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Native Trichogrammatid for Sustainable Pest Management

A Technical Report from Collection to Promotion

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Citation

Murali Baskaran, R. K., J. Sridhar, K. C. Sharma, P. Mooventhan and P. K. Ghosh. 2022. Native Trichogrammatid for Sustainable Pest Management: A Technical Report from Collection to Promotion. ICAR - National Institute of Biotic Stress Management, Raipur - 493225, Chhattisgarh, India, pp. 1-26.

Published by

Director and Vice-chancellor
ICAR - NIBSM, Raipur - 493 225
Chhattisgarh, India

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Printed by:

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FOREWORD

In recent past, controversies on the use of chemical pesticides in biotic stress management have increased public awareness of issues pertaining to environmental and human health. The greatest substitute for pesticides is considered to be biological control. Biological management is safe for the environment through the control of agricultural pests, disease vectors and invasive alien species etc. Notable indirect benefits also arise from reduced pesticide use by increasing farmer health, food safety, biodiversity conservation, maintenance of ecosystem services, as well as soil, water and air quality. Biological control options are abundant across the world which can provide ecologically viable control of biotic stress to sustain livelihood of mankind.

An egg parasitoid belonging to the family: Trichogrammatidae is a versatile and reported to be being used more than a century for the management of more than 100 species of Lepidoptera pests. The efficiency of egg parasitoid in biocontrol of crop pests under field conditions can be improved in two ways, using ecotypes or native populations and augmentation of released populations with kairomones. Ecotype is a geographically separated populations of the same species which can perform better due to wide adaptations in the concerned niche, besides having adaptation in the eco-system in which they are existing by co-evolving with the native crop pests. Kairomone mediated biological control is another approach which can allow the released and wild populations as well to spend comparatively longer period in the target fields in searching of immature stages of pests. Thus, augmentative biological control for native pests and classical biological control for invasive pests are considered as important milestones for successful biological suppression of biotic stress. The present technical report comprehends collection, identification, evaluation and promotion of Trichogrammatids in biological control of crop pests in Chhattisgarh state.

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Preface

In Indian agriculture, the widespread application of chemical pesticides to protect crops from biotic stresses has become a regular practice, with several unintended negative impacts on crops, people, animals, soil, water bodies, non-target creatures, and their surrounding environments. By 2050, the world's population is expected to increase to 9 billion people, necessitating a review and revision of current programmes for a 70% increase in food production. The government's strict regulations on chemical pesticides have created a favourable environment and provided a path for alternate, environmentally acceptable methods of managing biotic stress. Biological control has been identified as an emerging strategy that is rapidly expanding in the context of plant protection in India. The Government of India is particular in supporting organic farming, natural farming, precision farming etc., which increased the conversion arable lands to emerging agricultural production systems, besides increasing the requirement of biocontrol agents and biopesticides. Additionally, stakeholders are concentrating on the advantages of biological control by raising knowledge of the value of high-quality goods that promote a healthy way of life and likelihood. Research and development efforts to improve biological control are an added benefit to growing the industries both internationally and in India.

A technical report titled "**Native Trichogrammatid for Sustainable Pest Management: A Technical Report from Collection to Promotion**" consisting collection, identification, screening of eco-types, establishment of DBT Biotech KISAN Trichogramma Production Unit, mass-production and supply of two species of *Trichogramma*, production capacity of unit, area covered under various crops, identification of suitable kairomone for enhancing biocontrol potential, field experiments on kairomone mediated biocontrol of key pests of rice, wheat and chickpea and capacity building to stakeholder for creation of awareness on biocontrol agents with special reference to *Trichogramma* spp., was narrated with relevant pictures and graphs. The technical report was prepared based on the results obtained from surveys in 22 districts of Chhattisgarh, various lab and field experiments etc., in order to record the applications of native *Trichogramma* in common platform for the benefit of readers, learned faculties and colleagues, corporate, stakeholders, etc.

The coordinated work output by all authors in carefully gathering and compiling a variety of information from numerous sources is appreciated.

Authors

Contents

1. Introduction

Many negative repercussions have resulted from the widespread use of chemical pesticides, including insecticide resistance in the management of Lepidoptera pests, resulting in increased attention to alternative pest management strategies. Biological control is a phase of Natural control and defined as the action of parasites, predators or pathogens in maintaining another organism's population density at a lower average than would occur in their absence. The use of biological control agents, including *Trichogramma* spp., has been advocated as one of the eco-friendly components of IPM for Lepidoptera pests.

