiveness of pheromone, nano pesticides, and bio-control agents against soil insect pests. He congratulates all the participants for the successful discussion during two days workshop.

A total of eight Publications from SKNAU, RARI Durgapura; CSKHPKV, Palampur; GKVK Bengaluru and FARMER, Ghaziabad centers were released by the chief guest and other dignitaries. Dr. Mandeep Sharma, Acting Vice Chancellor, CSK HPKV, Palampur delivered key note address and briefed the role of the project in doubling farmers income across the country as a part of Hon'ble Prime Minister's flagship programme. Dr. R. S. Chandel, Organizing Secretary, CSK HPKV, Palampur delivered the message of Prof. H. K. Choudhary, Hon'ble Vice-chancellor, CSK- HPKV, Palampur to the house at this workshop due to his official visit at Leicester, UK.

SALIENT ACHIEVEMENTS OF AINP ON SAP DURING 2021-22

**Dr. A. S. Baloda,
Network Coordinator, Director, RARI, Durgapura, Jaipur, Rajasthan**

Introduction:

Soil arthropod pests are one of the major constraints in the production and productivity of several crops and cause million-dollar losses yearly, at times damage due to these pests goes up to 100% resulting in crop failures and sometimes necessitating re-sowing of the crop. White grubs belonging to Scarabaeidae are the serious pests damaging the root system by larval feeding resulting in huge losses. The damage inflicted is often noticed very late and their management is becoming very challenging due to their subterranean and polyphagous nature. White grub cause serious damage resulting up to 30-50 % yield loss in several parts of the country. Losses due to termites run to several millions of rupees in agricultural crops alone. Soil Arthropod pests damage to Rabi crops is as high as 37-40%, where 12-40 percent tuber damage by cutworms were also experienced; they cut seedlings at the base of the stem, resulting in lodging of the plants. Wireworms damage seeds thereby preventing seed germination and cause crop losses mainly in potatoes. Ghujia weevil and Red ants also have economic importance. In recent times, certain species of snails and slugs are becoming serious pests of the crops causing economic losses, mainly in vegetables, cereal, potatoes, carrots, maize, etc. The incidence of Molluscs (snails and slugs) was recorded in beans and peas at four locations in Himachal Pradesh.

Realizing the yield losses inflicted and seriousness of soil arthropod pests problem in several agricultural crops, the Indian Council of Agricultural Research started the All India Network Project on Soil Arthropod Pests. Subsequently, based on the severity of the damage, pheromonal works on the most predominant white grub species have been initiated in consultation with the Network Coordinator cell. With new aspiration and drive to coordinate location-specific research on soil arthropod pests management, now the project with sanctioned strength of 12 scientists to undertake the research work over a larger agro-ecological area.

White grubs have become increasingly difficult pests in India which are intensifying every year as evidenced by the several outbreaks that occurred over large areas in the recent past. As an unexpected emergence of white grubs beetles feeding on cotton flowers balls in Haryana, groundnut crop in Gujarat, cucurbits vegetables in Uttar Pradesh, citrus crop in Punjab and turmeric and sugarcane in Maharashtra and a major threat to numerous economically important crops may be due to intensive cultivation, improvements in irrigation facilities, conversion of fallow lands, deforestation as well as overall changes in the climatic scenario.

Mandate of AINP on SAP:

- To develop simple, economical, safe and practical integrated technology for the management of key white grubs and other soil arthropod pests under different agro climatic conditions and cropping systems of the country.

Objectives:

- Development of eco-friendly, bio-intensive integrated management strategies for soil arthropod pests, white grubs, termite, cutworms, wireworms, field cricket, mole cricket, root bugs, red ants, snails slugs, etc.
- Identification of local isolates of virulent host-specific pathogens (Entomopathogenic bacteria, fungi, virus and nematodes) for the management of soil arthropod pests.
- Isolation and identification of pheromones of key phytophagous white grub spp. (other than *Holotrichia consanguinea*, *Lepidiota mansueta*, *Holotrichia seticollis*) of different agro-ecological zones.
- To study the biodiversity, behaviour and crop losses with regard to soil arthropod pests to develop eco-friendly integrated management strategy.

Set up

With a view to fulfill the mandate effectively and efficiently, the Network project is functioning in close coordination with the following centers:

Main Centers

- RARI, Durgapura (Rajasthan)
- AAU, Jorhat (Assam)
- UAS, Bengaluru (Karnataka)
- CSK HPKV, Palampur (Himachal Pradesh)
- JAU, Junagadh (Gujarat)

Voluntary Centres

- VPKAS, Almora (Uttarakhand)
- FARMER Ghaziabad (Uttar Pradesh)
- RCSM, Kolhapur (Maharashtra)

National Collaboration:

- **NBAIR**
 - Taxonomic study of Scarabidae
 - For supply of fungal & bacterial biocontrol agents
 - Formulation of Nano-gels of pheromones
 - Pheromonal Studies

- Kairomonal studies
- **SBI- Coimbatore**
 - Study on Entomopathogenic Nematodes for management of white grubs
- **IARI Regional Station, Pune**
 - Study on Management of Termites

Brief summary of research achievements

Before planning any strategy for the management of insect pests, monitoring the pest is a pre requisite to understand the distribution and their species profiling. Last year pilot survey for species profiling was conducted at all centers of AINP ON SAP. At RARI, eight species of white grubs belonging to Melolonthinae and Rutelinae were collected with relative abundance of *Maladera insanabilis* (41.71%), *Holotrichia consanguinea* (38.90%). Ber, Apple ber, Neem, Guava, Mehandi, Castor, Khejari, and Moringa have been recorded as the main host trees of white grub beetles. The larval density of white grub was recorded between 4-11 grub/m² at eight locations in groundnut and pearl millet crops. The extent of damage at these locations were high where the grub population was 5 grub/m² or above.

At AAU-J; seven species of white grub were collected with relative abundance of *Apogonia ferruginea* (61.21%) and *Heteronychus* sp. (16.78%). Rose, Ber, Guava, Silikha, Satadal padma, Soalu and Agar were recorded as the main host trees of white grub beetles in this region. White grub infestation was recorded throughout the year between 5-35% in potato, sugarcane, colocasia, green gram, mango, ramie, areca nut, black pepper, and Kharif rice. Cutworm infestation was recorded between 5-25% in potato, toria, and king chilli in Majuli river island of Jorhat. Termites' infestation was recorded between 12-50% in sugarcane and tea. Red ants infestation was observed between 10-25% in potato, french bean, and cabbage.

At CSK HPKV, 14 species with the relative abundance of *Anomala varicolor* (23.38%) and *M. thomsoni* (15.49%); at Kullu, 10 species with the predominance of *M. thomsoni* (27.92%) and in Badegaon, 7 species with the high abundance of *Polyphylla* sp. (30.36%), at Sajar, 7 species with the maximum abundance of *B. coriacea* (29.73%) and 7-9 species with the relative abundance of *B. coriacea* (91.99% and 16.27%, respectively at Shilaroo and Chamba were recorded. Palampur centre also recorded the occurrence of two species of cutworm viz., *A. ipsilon* and *A. segetum* in Himachal Pradesh. Apple, stone fruits, walnut, wild rose, pear, nectarines, toon, mulberry and pecan nuts, passion fruits and wild spinach were recorded as host trees of white grub beetles in this region. At harvest time of potato, 10-50% white grub infestation in 14 potato growing locations and 1.8-6.4% incidence of wireworms in six locations was recorded. About 8.5-14.2% infestation due to cutworm was recorded in 5 crops viz., cabbage, tomato, pea, potato

and maize at 7 locations wherein a moderate level of infestation between 3.1-9.3% was observed in wheat crop. The infestation of red ants varied from 1.8 -6.4% at six locations in the potato crop. The incidence of Molluscs (snails and slugs) was also recorded as 13.9% in beans and 12.4% in peas at four locations.

At GKVK, 75 Scarab species belonging to four subfamilies, Cetoniinae, Rutelinae, Melolonthinae and Dynastinae was recorded in three major agro-climatic zones of Karnataka 40% of species belong to subfamily Cetoniinae followed by 32% of subfamily Rutelinae and 28% of species belong to Melolonthinae and Dynastinae. Maximum beetles were recorded on Neem, castor oil plant and Mulberry. A steady increase in white grub expansion was evident with 50% of areca nut and 80% of sugarcane fields.

At FARMER, 10 species of white grub collected belongs to four sub-families viz., Melolonthinae (96.69%), Rutelinae (2.24%), Scarabaeinae (0.61%), Dynastinae (0.46%) and Species *Holotrichia serrata* was found in abundance (73.01%). White grub adult beetle hosts recorded were Neem, Sheesham, Poplar, Guava, Jamun, Bakayan and Tun. White grub infestation in different crop were recorded as 5-7 grubs/ m² in sugarcane, 0-2 grub/ m² plant in turmeric, 1-4 grubs/m² in sorghum crop, 0-1 grub/m² in banana.

At RCSM, Kolhapur, seven species of white grubs belonging to Melolonthinae and Rutelinae were on host plants Neem, Babool, Ber, Ker and Moringa in this region. Twenty percent infestation was recorded in sugarcane crop at the rate 4.45 grubs/clumps and 27.45% infestation was recorded in groundnut at the rate 5.73 grubs/m².

At VPKAS, Almora, 54 species of scarab beetles were collected, which belong to 6 subfamilies viz., Melolonthinae (44.04%), Rutelinae (23.08%), Scarabaeinae (11.83%), Aphodiinae (9.25%), Hybosoridae (5.96%), Dynastinae (5.41%) and Geotrupidae (0.42%). The pre-dominant species were *Maladera similana* (11.5%) and *Aphodius nigrovirgatus* (9.25%). Preferred host plant of pleurostrict scarab beetles was recorded as Ligustrum sp. Elegant zinnia, Cyme rose and Common Crape Myrtle.

This detailed account of white grub monitoring was summarized only to acquaint the severity of damage and wide area covered by this pest which is increasing with time. In addition to this, receiving information regarding damage by different species of this pest to various crops from different parts of the country such as Maharashtra, Saurashtra Gujarat, Madhya Pradesh, Kerala, Jammu, etc. Scientists from Jammu, Madhya Pradesh, Andhra Pradesh, Maharashtra, Kerala, and Jodhpur Agricultural University also want to be a part of the coordinated project. This indicates the severity of damage and expansion of white grub infestation to newer areas and regions.

Therefore, to overcome the menace of white grubs and other soil arthropod pests, continuous surveillance and monitoring is required.

Pheromones and kairomones are highly species-specific and are safe to non-target organisms and the environment. Durgapura center has already isolated and identified the aggregating pheromone, methoxy benzene, of the predominant species, *Holotrichia consanguinea* and the technologies have been transferred to farmers from time to time to manage the pest. ICAR-AINP on SAP has developed a slow-release nanogel formulation of methoxy benzene, which is effective up to one month and, thus, avoiding replacement of septa frequently. The product is available at ICAR-AINP on SAP, Division of Entomology, RARI, Durgapura, Jaipur, Rajasthan. It has been included in the Package of Practices of white grub management in Rajasthan. AAU-J has isolated pheromonal compounds of *Lepidiota mansueta* viz., Cis-9 Hexadecenoic acid, Octadec-9 enoic acid, 1-Tetradecene, 1-Hexadecene and 1-Octadecenol in pure form and their five different blends were tested along with male and female body wash at Majuli during April, 2021. Almora centre isolated pheromone of scarab beetle, *Holotrichia seticollis* and identified as (1, 2; 1, 3 & 1, 4 diethyl benzene). The VL white grub beetle trap was patented (IN290170), commercialized and about 1960 pieces sold and used for management of scarab beetles.

Natural enemies of soil arthropod pests and some botanicals were also found reducing the field population of these pests. Efficacy of different EPF alone and mix with FYM was evaluated against *H. consanguinea* in groundnut at Research farm of RARI, Durgapura. Maximum pod yield 17.33 q/ha was recorded in *Metarhizium anisopliae* + FYM @ 1×10^9 CFU /gm/m², 15.78 q/ha pod yield was recorded in *Heterorhabditis indica* strain SBITND78 @ 10^8 IJs/ac treated crop field whereas it was only 2.89 q/ha pod yield in untreated plot. At AAU-J, evaluation of EPF against *L. mansueta* in green gram was done in Manjuli. *B. brongniartii* + FYM showed best result with 5.15 q/ha crop yield. In potato crop, highest tuber yield 137.00 q/ha was recorded in *H. indica* (Bio-Powder) @ 2.5 lakhs IJS per 5 gm/sqm treated plots. Moreover, the AAU-J has also developed a Jatropha oil based bio-formulation (AAU J oil 50 EC) which is found promising in managing different soil insect pests like cutworm and termites in potato and tea, respectively. At CSK HPKV, laboratory mortality of 3rd instar grubs of *H. longipennis* and *B. coriacea* due to EPF *B. brongniartii* (BbUASB₁₆ isolate) were recorded 16.23-65.86 % against *B. coriacea* grubs in subsequent weeks. In case of *H. longipennis* grubs exhibited mortality of 14.03, 29.56 and 62.90 % in first, second and third week of treatment, respectively.

The botanicals *Brahmastra* (prepared from five types of bitter leaves.), *Neemastra* (prepared from Cow dung, cow urine, neem leaves, and water), garlic + chilli extract and *Agniastra* (prepared by adding 5 kg of neem paste with around 1 kg of tobacco leaves, 0.5 kg of chillies and

0.5 kilo of garlic paste) were tested against 3rd and 6th instar larvae of cutworm (*A. segetum*) under laboratory conditions to know their deterrence. The order of feeding inhibition (FI) was obtained as *Brahmastra* > *Neemastra* > garlic + chilli extract > *Agniastra*. Ghaziabad centre isolated, identified and deposited in GenBank, two strains of EPNs *H. indica* (Accession Number OM149711) and (Accession number OM149712).

At VPKAS, Almora evaluated the efficacy of EPN against 1st instars of *Anomala bengalensis* and *Sophrops* sp. Among the entire tested EPNs native strain of *H. indica*, showed good potential with LD₅₀ 1230.27 IJs/ml against *A. bengalensis*. While, LD₅₀ 1023.29 (native strains) IJs/ml and 954.99 IJs/ml (commercial) were recorded against 1st instar of *Sophrops* sp. Analysis of the gut bacterial diversity of *A. bengalensis*, *H. longipennis*, *H. seticollis* and *B. coriacea* were carried out and a total of 45 bacteria isolated from the gut of white grubs were selected for identification through molecular characterization. The sequences obtained from PCR products of gut bacterial isolates were submitted to GenBank, NCBI and assigned accession numbers. Twenty-five Cellulolytic bacteria isolated from the different regions of the gut of white grub species, *A. bengalensis*, *H. longipennis*, *H. seticollis*, and *B. coriacea* were selected for identification through 16s rRNA sequencing and the phylogenetic tree was constructed using MEGA X software. A total of 15 field experiments to evaluate the efficacy of label claim insecticides against white grub, termites and cutworm through seed/setts treatment, drenching and granular application were done as four AINP on SAP centers as follows:

Profile of experiments carried out during 2021-22

Crops	Target Pests	Field Experiments
Sugarcane	White grub, termite	1 AAU-J, 2 FARMER, 2 GKVK
Potato	White grub	1 AAU-J, 1 CSK HPKV
Groundnut	White grub, termite	3 RARI, 2 RCSM
Chickpeas	Termite	1 RARI
Rajmash	White grub	1 CSK HPKV
Cabbage	cutworm	1 CSK HPKV
6	3	15

- At RARI, 7 insecticides as seed dresser in groundnut crop against *H. consanguinea* were evaluated and Imidacloprid 600 FS at the rate of 6.5ml/kg was found most effective at low plant mortality and low grub abundance with highest pod yield 28.04 q/ha.
- At RARI, 6 granular insecticides against *H. consanguinea* in groundnut crop showed that Chlorantraniliprole 0.4% GR was found most effective with low plant mortality and low grub abundance and highest pod yield 20.68 q/ha.
- At RARI, IPM approach for the management of soil arthropods in groundnut crop is slow release nanogel of pheromone Methoxy benzene (Anisole) is effective up to 25 days of installation and soil application of Neem cake@250kg/ha, seed treatment with Imidacloprid 600 FS @ 6.5 ml per kg seed, application of *Beauveria bassiana* 0.5g/m² and application of Imidacloprid 17.8 SL@ 300 ml/ha at 20-25 DAS is most effective.
 - At RARI, termite management in chickpea by seed treatment with Imidacloprid 600FS @ 6 ml per kg seed, drenching the crop with Imidacloprid 17.8 SL @ 360 ml or Fipronil 40% +Imidacloprid 40% per ha is most effective.
 - At AAU-J, Efficacy of six insecticides were evaluated against the 3rd instar larvae of *Lepidiota mansueta*. The soil application of Clothianidin 50 WDG @120 g a.i./ha (0.5g/lit. of water) recorded lowest percent of potato tuber damage as well as maximum yield.
 - At AAU-J, efficacy of 8 insecticides studied against termites in preserved setts of sugarcane and out of which the application of Clothianidin 50 WDG @ 1g/ l of water in preserved sugarcane setts has been recommended and included in the package of practices for *Kharif* crops of Assam.
 - At CSK HPKV, seed treatment in rajmash showed better results in Clothianidin 50 WDG (6.8% plant damage and 2.33 grubs/m²) followed by Chlorantraniliprole 18.5 SC (7.2% plant damage and 3.0 grubs/m²).
 - At CSK HPKV, Clothianidin 50 WDG at the rate 125 g a.i./ha was observed most effective among the 7 granular insecticides evaluated against white grubs in potato with least tuber damage on weight basis (4.86%) and number basis (5.36%).
 - At CSK HPKV, evaluation of synthetic chemicals against cutworms in cabbage at post sown application showed that Clothianidin 50 WDG treated plot recorded 1.90% plant infestation.
 - At FARMER, sugarcane setts treatment by 6 insecticides showed reduction of white grub population (90.90%), reduction in infested plant population (85.31%) and higher crop yield (773.33q/h) in Chlorantraniliprole 18.5 SC treated plot followed by Clothianidin 50

WDG with 84.81% white grub population reduction, 79.40% plant population reduction and higher 678.67q/h crop yield.

- At FARMER, white grub population reduction (89.28%), infested plant population reduction (72.36%) and highest crop yield (724 q/h) was recorded in Chlorantraniliprole 0.4% GR treated field among the 6 insecticides tested against white grub in sugarcane crop by drenching methodology followed by Clothianidin 50 WDG with 89.28% white grub population reduction, 70.19% plant population reduction and higher crop yield (705 q/h).
- At RCSM, Kolhapur, evaluated 7 granular insecticides in standing crop of sugarcane against white grub by drenching at the time of earthling up after 75 days of planting. Among them Imidacloprid 40% + Fipronil 40% WG @ 3g/ha recorded highest yield 95.57 t/ha followed by 84.72 t/ha in the treatment with Chlorantraniliprole 18.5 SC @ 500ml/ha.
- At RCSM, Kolhapur, seed treatment with different insecticides significantly reduced the incidence of termites in groundnut and results indicates that Thiamethoxam 30 FS @ 3 ml/ kg of seeds or Imidacloprid 600 FS @ 6.5 ml/kg of seed recorded least termites damage only 5-6% with significantly highest pod yield 6138-6225 kg/ha as compared to 31% damage and 5212 kg/ha pod yield in untreated control.
- At GKVK, Bengaluru conducted a field experiment in which sugarcane sett treatment was done by different insecticides; showed significant reduction of termite damage in sugarcane crop with Thiamethoxam 30 FS @ 1 ml/litre or Imidacloprid 600 FS @ 1 ml/litre recording least termite' damage of 5.07 to 6.01 % with highest cane yield of 138-142 t/ha compared to 30.31% damage with 106t/ha cane yield in untreated control plot.
- Soil drenching with Imidacloprid 17.8 SL @ 350 ml/ha also recorded least damage (11.33%) due to termites and highest cane yield of 125 t/ha compared to 30.66% damage with 102 t/ha cane yield in untreated control plot.

Taxonomic studies gives us various pieces of information such as locality, distribution, hosts, diagnostic features, natural enemies, ecology, behavior, etc. and these will leads to understanding the weak links of the pest and thus help in formulating strategies in managing the pest. Presently, ten species of white grub viz., *Holotrichia nagpurensis*, *Holotrichia rufoflava*, *Sophrops karschi*, *Idionycha excise*, *Brahmina mysorensis*, *Maladera rufocuprea*, *Anomala elata*, *Anomala biharensis*, *Anomala communis* and *Anomala dorsalis* in 21 states of the country was reported by NBAIR. The surveys revealed that continuous surveillance and monitoring is required for these species to ascertain their damage intensities, spread and occurrence.

Biodiversity of termites and development of maps on distribution of termite species, extensive surveys and collection of samples of different termite species were conducted in the three districts of Assam viz., Jorhat, Golaghat and Majuli by Jorhat centre. The distribution map of *H. serrata* and *Leucopholis* spp. with respect to ecological factors such as elevation, soil type and annual rainfall in Karnataka and distribution maps for 12 species of the genus *Protaetia* have been generated by Bengaluru centre.