Trichogramma spp. has been found attacking the eggs of insects from 11 different orders, with a preference towards Lepidoptera pests. In India, six species of Trichogrammatids including *T. chilonis*, *T. pretiosum*, *T. brassicae*, *T. raoi*, *T. japonicum,* and *T. ostriniae* are popular for Lepidoptera pest management. *T. chilonis* is found throughout the Indian subcontinent, where it is responsible for the large-scale mortality of *H. armigera, S. litura*, and other lepidopteran pests in a variety of crops, as well as controlling other lepidopteran and heteropteran insect pests. *T. japonicum* has been suggested as an efficient species for controlling Lepidoptera pests that create egg masses because it possesses a lengthy ovipositor that can parasitize eggs in deeper levels of the egg mass. Inundative releases of *Trichogramma* spp. for the management of Lepidoptera pests of major crops including maize corn borer, diamondback moth, cotton bollworms, rice striped stem borer, rice yellow stem borer and leaf folder *etc*., have been reported worldwide.

Semiochemical based biocontrol approach is the way forward worldwide, which can directly or indirectly be useful to managing key pests of crops. Inter-specific semiochemicals can mediate interactions between host plants, herbivores, and their natural enemies. Natural enemies of important insect pests, particularly Hymenopterans, use chemical signals produced by herbivore-induced host plants or host insects, known as 'Kairomones,' to locate the host plants or host insects. Kairomones are inter-specific semiochemicals that mediate interactions beneficial to organisms that detect them. For decades, the use of kairomones for the biocontrol of insect pests has piqued researchers' curiosity (Kumar et al. 2018; Murali-Baskaran et al. 2018). Because of their limited host-searching capacity and detection range of signals from injured host plants, biocontrol agents are frequently unable to effectively regulate insect pest populations.

Ecotypes of *Trichogramma* spp., sometimes called ecospecies, describes a genetically distinct geographic variety, population, or race within a species, which is genotypically adapted to specific environmental conditions. Such ecotypes can perform better than other populations of the same species existing in different geographical areas of a region, as they co-evolve with their prey in a particular agro-climatic zone. Such eco-types are called wild population and could not perform efficiently as they are less numerous under natural agro-ecosystem. Ecotypes can be made efficient when they are collected; multiplied artificially under laboratory condition and released scientifically under field condition with suitable augmentation. In order to collect efficient eco-types of *Trichogramma* spp., for pest management, surveys were made in 22 districts of Chhattisgarh, covering 18 crop ecosystems.

Hymenopterans, especially Trichogrammatids are responsive to the herbivore induced plant volatiles (HIPVs). Using synthetic form of promising volatiles in suitable formulation under field conditions can augment the released parasitoids which ultimately increase the efficacy by enhancing their searching capacity. A success story involving *Trichogramma* spp., native to Chhattisgarh through collection, identification, lab and field evaluation, mass-production, optimization of time and number of releases of wasp, identification of suitable kairomone formulation for enhancing its foraging activity, promotion and capacity building on the field applications to stakeholders are narrated in this technical report along with relevant pictures, data, graphs etc.

2. Collection of native *Trichogramma* spp.

A total of 22 districts of Chhattisgarh were surveyed during 2019-20 to collect native bio-control agents. Sentinel egg cards were used to trap the native egg parasitoids in 63 places, covering 18 forest and crop ecosystems (Fig. 1).