Social engineering, the application of scientific research for soil arthropod pest management was carried out by each centre of AINP on SAP throughout the year. At RARI, 25 training programmes were conducted in groundnut fields and scientists of AINP-SAP participated as resource persons in training programmes organized by various departments/NGOs/farmers'. AAU-J carried out the social engineering/farmers participatory approach for the adult management of *L. mansueta* through light trap and scouting in Majuli river island of Assam. This mass campaigning programme was conducted by involving 35 *Lepidiota* Management Group (LMG) in collaboration with district administration, State Department of Agriculture, NGOs etc. CSK HPKV organized 3 farmers training programme at 3 locations. GKVK, centre carried out 29 farmers' trainings, 20 trainings for extension functionaries, 7 field days, and 8 method demonstration programme for white grub management. FARMER, Ghaziabad organized 6 farmers' trainings, 1 training for extension functionaries, 1 field day, participated in 5 exhibitions, 4 methods demonstrated and 1 technology showcasing regarding collection and destruction of adult beetles of white grubs in 6 districts of western UP and a total of 1480 beneficiaries benefited from these all activities.

As part of nutritional profiling of edible insects, analysis of desert locust, *Schistocerca gregaria* collected from RARI, Durgapura, Jaipur was analyzed and the results of the proximate analysis showed moisture, crude protein, carbohydrate, crude fat, crude fiber and ash content of 12.33%, 48.17%, 17.05%, 44.08%, 12.01% and 3.36%, respectively. Elemental analysis was done for 7 minerals, out of which K (49.93 mg/100g) was found to be the highest followed by Na (34.77 mg/100g) and Ca (26.15mg/100g). The Mg, Fe, Zn and Cu contents were recorded to be 20.15, 12.76, 12.18 and 4.85 mg/100g, respectively. AAU-J analyzed the nutritional profiling of 22 different insects (5 scarab species, 5 edible aquatic insects, 6 edible sericigenous insects, 4 Orthopterans and the desert locusts and termites) in terms of proximate, elemental, amino acid and fatty acid profiling etc. Research works on development of value-added food products fortified with insect powders as well as advance nutritional studies on edible insect powders aiming toxicological and microbial studies, sensory evaluation, and impact of cooking and preparation of edible insects on the nutritional quality, post-harvest aspects etc. are in progress.

AAU, Jorhat centre developed and standardized the method of extraction of Snail mucin by solvent and solvent free methods and also standardized the protocol for converting the liquid snail mucin to dry form. The centre has also developed some value-added products like diya, bouquet, pen stand etc. by utilizing the empty shells of Giant African snails.

The most important control measures for the white grubs are based upon observations regarding their life cycle; therefore, a thorough knowledge of the pest biology is necessary before developing management practices to control them. The biology of 5 predominant species *H. serrata*, *H. consanguinea*, *H. nagpurensis*, *A. dimidiata*, *M. Insanabilis* was studied in FARMER, laboratory.

Publications: During the year 2021-22, a total of 50 Research papers/symposium/papers/reviews/technical bulletins, etc. were published by the different centres under AINP on SAP.

SESSION II: PANEL DISCUSSION FOR COLLABORATION BETWEEN INSTITUTES AND AICRPS/AINP/NCIPM; ATR AND FEEDBACK

Chairman	Dr. T. R. Sharma, DDG (CS), ICAR, New Delhi
Co-Chair	Dr. S. C. Dubey, ADG (PP&B), ICAR, New Delhi
Rapporteurs	Dr. Amit Paschapur, Scientist, Almora Dr. Sudhanshu Bhagwati, Scientist, AAU, Jorhat

Speakers:

- Dr. Subhash Chander, Director, ICAR-NCIPM, New Delhi
- Dr. M. Nagesh, Director, ICAR-NBAIR, Bengaluru
- Dr. H.V. Singh, Director, ICAR-NBAIM, Mau
- Dr. Vipin Chaudhary, Coordinator, ICAR- AINP on Vertebrates Pest Management
- Dr. Anil Sirohi, Project Coordinator, ICAR-AICRP on Nematodes
- **Dr. Balraj Singh, Project Coordinator, ICAR- AICRP on Honey Bees and Pollinators**
- Dr. C. Chinnamade Gowda, Network Coordinator, ICAR-AINP on Agricultural Acarology
- Dr. Vandana Tripathi, Network Coordinator, ICAR-AINP on Pesticide Residues

Suggestions:

- ICAR-NCIPM, New Delhi, suggested for adaptation of bio-intensive in IPM practices to manage soil insect pests which will not be harmful to fauna and flora and facilitate in documentation of different soil insects in consideration of climate-changing scenarios.
- ICAR-NBAIR, Bangalore can collaborate with ICAR-AINP on SAP in the areas namely, insect taxonomy and species distribution studies, biological management of different soil insect pests by utilizing available EPN, EPF & Bt strains, Pheromonal studies of different white grub species after signing MoU with different SAUs, studies of white grub species distribution on based on climate change, and adoption of drone technology for white grub management.
- ICAR-NBAIM, Mau, suggested collaborating with ICAR-AINP on SAP and agreed to provide all available microbial bioagents for evaluation against different soil insect pests.
- ICAR-AICRP on Nematodes made a suggestion to support AINP on SAP for sharing its technology of identification and mass multiplication of entomopathogenic nematodes; this is valuable in the management of different soil arthropod pests.

- ICAR-AINP on Agricultural Acarology Suggested to assist ICAR-AINP on SAP in the survey and exploration of different predatory mites for the management of different soil insect pests.
- ICAR-AICRP on Pesticide Residues suggested collaboration with ICAR AINP on SAP for pesticide residue analysis of soil and crop product samples, after the national recommendation of insecticides against various soil insect pests.
- ICAR-AINP on Vertebrate Pest Management and ICAR- AICRP on Honey Bees and Pollinators was found helpless to assist with ICAR-AINP on SAP.

Panellists

- A proper protocol should be developed for uniform data collection regarding biodiversity, distribution map, and crop loss assessment. He also suggested equal distribution of work for each center within a timeline. **(Dr. P. K. Mehta, (Retd.) Dean College of Agriculture & PS, Entomology, CSK-HPKV-Palampur, HP)**
- Natural enemies available in a particular area should be multiplied for application in another required area for pest protection and significant data for each bio-agent including compatibility with other beneficial fauna should be developed for making an easy registration process of them. **(Dr. R. D. Gautam, Professor & Head (Retd.), Entomology, IARI, New Delhi)**
- Project progress review meeting with panelist should be done 3-4 times online each year for better performance of the project. A strong manual with detailed protocol and tables should be developed in the supervision of experts so that experiments can verify. Significant data on crop loss assessments, pest population structure, host plant resistance can be generated with the collaboration of other 6 AINPs. He also highlighted the importance of artificial intelligence (Drone technology) in AINP on SAP. **(Dr. G. K. Mahapatro, Head, ICAR-IARI, Regional Station, Pune, National Fellow, ICAR & Principal Scientist)**

Recommendations / Suggestions by Dr. S. C. Dubey, ADG (PP&B), ICAR, New Delhi

- IPM module for soil pest management should be developed in consultation/discussion with ICAR-NCIPM and for the purpose, annual reports of ICAR-NCIPM, New Delhi may be seen.
- ICAR-NBAIR, Bangalore should help AINP on SAP in technology development, Pheromones generation.

- The effective strains of bioagents from different centres should be evaluated against target pest across the centres of AINP on SAP.
- Promotion should be done to use only label claim pesticides by each centre of AINP on SAP.
- International/National standards should be adopted to collect crop loss assessment data by each centre of AINP on SAP.

Recommendations / Suggestions by Dr. T. R. Sharma, DDG (CS), ICAR, New Delhi

- Recommended for mentioning the framing of the timeline for carrying out the aforementioned activities with collaborations of other institutes
- All specific suggestions should be included in Technical Programme to set targets in the future.

SESSION III: PRESENTATION OF PROGRESS REPORTS AND TECHNICAL PROGRAMME BY THE CENTERS

Chair	Dr. T. R. Sharma, DDG (CS), ICAR, New Delhi
Co-Chair	Dr. S. C. Dubey, ADG (PP&B), ICAR, New Delhi
Rapporteurs	Dr. S. K. Verma, Scientist, CSK HPKV, Palampur Dr. Kritdeepan Sarmah, Jr. Scientist, AAU-Jorhat

Speakers:

- Dr. Arup Kumar Sarma, Principal Scientist, AINP on SAP, AAU, Jorhat, Assam
- Dr. D. Rajanna /Dr. Prakash, Principal Scientist, AINP on SAP, University of Agricultural Sciences G.K.V.K, Bengaluru, Karnataka
- Dr. K. S. Verma, Principal Scientist, AINP on SAP, CSK HPKV, Palampur
- Dr. B. L. Jakhar, Associate Professor, AINP on SAP, RARI, Durgapura, Jaipur
- Dr. Amit Paschapur, Scientist, AINP on SAP, VPKAS, Almora
- Dr. U. B. Hole, Professor of Entomology, AINP on SAP, RSCSM College of Agriculture, MPKV, Rahuri, Kolhapur, Maharashtra
- Mr. J. P. Singh, Secretary/Dr. Seema Rani, Research Associate, VC AINP on SAP, FARMER NGO, Ghaziabad, Uttar Pradesh
- Dr. Kolla Sreedevi, Principal Scientist, NBAIR, Bengaluru, Karnataka
- Dr. Deepa Bhagat, Principal Scientist, NBAIR, Bengaluru, Karnataka

Special invitees:

- Dr. Sharad Mohan, Principal Scientist, Division of Nematology, IARI, New Delhi
- Dr. B. Singaravelu, Principal Scientist, Sugarcane Breeding Institute, Coimbatore
- Dr. Shankar Narayanan, Entomologist, Sugarcane Breeding Institute, Regional Centre, Coimbatore

Achievements:

All major achievements of AINP on SAP during 2021-22 from all centers have been summarized above by Dr. A. S. Baloda, Network Coordinator.