2.1. Sentinel cards in various crops



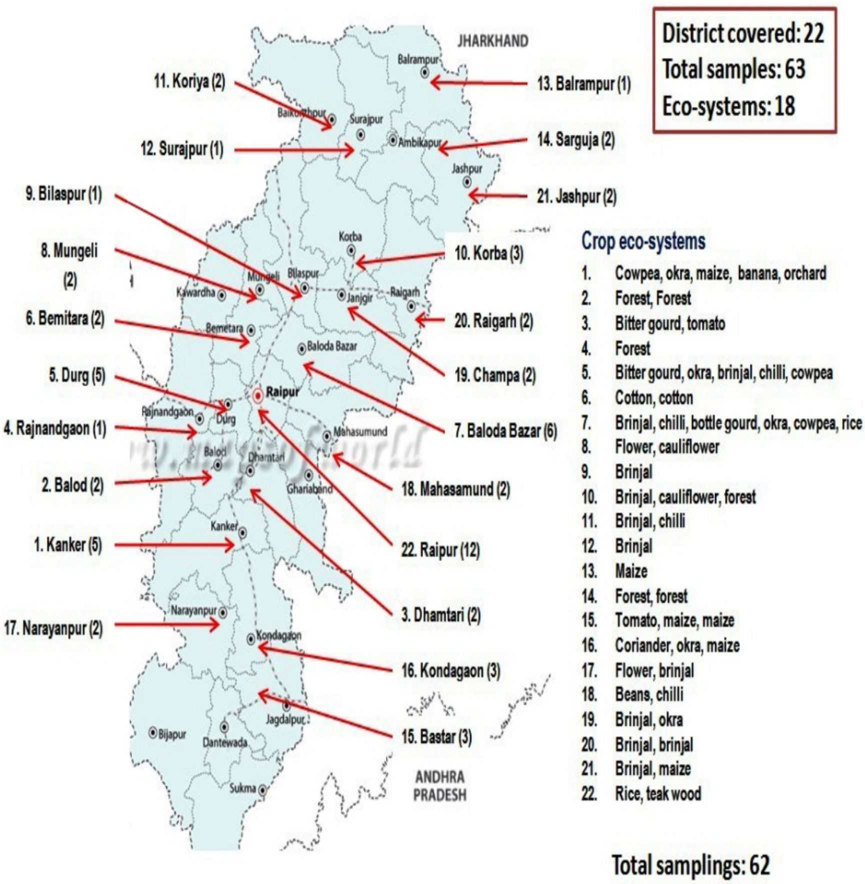

Fig 1. Sites of sentinel cards used to trap *Trichogramma* spp.

2.2. Distribution of Trichogramma spp., in Chhattisgarh

A total of 20 eco-types of *Trichogramma* were recovered and identified at species level (Fig. 2).

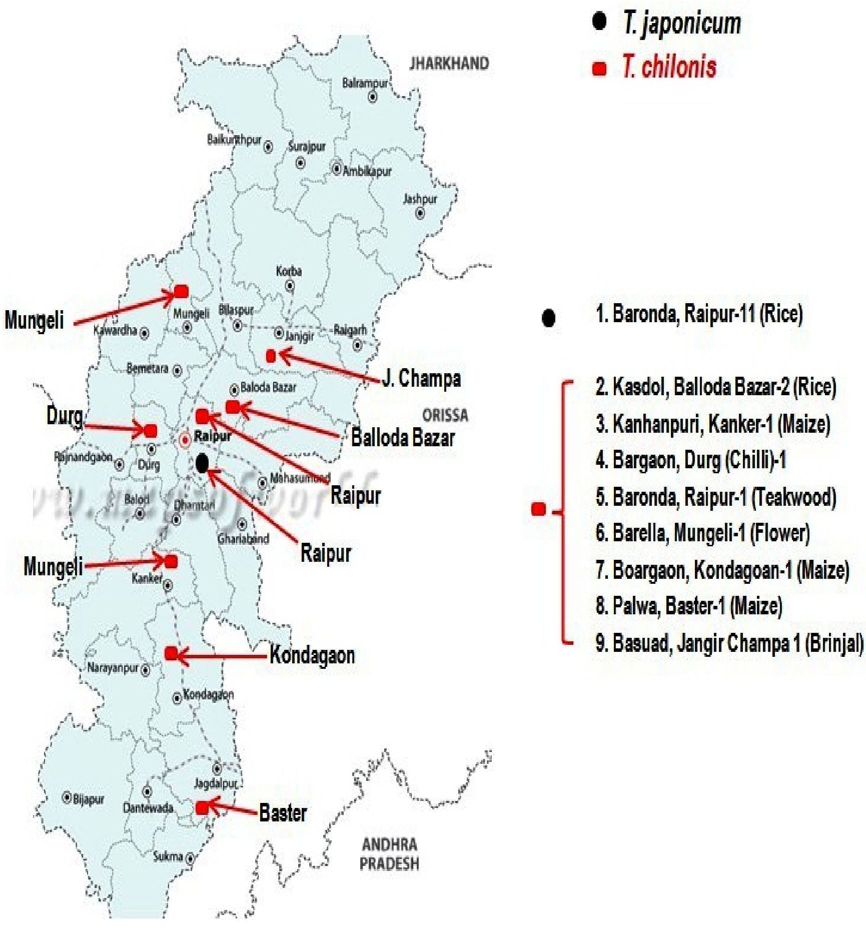

Fig 2. Distribution of *Trichogramma* spp., in Chhattisgarh

3. Identification

The recovered parasitoids from sentinel cards were identified with the help of ICAR-NBAIR, Bengaluru. Out of 20 eco-types of egg parasitoids, 11 *T. japonicum* and two *T. chilonis* from rice, one (*T. chilonis*) from maize, one (*T. chilonis*) from chilli and one (*T. chilonis*) from teak wood eco-systems were recovered (Table 12). Four eco-types recovered from flower, maize and brinjal eco-systems were sent to ICAR-NBAIR, Bengaluru for identification.