Recommendations / Suggestions by Panelists

- Recommendation were made for the standardization of light traps to study the biodiversity of different white grub species and completion of the crop loss assessment

data of one or two crops each year by all the AINP on SAP centers. CSK-HPKV may assist other AINP on SAP centers in studying the scarabaeid population's genetic structure. Studies on resistant host plants for white grub should be included in the technical program of 2022-24. **(Dr. P.K. Mehta, (Retd.) Dean College of Agriculture & PS, Entomology, CSKHPKV-Palampur)**

- Counsel to study the natural enemies' biodiversity along with the soil arthropod pests' complex. **(Dr. R.D. Gautam, Professor & Head (Retd.), Entomology, IARI, New Delhi)**
- Advised to create a format for report writing and uniform data collection from each center, evaluation of the project progress twice in a year, and the inclusion of one hardcore biotechnologist in the group for carrying out different biotechnological research activities. **(Dr. G.K. Mahapatro, Head, ICAR-IARI, Regional Station, Pune, National Fellow, ICAR & Principal Scientist)**

Recommendations / Suggestions by Dr. S C. Dubey, ADG (PP&B), ICAR, New Delhi

- Emphasis must be given to generate data of Bt-62 (Bacterial strain) isolated by Sugarcane Breeding Institute, Coimbatore as a biocontrol agent against white grub. **(Action: Network Coordinator and All PIs of centres)**
- Commercialization of all the technology developed under the project should go through Agri-Innovation. **(Action: Network Coordinator and All PIs of centres)**
- Calculation of cost-benefit (C:B) ratio of any product and technology development under the project must be done. **(Action: All PIs of Centres)**
- Instructed to recheck the data regarding IPM modules in ground nut. **(Action: RARI, Durgapura Centre)**
- Up scaling of the technology for development of plant extract if effective results were obtained and also taxonomically verify the species of the sample with the help of Dr. Kolla Sreedevi, NBAIR, Bengaluru. **(Action: Almora Centre)**
- Confirmation of the newly identified species by using advanced molecular techniques. **(Action: Dr. K. Sreedevi, NBAIR, Bengaluru)**

Recommendations / Suggestions by Dr. T. R. Sharma, DDG (CS), ICAR, New Delhi

- Dr. Sharad Mohan (Principal Scientist, Division of Entomology, IARI, New Delhi) and Dr. C. Sankarnarayanan (Principal Scientist, Nematology, Sugarcane Breeding Institute, Coimbatore) should be involved in the AINP on SAP for their expertise on EPNs as they are effective against white grub and other insect pests. **(Action: Network Coordinator)**

- Collaboration of all the centres with different institutes by signing MOUs for better research to be initiated. (**Action: Network Coordinator and All PIs of centres**)
- All the presentations should be concise, specific and must be presented within stipulated time next year. (**Action: Network Coordinator and All PIs of centres**)
- Emphasis should be given on application of statistics for better data interpretation of the results. (**Action: Network Coordinator and All PIs of centres**)
- Emphasis should be given for use of pheromone and semio-chemical technology as well as promotion of EPNs in management of insect pests. (**Action: Network Coordinator and All PIs of centres**)
- Scaling up as well as commercialization of pheromone to be done. (**Action: Dr. Deepa Bhagat, NBAIR, Bengaluru**)

The recommendations and the technical Programme for 2022-24 were finalized during the season.

SESSION IV: TECHNICAL PROGRAMME FOR 2022-24

Chair	Dr. S. C. Dubey, Assistant Director General (PP&BS), ICAR, New Delhi
Co-Chair	Dr. Arjun Singh Baloda, Network Coordinator, AINP on SAP & Director, RARI, (SKNAU, Jobner) Durgapura, Jaipur
Rapporteurs	Dr. Amit Paschapur, Scientist, Almora Dr. Sudhanshu Bhagwati, Scientist, AAU, Jorhat

An encouraging discussion conducted on technical programme that followed during 2021-22; to make it more efficient regarding of soil arthropod pests studies at different climatic zones of the country.

Recommendations/ Suggestions:

All the AINP on SAP centres will include their validated technologies in the package of practice of various states pest protection programme. **(Action: Network Coordinator)**

- Crop loss assessment with respect to economic values due to soil arthropod pests should be included in technical programme of 2022-24. **(Action: Network Coordinator and All PIs of centres)**
- White/yellow light with 250-350 micrometer wavelength or bright 160 watt mercury vapor lamps are ideal for beetles' collection at any areas. All data collection of beetles & their natural enemies through light trap/pheromone trap should be on GPS location and climatic correlation based. **(Action: Network Coordinator and All PIs of centres)**
- Studies on population monitoring of beetles on host trees has to be studied in more details as host preference, host resistance, ETL etc. **(Action: Network Coordinator and All PIs of centres)**
- Isolated and identified native strains of natural enemies of white grub by different centers were evaluated initially in laboratory following suitable bioassays techniques and after that large scale field studies will be conducted. **(Action: Network Coordinator and All PIs of centres)**
- To update farmers about soil arthropod pest biology and their management through ecofriendly advanced technology; field days, farmers meetings and farmer fairs should be organized or participated on a regular basis. **(Action: Network Coordinator and All PIs of centres)**
- After proper identification and biodiversity studies of termites'; a distribution maps in different states should be developed. **(Action: Network Coordinator and All PIs of centres)**

- The Bio-agent-based management strategies for termites have to be developed along with meticulous preliminary laboratory bioassays. **(Action: Network Coordinator and All PIs of centres)**
- A pheromone for one predominant species of white grub should be developed. **(Action: All PIs of centres)**
- A comprehensive note on use of drones for surveillance, diagnostic and recommendation of management practices against soil arthropod pests at various climatic zones locations should be prepared by each center. **(Action: All PIs of centres)**
- For management of white grubs through chemical methods, only label claimed insecticides have to be tested and the promising results should be included in the package of practices of different states and the B:C ratio of insecticides also calculated. **(Action: All PIs of centres)**
- Technical Manuals must be developed for the data recording of research observations in the experiments of AINP. Tables, procedures, protocols, damage/infestation methods/methodologies should be clearly detailed in the manual, and all AINP centres should follow uniform data recording procedures with replicable tables, data spread sheets etc. **(Action: All PIs of the centres)**
- Different strains of bioagents viz., EPN, EPF, EPB etc and their commercial formulations make available for evaluation in laboratory and field conditions against target pest with proper protocol. **(Action: SBI, Coimbatore, NBAIR & GKVK Bengaluru and FARMER, Ghaziabad)**
- After proper identification and biodiversity studies of cutworm'; a distribution maps and a suitable IPM strategies will be developed. **(Action: AINP on SAP CSK-HPKV, Palampur centres)**
- To make easy the identification of major white grub species; a well developed illustrative diagrammatic presentation and taxonomic keys of dominant white grub species will be developed. **(Action: GKVK and NBAIR, Bengaluru, Karnataka)**
- The entomopathogenic fungi *Beauveria brongniartii* will be provided to other centers along with proper bioassays methodology. **(Action: GKVK, Bengaluru)**
- The morphological characterization of white grub collections by each center of AINP on SAP should be done at NBAIR. **(Action: Dr. Kolla Sreedevi, Principal Scientist, NBAIR, Bengaluru, Karnataka)**
- A standard protocol for uniform data collection on genetic variability, infestation, population structure of white grub, in different crops at different climatic zones of the country should be developed and followed by each center. **(Action: Dr. K. V. Prakash, Entomologist, NBAIR, Bengaluru, Karnataka)**

- Digitalization of identified white grub species data should be completed within one year. **(Action: Dr. K. V. Prakash, Entomologist, NBAIR, Bengaluru, Karnataka)**
- The sawdust based bio-formulation should be supplied to different centres for confirming its efficacy against various insect pests. **(Action: AAU-Jorhat, Assam)**
- The work on the utilization of white grub gut-flora for decomposition of organic matter and crop residues will continue at Almora center and the standardized pheromone collection apparatus should be supplied to other centers **(Action: VPKAS, Almora)**
- A 7-10 days training programme on isolation and characterization of insect semio-chemicals will be organized at NBAIR, Bangalore. **(Dr. Deepa Bhagat, Principal Scientist, NBAIR, Bengaluru)**

All valuable suggestions and recommendations will be incorporated into the technical programme 2022-2024.

SESSION V: INSTITUTE AND INDUSTRY INTERACTIONS (I-I-I)

Chair	Dr. S. C. Dubey, Assistant Director General (PP&B), ICAR, New Delhi
Co chair	Dr. Arjun Singh Baloda, Network Coordinator, AINP on SAP & Director, RARI, (SKNAU, Jobner) Durgapura, Jaipur
Rapporteurs	Dr. K.V. Prakash, Assistant Entomologist, GKVK, Bengaluru Dr. B. L. Jakhar, Associate Professor, RARI, Durgapura, Jaipur
Speakers	Industrialist, Farmer, Expert panelist

The session started with the welcome address by Dr. Arjun Singh Baloda. He shared his ICAR – Institution experience and presented the current scenario, challenges, scope, and opportunities in ICAR- Institute - Industry interaction. He told that the institute and industry interactions (I-I-I) is the most preferred activity for mutual benefit and growth of both. This type of workshop provides the best platform for showcasing the best advancements, implementation, and impact for the institute and industry. He highlighted the key role of native strains of different bioagents in crop protection.

The industrialist Mr. Khandelwal briefed up about the activities being undertaken towards enhancing bioagents use in various agricultural activities. He stated that the banana weevil successfully controlled by EPN. He requested the scientists of different institutions that after product development and recommendation; they should assist them in registration of the final product by sharing toxicological data of the product. To fulfill the need of funds in institutes to develop a product or technology, he offered public-private collaborations.

One farmer from Punjab informed that the white grub-infested 5-acre guavas orchard in Haryana was successfully controlled by entomopathogenic nematodes. He informed white grub beetles infestation in cotton bolls and white grubs in citrus plants also. He appreciated the farmers' meet programs conducted by ICAR for farmers' awareness and demand for more such activities on a large scale.

Dr. S. C. Dubey, ADG (PP&B), ICAR, New Delhi thanked all the participations for participating in a healthy and active discussion for the improvement in AINP on SAP technical programme 2022-24. In his logical conclusion, he stated that effective bioagents and pesticides should be registered and the toxicological data should be displayed on website of the institutes. He also stated that as per new guidelines of registration, no need to generate toxicological data for the same species of bioagents or for similar formulations already registered having similarity in conserve region. He suggested that anyone can generate new formulation after signing MOU on royalty basis. He also point out that as less number of players active in this field, scaling up of

technology and sharing of technical backup with industries after MOU is ICAR moral responsibilities.

All valuable suggestions and recommendations will be incorporated into the technical programme 2022-24.

SESSION VI: VALEDICTORY AND PLENARY

Chair	Dr. S. C. Dubey, Assistant Director General (PP&B), ICAR, New Delhi
Co- Chair	Dr. Arjun Singh Baloda, Network Coordinator, AINP on SAP & Director, RARI, (SKNAU, Jobner) Durgapura, Jaipur Dr. S. P. Dixit, Director of Research, CSK HPKV, Palampur
Panelists	Dr. P.K. Mehta, (Red.) Dean College of Agriculture & PS, Entomology, CSKHPKV-Palampur Dr. G.K. Mahapatro, Head, ICAR-IARI, Regional Station, Pune, National Fellow, ICAR & Principal Scientist Dr. R. D. Gautum, Professor & Head (Retd.), Entomology, IARI, New Delhi
Rapporteurs of each session	Dr. Sudhanshu Bhagwati, Scientist, AAU-J Dr. Kritdeepan Sarmah, Junior Scientist, AAU-J Dr. Amit Paschapur, Scientist, Almora Dr. K. S. Verma, Scientist, CSK-HPKV, Palampur Dr. K.V. Prakash, Entomologist, GKVK, Bengaluru
Convener	Dr. Ajay Sood, CSK-HPKV, Palampur

Recommendations/Suggestions:

- Dr. R. D. Gautam, Professor & Head (Retd.), Entomology, IARI, New Delhi appreciated the teamwork done under ICAR-AINP on SAP and blessed for the future.
- Dr. P.K. Mehta, (Red.) Dean College of Agriculture & PS, Entomology, CSK-HPKV, Palampur, cherished the AINP on SAP team for exclusive work done at each centre. He also showed extreme happiness to rejoining the AINP on SAP team and assuring for any help in the future also.
- Dr. G.K. Mahapatro, Head, ICAR-IARI, Regional Station, Pune, National Fellow, ICAR & Principal Scientist, valued all the significant discussion done in two days on soil arthropod pests management. He shared his rich experience on termite management and assured of any assistance in the project by sharing his research experience.
- Dr. S. P. Dixit (Soil Scientist), Director of Research, CSK-HPKV, Palampur thanked ICAR for choosing the CSK, HPKV venue for conducting the workshop and he also thanked all dignitaries for participating in the annual review meeting of AINP on SAP. He proposed his willingness to conduct such events at CSK HPKV Palampur in the future also.
- Dr. S. C. Dubey, Assistant Director General (PP&B), ICAR, New Delhi, appreciated the healthy discussion done in two days. He was hopeful to incorporate all suggestions and recommendations in the technical program 2022-24. He suggested that the mid-term

review of project progress with panelists will work as a catalyst. He advised all presenters for the pinpoint presentation; like Hon'ble PM include all important things within 15 minutes "Man Ki Baat" program to the nation. The presentation should be output-oriented as the technology developed and publications. AINP on SAP should support students to do field experiments and generate data related to the project and publications. He thanked Dr. Madeep Sharma, Acting VC, CSK-HPKV, Dr. S. P. Dixit, Director, Research, CSK-HPKV for support, encouragement, and extraordinary hospitality, Dr. Chandel for the successful organization of the program, Dr. A. S. Baloda and his entire team, all dignitaries, Industrialist Mr. H. Khandalwal and farmers from Punjab for valuable inputs and make the successful event.

- At last, Dr. Arjun Singh Baloda, Network Coordinator, AINP on SAP & Director, RARI, (SKNAU, Jobner) Durgapura, Jaipur in his concluding remarks firstly thanked Dr. Ajay Sood for conveying the session smoothly. Hon'ble VC, CSK-HPKV, Palampur, Dr. T. R. Sharma, DDG (CS), ICAR, Dr. S. C. Dubey, ADG (PP&B), ICAR, and Directors of AINPs participated online, for their valuable time, direction, suggestions and recommendations in planning of technical programme 2022-2024; He thanked Dr. R. S. Chandel and all staff members for the fantastic arrangement and hospitality. Further, he thanked to Panelists, Speakers, and Rapporteurs of all Session, PIs of AINP on SAP Centers, NBAIR, Students of CSK-HPKV, Industrialist, farmers, and other all participants. He assured that all valuable suggestions and recommendations will be incorporated into the technical programme 2022-2024.

**ACTION TAKEN REPORT OF THE RECOMMENDATIONS OF 22ND
ANNUAL REVIEW MEETING**

S. No.	Recommendation	Action taken
1.	Slow release nano-gel pheromone is a potential technology and needs to be commercialized.	ICAR-AINP on SAP has developed a slow-release nanogel formulation of methoxy benzene, is available at ICAR-AINP on SAP, Division of Entomology, RARI, Durgapura, Jaipur, Rajasthan. It has been included in the Package of Practices of white grub management in Rajasthan.
2.	Crop losses inflicted by the key species of white grubs and other soil insect pests needs to be estimated.	In progress
3.	Population studies of white grubs under diverse cropping systems needs to be undertaken.	In progress
4.	Bio-pesticides used in soil insect pest management programme should be collected from the known sources.	Done accordingly
5.	AAU-J, Assam and CSK-HPKV, Palampur centre directed to use drone as a means of artificial intelligence in pesticide application as well as for the monitoring of white grub infestation areas should be explored.	Monitoring of white grub infestation areas were explored by drone as a means of artificial intelligence at both concerned centers.
6.	Efforts to be made to develop talc based formulations of different potential local strains of Entomopathogenic Nematode (EPN), Entomopathogenic Fungi (EPF) etc. to manage various soil insect pests.	<ul style="list-style-type: none"> • A biopowder of local strain of Entomopathogenic Nematode (EPN) <i>Heterorhabditis indica</i> developed at FARMER VC Ghaziabad to manage white grub. • A talc based formulations of local strain of Entomopathogenic Fungi (EPF) <i>Beauveria Brongniartii</i>, developed at GKVK, Bangaluru to manage white grub.
7.	Insecticides having label claim against various soil insect pests only to be included in management programme.	Only label claim insecticides were used for soil insect pests management at all centers of AINP on SAP.
8.	The social engineering work can be taken up by all the centres involved in the project so that an effective management of the white grubs and other soil arthropod pests can be attained over large areas.	The social engineering by using different technologies viz., FLDs, farmers trainings, new technology demonstrations, participations in various

S. No.	Recommendation	Action taken
		organizations were attained over large areas by all the AINP on SAP centres for effective management of soil arthropod pests.
9.	Countrywide map of different white grub species is to be prepared.	Country wide map of predominant white grub species was prepared by NBAIR (Dr. Kolla Sreedavi)
10.	Effect of climate change and its possible impact on population dynamics of soil arthropod pests needs to be studied.	Ongoing and continuous
11.	Project scientists should also organize meeting with NGO's, SHGs for the transfer of proven technologies to the farmers' field and other stakeholders.	Done accordingly
12.	Development of IPM module for the termite and other soil arthropod pests.	The IPM modules for predominate species of white grub in sugarcane, groundnut, potato, areca-nut, turmeric, and ginger have been developed. The IPM modules for predominant species of termites are in progress.
13.	The website of the project should be updated with success stories and other related information on the soil insect pests.	Ongoing and continuous
14.	The funds allotted under TSP should be utilized by the centres for conducting training programmes, organizing interactive sessions with farmers and providing equipment to farmers.	Done accordingly
15.	All the coordinated centers should submit their UC on or before 15 th May and AUC on or before 31 st August.	Done accordingly
16.	The monthly progress report should be submitted by 15 th of every month for its onward transmission to the Council.	Done accordingly

LIST OF PARTICIPANTS

Indian Council of Agricultural Research, New Delhi:

- Dr. T. R. Sharma, Deputy Director General (CS), ICAR, New Delhi
- Dr. S. C. Dubey, Assistant Director General (PP&BS), ICAR, New Delhi

Experts:

- Dr. P.K. Mehta, (Red.) Dean College of Agriculture & PS, Division of Entomology, CSK HPKV-Palampur
- Dr. G.K. Mahapatro, Head, ICAR-IARI, Regional Station, Pune, National Fellow, ICAR & Principal Scientist
- Dr. R. D. Gautam, Professor & Head (Retd.), Division of Entomology, IARI, New Delhi

Members online:

- Dr. Subhash Chander, Director, NCIPM, New Delhi
- Dr. M. Nagesh, Director, NBAIR, Bengaluru
- Dr. H.V. Singh, Director, NBAIM, Mau
- Dr. Vipin Chaudhary, Coordinator, AINP on Vertebrates Pest Management
- Dr. Anil Sirohi, Project Coordinator, Nematodes
- Dr. Balraj Singh, Project Coordinator, AICRP on Honey Bees and Pollinators
- Dr. C. Chinnamade Gowda, Network Coordinator, Acarology
- Dr. Vandana Tripathi, Network Coordinator, AINP on Pesticide Residues

Members Absent:

- Dr. V.V. Ramamurthy, Former Head, Division of Entomology, IARI, New Delhi
- Dr. Ashok Bhatnagar, Ex-Network Coordinator, AINP on SAP, RARI Durgapura
- Dr. Dharmrajsingh Jethva, Scientist, JAU-J, Junagadh, Gujarat

SKNAU, RARI, Jaipur, Rajasthan:

- Dr. Arjun Singh Baloda, Network Coordinator, AINP on SAP, Director, RARI
- Dr. B.L. Jakhar, Associate Professor, Entomology Division
- Dr. Swati Bugalia, YP, Biotechnologist
- Mr. Amar Chand Verma, Technical Assistant
- Mr. Ashok Kumar Verma, Technical Assistant

AAU- J, Assam:

- Dr. Arup Sarmah, Principal Scientist
- Dr. Dr. Sudhansu Bhagawati, Scientist
- Dr. Kritdeepan Sarmah, Scientist

GKVK, Bengaluru, Karnataka:

- Dr. D. Rajanna, Principal Scientist
- Dr. K. V. Prakash, Entomologist

NBAIR, Bengaluru, Karnataka :

- Dr. Kolla Sreedevi, Principal Scientist
- Dr. Deepa Bhagat, Principal Scientist

CSK-HPKV, Palampur, Himachal Pradesh

- Dr. R. S. Chandel, Principal Scientist
- Dr. K.S. Verma, Principal Scientist
- Dr. Suman Sanjta, Assistant Professor

VPKAS, Almora, Uttarakhand:

- Dr. Amit Paschapur, Scientist

RCSM, Kolhapur, Maharashtra:

- Dr. U. B. Hole, Professor of Entomology

FARMER VC, Ghaziabad, Uttar Pradesh:

- Mr. J. P. Singh, Secretary, FARMER NGO
- Dr. Seema Rani, Research Associate
- Mrs. Rinni, M.Sc. M. tech., Biotechnologist

GBPUAT, Pantnagar, Uttarakhand:

- Dr. A.K. Pandey, Principal Scientist

Special invitees:

- Dr Sharad Mohan, Principal Scientist, Division of Nematology, IARI, New Delhi
- Dr. B. Singaravelu, Principal Scientist, Sugarcane Breeding Institute, Coimbatore
- Dr. Shankar Narayan, Entomologist, Sugarcane Breeding Institute, Regional Centre, Coimbatore
- Mr. Harish Khandelwal, Industrialist
- Mr. Raja Ram Bhidosra, Farmer, Nohar
- Mr. Bharat Singh, Farmer, Chahuwali

Host Institute:

- Dr. Mandeep Sharma, acting Vice-chancellor, CSK- HPKV, Palampur
- Dr. S.P. Dixit, Director of Research, CSKHPKV, Palampur HP
- Dr. V.K. Sharma, Director of Extension Education, CSKHPKV, Palampur HP
- Dr. D.K. Vats, Dean, College of Agriculture, CSKHPKV, Palampur HP
- Dr. A.K. Sood, Principal Scientist, Department of Entomology, CSKHPKV, Palampur HP
- Dr. Surjeet Kumar, Professor, Department of Entomology, CSKHPKV, Palampur HP
- Dr. S.D. Sharma, Principal Scientist, Department of Entomology, CSKHPKV, Palampur HP
- Dr. P.K. Sharma, Principal Scientist, Department of Entomology, CSKHPKV, Palampur HP
- Dr. P.C. Sharma, Principal Scientist, Department of Entomology, CSKHPKV, Palampur HP
- Dr. S.K. Sharma, Principal Scientist, Bee Research Station, Department of Entomology, CSKHPKV, Palampur HP
- Dr. Anjana Thakur, Assistant Entomologist, Department of Entomology, CSKHPKV, Palampur HP
- Dr. Sharmishtha Thakur Assistant Professor, Department of Entomology, CSKHPKV, Palampur HP
- Dr. Radhika Sharma, Assistant Professor, Zoology, College of Basic Sciences, CSK, HPKV, Palampur HP
- Dr. Saurbh Soni, Junior Research Fellow, Department of Entomology, CSKHPKV, Palampur HP
- Mr. Himanshu Thakur, Ph.D. Scholar, Department of Entomology, CSKHPKV, Palampur HP
- Mr. Karthik R., Ph.D. Scholar, Department of Entomology, CSKHPKV, Palampur HP
- Ms. Shalika Kumari, Ph.D. Scholar, Department of Entomology, CSKHPKV, Palampur HP
- Dr. Sumit Vashishth, SMS (Entomology), KVK, Tabo, Spiti HP
- Mr. Neeraj Guleria, Assistant Entomologist, RSS Salooni, Chamba, CSK, HPKV- Palampur

TECHNICAL PROGRAMME FOR 2022-24

I. Species profiling of soil arthropod pests, white grub, termites, cutworm etc. through trap

- White/yellow light with 250-350 micrometer wave-length or bright 160 watt mercury vapor lamps are ideal for white grub beetles' collection at any areas.
- All data collection of beetles & their natural enemies through light trap/pheromone trap should be on GPS location and climatic correlation based reported by each centre.
- Quality pictures of each collected species should be captured and presented in the report.
- Mapping of white grub/termites/ cutworm in Rajasthan, Assam, Himachal Pradesh, Karnataka, Uttar Pradesh, Maharashtra, Uttarakhand and Gujarat by each definite centre.

Beetles collections and weather conditions during ----- in -----

Months	Temperature (°C)	Humidity (%)	Rainfall (mm)	Rain days (No.)	Beetle collection (No.)
April					
May					
June					
July					
August					
September					

Relative abundance of beetles and GPS location during ----- in -----

Sub family	Species	Number	RA (%)	Location (GPS)

(Allotted for all centres)

II. Population monitoring on host trees

Studies on population monitoring of beetles on host trees has to be studied in more details as host preference, host resistance, ETL etc. by each centre.

GPS Location	Sub family/ Species	Preference host trees	Resistance host trees

(Allotted for all centres)

III. Kairomonal study

After confirmation of the preferred host by the adult beetle kairomonal studies on scarab beetles as well as cutworm moths will be undertaken by all the centres. For these studies collect the sample of preferred host of beetles and send to Dr. Deepa Bhagat, Principle Scientist, NBAIR, and Bengaluru as her suggestion/protocol or a 7-10 days training programme on isolation and characterization of insect semiochemicals will be organized at NBAIR, Bengaluru.

(Allotted for all centres)

IV. Pheromone studies on predominant white grub species

The concerned centre will isolate pheromone gland of the relevant species by solvent extract of glands as well as whole body or isolation of pheromone by confinement and rinse method and trapping of volatiles/ pheromones by using suitable adsorbents. The extracts containing the pheromone will be analyzed in GC-MS to identify the compounds. Bioassay will be carried out with relevant species to establish the efficacy of identified compound.

Assam	<i>L.mansueta</i> (Efforts will be made to revisit the already identified pheromonal compounds through GCMS-EAG analysis and their further synthesis/field testing will be carried out in collaborative mode with other institutes).
Karnataka	Extraction, identification, synthesis and field testing of pheromonal compounds of <i>Leucopholis burmeisteri</i>
HP	Extraction, identification, synthesis and field testing of pheromonal compounds of <i>Brahmina coriacea</i> .
UK	Extraction and identification of pheromones of <i>Anomala bengalensis</i> and their testing in both laboratory and field conditions.
Gujarat	Being a newly introduced centre, concerted attempts should be made to study the diversity phytophagous scarab fauna of Gujarat. Subsequently based on severity of damage, pheromonal works on the most predominant white grub species has to be initiated in consultation with the Networking cell.

V. Population monitoring and their extent of damage in different crops

Surveys will be carried out at least once in a week during peak emergence to determine the extent of damage in specific crop inflicted by various soil insect and molluscan pests on different economically important crops by counting the number of the affected plants and grubs per square meter area in soil. The information with quality photographs should be sent to the Coordinating cell for further compilation (month wise). Use of GPS has been made mandatory for this survey works.

Observations table:

Date	Location (GPS)	Crops	Number of Grub/M ² area in soil	Extent of damage

(Allotted for all centres)

VI. Survey of natural enemies of soil arthropod pests

Isolated and identified native strains of natural enemies of white grub by different centers will be evaluated initially in laboratory following suitable bioassays techniques and after that large scale field studies will be conducted.

To monitor the occurrence of natural enemies (parasitoids, predators & pathogens) of major soil arthropod pests, seasonal soil sampling will be done in the endemic pockets. Each center will undertake the sampling method of each organism according to the cropping system. Natural enemies should be sent to NBAIR, Bangalore and IARI, New Delhi; who will act as consultant scientists of this group and will facilitate its identification, culturing and providing necessary details regarding receipt No. and code numbers etc.

(Allotted for all centres)

VII. Surveillance of white grub through DRONE (dynamic remotely operated navigation equipment) technology

Drone will be operated in crop fields during survey programme for monitoring the incidence of soil insect pests. The auto captured images and video clips can be downloaded and assessed for the incidence of soil insect pests.

Methodology: Drone camera (Model: DJI Phantom 4 with a flying capacity up to 2 KM and up to 120 m height or any other available models) can be operated after first shower of monsoon to capture the images to check the emergence of beetle and feeding on host trees as defoliation as well as in crop field (sugarcane, ground nut, areca nut, potato field etc.) during survey programme. The technology can also be used for monitoring of scarab beetle incidence in fruit orchards of hilly regions as well as plain areas/ riverine areas. Attempts should be made to use drone technology to survey the termite mounds and their architecture.

A comprehensive note on use of drones for surveillance, diagnostic and recommendation of management practices against soil arthropod pests at various climatic zones should be prepared by each center.

(Allotted for all centres)

VIII. Crop loss assessment at different climatic zones due to soil arthropod pests

There is a distinction between yield loss and crop loss. Yield loss involves less than a field, e.g., a plot, and a single causal factor, e.g., insects. Crop loss refers to dimensions the size of at least a field, but most often of a region, and is used when considering the reduction in yield relative to a reference yield, e.g., crop loss = attainable yield - actual yield. Crop loss can be from single or multiple factors. Ultimately insect damage affects the plant's phys

Centres	Area (Acre)	Target Pest	Target crops
Rajasthan			
Assam			
Himachal Pradesh			
Karnataka			
Uttar Pradesh			
Maharashtra			

Uttarakhand			
Gujarat			

(Allotted for all centres)

IX. WHITE GRUB TAXONOMY (NBAIR, Bengaluru and UAS, GKVK, Bengaluru)

- Compilation of literature on Scarabs of India- Continued
- Development of Taxonomic keys for Scarabs of India
- Description of white grubs of Karnataka, Tamil Nadu, Telangana, Kerala, Himachal Pradesh, Eastern states, Uttarakhand, Utter Pradesh and Rajasthan in phased manner
- All centres will be sent new species recorded at your centre for identification.

X. Development of Distribution maps of white grub

Following centres will develop distribution maps of different predominant white grub species of respective states as mentioned below:

- Durgapura : Rajasthan, MP and Haryana
Palampur : HP, JK, Punjab
Gujarat : Gujarat
Kolhapur : Maharashtra, Goa and Odisha
Bengaluru : Karnataka, Andhra Pradesh, Telangana, Tamil Nadu, Kerala
Jorhat : Assam, Arunachal Pradesh and Manipur
Almora : Uttarakhand

All the centres should complete the work under the supervision of Dr. K. Sreedevi, NBAIR, Bengaluru (Nodal Officer) and submit the map detail within six month to her.

XI. Development of Distribution maps of termite

Following centres will develop distribution maps of termite species of respective states as mentioned below:

- Durgapura : Rajasthan
Palampur : HP
Gujarat : Gujarat
Kolhapur : Maharashtra
Bengaluru : Karnataka
Jorhat : Assam
Almora : Uttarakhand
Ghaziabad : UP

All the centres should complete the distribution map of termite under the supervision of Dr. Kalleshwara Swamy, Assistant Professor, Department of Entomology, COA, University of Agricultural & Horticultural Sciences, Navile, Shivamogga-577504. Karnataka and submit the map detail within six month to her.

XII. Biodiversity studies termites

Biodiversity studies on termite species will be conducted in concerned state of the centre. Survey will be conducted in different habitats comprising agricultural crops, forestry and horticulture plantation, wooden structures (buildings) to collect different species of termites.

XIII. Study of local isolates of EPFs and EPNs for their Infectivity against soil arthropod pests:

The existing identified isolates would be screened against most damaging white grub species of the region and efforts should be given to determine LC₅₀/ LD₅₀ value of potential strains. Development of formulation and field testing of the same should be carried out against the targeted species.

XIV. Management of target pests through chemicals

For management of soil arthropod pests through chemical methods, only label claimed insecticides have to be tested and the promising results have to be included in the package of practices of different states and the B:C ratio of insecticides also calculated.

White grub

Evaluation of granular insecticides against white grub:

Experiment Details:

Location :Jorhat (pre-sowing), Palampur (post-sowing), Durgapura (Post sowing),
Kolhapur (Post sowing), Ghaziabad (Post sowing), Gujarat (Post sowing)

Sowing time :As per Recommended Package of Practices

Design :RBD

Replication :3

Crop :Jorhat (Green gram), Palampur (Potato) , Durgapura (Groundnut),
Kolhapur (Sugarcane), Ghaziabad (Sugarcane), Gujarat (Groundnut)

Fertilizer : at recommended doses

Treatments : 7

Observation : Plant mortality (%), Larval population/ m², Yield (q/h), Pesticides residues analysis and B: C ratio.

Treatment details:

S.N.	Treatments	Hills	Plains
1.	Clothianidin 50 WDG	120 g a.i./ha	120 g a.i./ha
2.	Fipronil 0.3G	-	50 g a.i./ha
3.	Thiamethoxam 25WG	80 g a.i./ha	80 g a.i./ha
4.	Imidacloprid 70 WG	300g a.i./ha	300g a.i./ha
5.	chlorantraniliprole 0.4% GR*	-	100 g a.i./ha
6.	Fifronil40%+Imidacloprid	300 g/ha	300 g/ha

	40% WG*		
7.	Control		

Evaluation of some insecticides against white grub as seed dresser application and drenching in standing crop:

Experiment Details:

Location :Jorhat (pre-sowing), Palampur (post-sowing), Durgapura, Kolhapur, Ghaziabad, Gujarat, Bengaluru

Sowing time :As per Recommended Package of Practices

Design :RBD

Replication :3

Crop :Jorhat (Colocasia), Palampur (Potato & Rajmash), Durgapura (Groundnut), Kolhapur (Sugarcane, Groundnut & Soybean), Ghaziabad (Sugarcane), Gujarat (Groundnut), Bengaluru (Arecanut)

Fertilizer :Recommended doses

Treatments :8

Observation :Plant mortality (%), Larval population /m², Yield (q/h) Pesticides residues analysis and B: C ratio.

Treatment details:

Treatment	Hill		Plain	
	Seed treatment	Drenching in standing crop (post sowing)	Seed treatment	Drenching in standing crop (post sowing)
Imidacloprid 17.8 SL	48g a.i./ha	60g a.i./ha	-	-
Thiamethoxam 30 FS	80g a.i./ha	150g a.i./ha	80ga.i./ha	150g a.i./ha
Fipronil 5SC	-	-	100g a.i./ha	150g a.i./ha
Clothianidin 50 WDG	80 g a.i./ha	125 g a.i./ha	80g a.i./ha	125g a.i./ha
Imidacloprid 600 FS	500g a.i./ml/ha	1000 g a.i./ml/ha	500g a.i/ml./ha	1000g a.i.ml./ha
Chlorantraniliprole 18.5 SC*	-	-	500 ml/ha	500 ml/ha
Fifronil 40%+Imidacloprid 40% WG*	3g per kg seed	300 g/ha	3 g per kg seed	300 g/ha
Control				

*For pesticides residues analysis centers try to send nearby residue analysis laboratory at your location otherwise may send their samples to AINP on Pesticide Residue's Laboratory, Division of Entomology, RARI, Durgapura, Jaipur (Rajasthan) -302018.

TERMITE

Management of termite through seed treatment:

Experiment Details:

Location : Palampur, Bengaluru, Gujarat

Sowing time : As per POP

Design : RBD

Replication : 3

Crop : Palampur (Wheat),
Bengaluru (Groundnut), Jorhat (Moong bean) Gujarat (Groundnut)

Fertilizer : Recommended doses as per POP

Treatments : 10

Observation : Per cent Plant damage, Protection over control, Yield (q/h)
Pesticides residues analysis and B:C ratio.

Treatment details:

S.N.	Treatments	Dose(per kg seed)
1.	Thiamethoxam 25 WG	3.2 g
2.	Imidacloprid 17.8 SL	3.0 ml
3.	Acephate 50% + imidacloprid 1.8%	4.0 g
4.	Fipronil 5 SC	10.00 ml
5.	Thiamethoxam 30 FS	3.0 ml
6.	Imidacloprid 600 FS	6.5 ml
7.	Clothianidin 50 WDG	1.5
8.	Fipronil 40%+Imidacloprid 40% WG*	3.0 g
9.	Chlorantraniliprole 18.5 SC*	2.0 ml
10.	Untreated check	-

Management of termites through drenching:

Experiment details:

Location : Palampur, Bengaluru, Gujarat

Sowing time : As per POP

Design : RBD

Replication : 3

Crop : Palampur (Wheat), Bengaluru (Groundnut), Jorhat (Moong bean)
Gujarat (Groundnut)

Fertilizer : Recommended doses as POP

Treatments : 10

Observation : Per cent Plant damage, Protection over control, Yield (q/h)
Pesticides residues analysis and B:C ration should also be given.

Treatment details:

S.N.	Treatments	Dose per ha
1.	Thiamethoxam 25 WG	600 g
2.	Imidacloprid 17.8 SL	360 ml
3.	Acephate 50% + imidacloprid 1%	1250g
4.	Fifronil 5 SC	3.0 lit.
5.	Thiamethoxam 30 FS	600g
6.	Imidacloprid 600 FS	1042
7.	Clothianidin 50 WDG	300g
8.	Fifronil 40%+Imidacloprid 40% WG*	500 g
9.	Chlorantraniliprole 18.5 SC*	500 ml
10.	Control	-

Management of Termites through IPM

Experiment details

Location : Durgapura
Sowing time : As per POP
Crop : Chickpea
Design : RBD
Replication : 4 Modules
Fertilizer : Recommended doses as POP
Treatments :4
Observation : Per cent Plant damage, Yield (q/h)/
germination (%) and B:C ratio

Treatment details:

S.N.	Treatments	Dose
IPM-I	Application of <i>Beauveria bassiana</i> (mix with FYM and apply in furrow before sowing)	0.5 g/m ²
	Seed treatment with imidacloprid 600 FS	5.0 g/kg seed
	*Placing of earthen pots in the field with shelled cobs of maize (4-5 days after sowing)	30/ha
	Drenching of Imidacloprid 17.8SL (50 days after sowing)	600 ml/ha
IPM-II	Application of <i>Metarhizium anisopliae</i> (mix with FYM and apply in furrow before sowing)	0.5 g/m ²
	Seed treatment with imidacloprid 600 FS	5.0 g/kg seed
	*Placing of earthen pots in the field with fresh cow dung (4-5 days after sowing)	30/ha
	Drenching of Fifronil 5 SC (50 days after sowing)	3.0 lit./ha
IPM-III	Application of <i>Heterorhabditis indica</i> (mix with FYM and apply in	0.5 g/m ²

	furrow before sowing)	
	Seed treatment with imidacloprid 600 FS	5.0 g/kg seed
	*Placing of earthen pots in the field with wooden pieces (4-5 days after sowing)	30/ha
	Drenching of Fipronil 40%+Imidacloprid 40% WG (50 days after sowing)	500ml/ha
IPM-IV	Untreated check	-

Management of termite through sett treatment in sugarcane crop

Experiment details

Location	: Kolhapur, Ghaziabad, Bengaluru (As OFT)
Sowing time	: As per POP
Design	: RBD
Replication	: 3
Fertilizer	: Recommended doses as POP
Treatments	:10
Observation	: Per cent Plant damage, Protection over control, Yield (q/h)/ germination (%), Pesticides residues analysis and B:C ratio

Treatment details:

S.N.	Treatments	Dose(per litre water)
1.	Thiamethoxam 25 WG	1 g
2.	Imidacloprid 17.8 SL	1ml
3.	Acephate 50% + imidacloprid 1%	1 g
4.	Fipronil 5 SC	1 ml
5.	Thiamethoxam 35 FS	1 ml
6.	Imidacloprid 600 FS	1 ml
7.	Clothianidin 50 WDG	1 g
8.	Fipronil 40%+Imidacloprid 40% WG	1 g
9.	Chlorantraniliprole 18.5 SC	0.5ml
10.	Untreated check	-

Drenching in standing sugarcane/ tea crop through water

Experiment details:

Location	: Jorhat (Tea), Kolhapur, Ghaziabad, Bengaluru
Sowing time	: As per POP
Design	: RBD
Replication	: 3
Fertilizer	: Recommended doses as POP
Treatments	: 7
Observation	: Per cent Plant damage, Protection over control, Yield (q/h) Pesticides residues analysis and B:C ratio

Treatment details:

S.N.	Treatments	Dose(per ha)
1.	Imidacloprid 600 FS	800 ml
2.	Imidacloprid 17.8 SL	350 ml
3.	Fipronil 5 SC	2 litre
4.	Imidacloprid 70 WS	160 ml
5.	Clothianidin 50 WDG	250 g
6.	Chlorantraniliprole 18.5 SC	500 ml
7.	Control	-

*For pesticides residues analysis centers try to send nearby residue analysis laboratory at your location otherwise may send their samples to AINP on Pesticide Residue's Laboratory, Division of Entomology, RARI, Durgapura, Jaipur (Rajasthan) -302018

Cutworms

Field evaluation of pre-sown application of different granular insecticides against cutworm

Experiment details:

Location : Palampur
 Sowing time : Normal
 Crop :Cabbage
 Design : RBD
 Replication : 4
 Fertilizer : Recommended doses
 Treatments : 5
 Observation : Per cent damage, Protection over control, Yield (q/h)
 Pesticides residues analysis and B:C ration should also be given.

Treatment details:

S.N.	Treatments	Dose
1.	Imidacloprid 0.3GR	45 g a. i./ha
2.	Clothianidin 50 WDG	120 g a.i./ha
3.	Fipronil 0.3G	50 g a.i./ha
4.	Thiamethoxam 25WG	80 g a.i./ha
5.	Untreated check	-

Field evaluation of post-sown application of different granular insecticides against cutworm

Experiment details:

Location :Palampur
 Sowing time :As Per POP
 Crop :Cabbage
 Design :RBD
 Replication :4
 Fertilizer :Recommended doses as POP
 Treatments :5

Observation :Per cent damage, Protection over control, Yield (q/h)
Pesticides residues analysis and B:C ration should also be given.

Treatment details:

S.N.	Treatments	Dose
1.	Imidacloprid 0.3GR	45 g a. i./ha
2.	Clothianidin 50 WDG	120 g a.i./ha
3.	Fipronil 0.3G	50 g a.i./ha
4.	Thiamethoxam 25WG	80 g a.i./ha
5.	Untreated check	-

Field evaluation of post planting application of different liquid insecticides against cutworm

Experiment details:

Location :Palampur
Sowing time :Normal
Crop :Cabbage
Design :RBD
Replication :4
Fertilizer :Recommended doses
Treatments :6
Observation :Per cent damage, Protection over control, Yield (q/h)
Pesticides residues analysis and B:C ration should also be given.

Treatment details:

S.N.	Treatments	Dose
1.	Imidacloprid 17.8.SL	60 g a. i./ha
2.	Clothianidin 50 WDG	120 g a.i./ha
3.	Fipronil 0.3G	50 g a.i./ha
4.	Thiamethoxam 25WG	80 g a.i./ha
5.	Chlorpyrifos 20EC	500 g a.i./ha
6.	Untreated check	-

XV. Management of target pest through biocontrol agents

Field evaluation of EPN/EPF/BT and against white grub

Treatment Details:

Sr. No.	Treatment	Dose
T ₁	<i>Metarhizium anisopliae</i> (WP) mixed with FYM	1x10 ⁹ CFU per gm/m ²
T ₂	<i>Beauveria bassiana</i> (WP) mixed with FYM	1x10 ⁹ CFU per gm/m ²
T ₃	<i>Beauveria brongniartii</i> (Soil Formulation) mixed with FYM	1x10 ⁹ CFU per gm/m ²

T ₄	<i>Heterorhabditis indica</i> strain SBITND78	10 ⁸ IJs/ac
T ₅	<i>Heterorhabditis bacteriophora</i> strain SBIP5	10 ⁸ IJs/ac
T ₆	<i>Steinernema surkhetense</i> strain SBIP3	10 ⁸ IJs/ac
T ₇	<i>Steinernema siamkayai</i> strain SBITNT1	10 ⁸ IJs/ac
T ₈	<i>Steinernema thermophilum</i> strain SBIH1	10 ⁸ IJs/ac
T ₉	NBAIR-BtAN4 strain of <i>Bacillus thuringiensis</i>	3 litre/acre
T ₁₀	NBAIR-Bt25 strain of <i>Bacillus thuringiensis</i>	3 litre/acre
T ₁₁	NBAIR-BATP strain of <i>Bacillus albus</i>	2.5 Kg of talc mixed with 100 kg of FYM
T ₁₂	Insecticidal mixture (<i>Joiba Shakti</i>) AAU	250 kg/ ha
T ₁₃	Recommended insecticide	As per recommendation
T ₁₄	Control	-
	Design	RBD
	Replication	3
	Sowing time	As per respected zones and centres

Method of Application for EPF:

Apply entomopathogenic fungi's powered formulation mix with 100 kg FYM and without mix with FYM in row by 5 cm deep furrow extending front to back. The raised soil beside the furrow push back to cover formulation.

Observations to be recorded:-

- i) The number of white grubs per 10 meter row in the root zone will be recorded at 60 days after treatment (DAT).
- ii) The per cent decrease in white grub damage and white grub population will be calculated. Data will be subjected to analysis of variance.

Method of Application for Bt:-

- *B. thuringiensis* NBAIR-BT25 @ 3 litre/acre as soil drenching for two times at the interval of 7 days.
- *B. thuringiensis* NBAIR-BTAN4 @ 3 litre/acre as soil drenching for two times at the interval of 7 days.
- *Bacillus albus* NBAIR-BATP @ 2.5 Kg of talc mixed with 100 kg of FYM with Intermittent water sprinkling and incubate for 15 days. After that soil apply to individual plant.

Observations to be recorded:-

- i) Per cent reduction of white grub population
- ii) Yield will be recorded at the time of harvesting (comparison with insecticides and control)
- iii) C:B Ratio

Method of application for EPNs:-

- EPN should be applied at first beetle emergence during onset of summer shower (April – June)
- Irrigate the field prior and after EPN application and keeping the treated area wet for at least 5 days post application
- The ideal time of application is at evening hours so EPN can become active at night without risk of sunlight damage
- Give application that is more concentrated in the border rows extending to five to seven meters inside (white grub infestation generally seen on the boundaries of the plots and extending to a few meters inside).
- Mix the EPN formulation with water (150g EPN formulation/ sprayer tank) and can be applied using knapsack sprayer (nozzle and inside filters of the spray equipments should be removed to prevent them from becoming clogged with nematodes) in each sugarcane clump /any crop by making a 15-20cm pit using a crowbar.

Observations to be recorded:-

i) Initial grub population per sq. m

ii) Grub observation per sq. m at 15 days and 30 days after EPN application and observe for dead reddish (*Heterorhabditis* infection) or black coloured (*Steinernema* infection) dead grubs

Field evaluation of EPN/EPF/BT and against white grub

Treatments	White grub population				White grub damage	Yield (q/h)
	Initial White grub population	White grub population (15 Days after Application)	White grub population (30 Days after Application)	White grub population (60 Days after Application)	Damage (%)	
T1						
T2						
T3						
T4						
T5						
T6						
T7						
T8						
T9						
T10						
T11						
T12						
T13						
Control						
CD (P=0.05)						
CV %						

The material for biocontrol trials will be supplied by Dr. R. Rangeshwaran, NBAIR, Bangalore (*Metarhizium anisopliae*) and Dr. J.P. Singh, FARMER, Ghaziabad (EPNs, *B. bassiana* & *M. anisopliae*) and Dr. Rajanna, PI, AINP on SAP-Bengaluru, (*Beauveria brongniartii*). Dr. C. Sankaranarayanan, ICAR-SBI, Coimbatore (EPN, *Heterorhabditis indica*, *Heterorhabditis bacteriophora*, *Steinernema surkhetense*, *Steinernema siamkayai*, and *Steinernema thermophilum* strains) and Dr Badal Bhattacharya, Professor AAU-Jorhat (Insecticidal Mixture). Application of biopesticides should coincide with mass emergence of beetles after first shower of monsoon.

***All centres should communicate for above microbials for testing at least one month in advance.**

(Allotted for all centres)

XVI. Social engineering/ Extension activities

Social Engineering/Large community mobilization/ Mass campaigning for both grub & adult management will be carried out at endemic pockets by following the work plan given below.

Details of work plan/activities of Social Engineering:

Centres	Targeted white grub species	District(s) to be covered	Beneficiary farmers (Approx.)			
Rajasthan	White grub, termites	10	5000			
Assam	White grub, termites, snails etc	10	5000			
Himachal Pradesh	White grub, termites, cutworm	10	5000			
Karnataka	White grub, termites	10	5000			
Uttar Pradesh	White grub, termites	10	5000			
Maharashtra	White grub, termites	10	5000			
Uttarakhand	White grub, termites	10	5000			
Gujarat	White grub, termites	10	5000			
Targets (in numbers) for implementing different social engineering tools						
Centres	Farmer s training	Training for extension functionari es	Field day	Exhibition (organized/ Participation	Method demonstratio n	Technology showcasing
Rajasthan	10	5	5	5	5	5
Assam	10	5	5	5	5	5
Himachal	10	5	5	5	5	5

Pradesh						
Karnataka	10	5	5	5	5	5
Uttar Pradesh	10	5	5	5	5	5
Maharashtra	10	5	5	5	5	5
Uttarakhand	10	5	5	5	5	5
Gujarat	10	5	5	5	5	5

General guidelines:

- Only the proven technologies (use of pheromonal lures, light traps, scouting, use of microbials, seed treatment, mechanical exclusion methods etc.) should be demonstrated in the farmers field under Technology showcasing/Method demonstration.
- Technology showcasing should be based on already eco-friendly IPM modules. It has to be demonstrated in the highly beetle endemic pockets covering an area (not less than 1acres).
- All social engineering activities should be collaborated with KVKs, State Department of Agriculture, NGOs etc. to establish better linkage.
- All social engineering activities should be planned/distributed throughout the year against both white grubs/adults and others soil arthropod pests.
- All centres should report the “Coordinating cell” about their targeted activities so that the same is reflected in the Monthly progress report.
- The impact of activities should be assessed/studied in collaboration with Agricultural Economists/Extension Scientists and adopt follow-up actions.
- Success story of social engineering works should be shared/uploaded through social networking means (Facebook, WhatsApp) and YouTube.

Commercialization of technology

Commercialization of all the technology developed under the project should go through Agri-Innovation

Publications

Each center of AINP on SAP should have to publish at least 2 research papers (NAAS rating above 6)

***Each centre will send half-yearly progress report to coordinating cell for better evaluation of the project progress in a year.**

LOCATION SPECIFIC TRIALS

Each centre will conduct experiments of local importance based on the feedback received from different sources.

RARI, Durgapura (Rajasthan)

- Studies of gut micro-flora of major white grub species of Rajasthan
- Dissemination and popularization of nanogel slow release pheromone Technology
- Molecular characterization of *Holotrichia consanguinea*
- Isolation and identification of *Bacillus thuringiensis* (Bt) strains from soil
- Bioassay of *Bacillus thuringiensis* (Bt) strains against white grub in laboratory

AAU-Jorhat (Assam)

- Survey, collection, identification and mapping of the major soil insect-pests of potato grown in different Agro-ecological zones of Assam
- Advanced nutritional analysis of edible soil dwelling insects of Assam
- Exploration of Indigenous Technical knowledge (ITKs) against different soil insect-pests as practiced by different tribal farming communities of Assam
- Field evaluation of insecticidal mixture (*Joiba Shakti*) against some major soil insect pests of potato

CSK-HPKV, Palampur (Himachal Pradesh)

- Diversity and biology of *Anomala* species
- Studies on the symbionts of *Brahmina coriacea*
- Interaction effects of entomopathogenic nematodes with novel insecticides
- Molecular characterization of termite species

GKVK, Bengaluru (Karnataka)

- Studies on biogeography of major white grubs in Karnataka
- Evaluation of bio-agents against white grubs
- Demonstration and popularization of insecticide free management practices for white grubs in arecanut
- Creating a digital repository of Indian Scarabaeidae using specimens available at Bengaluru centre

JAU-Junagadh (Gujarat)

- Being a newly introduced centre, concerted attempts will be made to study the diversity phytophagous scarab fauna of Gujarat
- Subsequently based on severity of damage management study will be carried out

Voluntary Centres

FARMER, Ghaziabad (Uttar Pradesh)

- Isolation, identification and evaluation of efficacy of entomopathogenic nematodes (EPN), entomopathogenic fungi (EPF) strains and other natural enemies from local soil
- Capacity building of state & sugar mills functionaries, rural youths, women and farmers by organizing training on management of white grub and other sugarcane pests and diseases
- Training and supply of culture for mass multiplication and application of bio-agents; EPN /EPF, bio-fertilizers/ bio-pesticides at village/farm level

VPKAS, Almora (Uttarakhand)

- Molecular phylogeny of major Melolonthinae and Rutelinae white grubs using mitochondrial genes
- Studies of gut micro flora of major white grub species of Uttarakhand
- Isolation of native entomopathogens and their use in white grub management

RCSM, Kolhapur (Maharashtra)

- Distribution map of the white grub species in Western Maharashtra
- Biology of *Leucopholis lepidophora* and *Holotrichia serrata* under the changing climatic Conditions
- Bio efficacy of Entomopathogenic fungi against *L. lepidophora* infesting Sugarcane crop

Indian Council of Agricultural Research, New Delhi



**NETWORK UNIT
S.K.N. AGRICULTURE UNIVERSITY
RAJASTHAN AGRICULTURAL RESEARCH INSTITUTE,
DURGAPURA, JAIPUR 302018**