4. Comparative parasitic activity of native *Trichogramma* spp.

The parasitic activity of three native *Trichogramma* including *T. chilonis* collected from rice (Balloda Bazar), *T. chilonis* collected from maize (Kanker district) and *T. japonicum* with species of NBAIR, Bengaluru was studied which resulted that *T. japonicum* collected from farmer's field recorded the maximum parasitic activity of 86.4% but on a par with NBAIR species (82.3%). *T. chilonis* obtained from NBAIR showed the highest parasitic activity of 76.9%, followed by two native population of *T. chilonis*, recording 71.1 and 66.4%, respectively (Fig. 3).

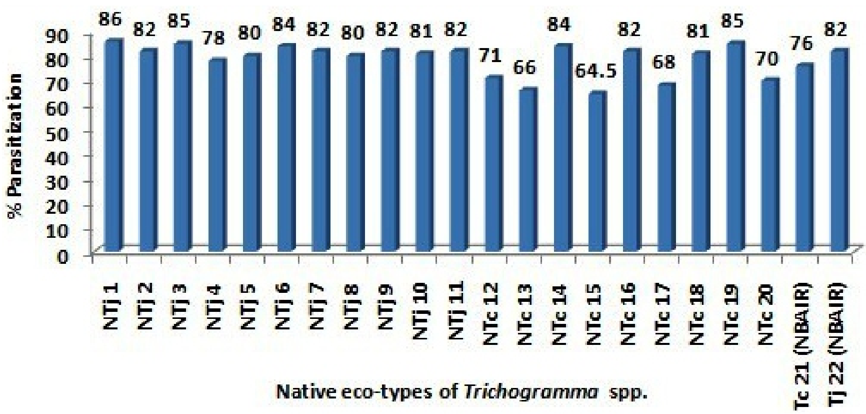

Fig 3.Parasitic rate of native *Trichogramma* spp., at 7 days after inoculation

5. Promotion of native *Trichogramma* spp., through DBT Biotech KISAN project

A separate laboratory has been established at ICAR-NIBSM, Raipur for mass-production and supply to the stakeholders with the financial support of DBT Biotech KISAN project, sponsored by Department of Biotechnology, New Delhi. Two species including *T. japonicum* and *T. chilonis* are being mass-produced in this laboratory for conducting various field and laboratory experiments and also to create awareness on biocontrol agents among stakeholders in the jurisdiction of the partner KVKs (IGKV, Raipur) of DBT Biotech KISAN project (Fig. 4).

Fig 4. Trichogramma production unit at ICAR-NIBSM

6. Mass production of egg parasitoid

6.1. Mass-production of Corcyra eggs

The *C. cephalonica* is reared on broken pearl millet [*Pennesitum glaucum* (L.)] grains-based medium in the *Trichogramma* mass-production unit of School of Crop Health Management Research, ICAR-National Institute of Biotic Stress Management (ICAR-NIBSM), Raipur, Chhattisgarh, India. The newly emerged *C. cephalonica* adults are contained in oviposition cages of size (27 cm height and 28 cm dia), with a wire mesh at the bottom and lateral sides for ventilation. Adults are provided with a 50% honey solution as adult food. Daily, eggs are collected from the bottom of a blotting paper placed in a plastic tray,

Fig 5. Mass-culture of *C. cephalonica*

and sieved to remove wing scales and insect appendages. In a plastic container (45 x 30 x 10 cm), cleaned eggs are sprinkled over broken pearl millet grains at a rate of 18,000 to 20,000 eggs/2.5 kg of grains, fortified with 10 g of yeast, and covered with a tightly woven cotton cloth. Care is taken to maintain the culture free of storage mite, red flour beetle, and diseases by mixing it with 5 g of wettable sulfur 80 WP and streptomycin sulfate 0.5%. The protocol is repeated to continue and maintain *Corcyra* culture throughout the year (Fig. 5).

6.2. Culture of egg parasitoid, Trichogramma spp.

In the *Trichogramma* production facility, ICAR-NIBSM, Raipur, the *Trichogramma japonicum,* and *T. chilonis* colonies are cultured on irradiated one-day-old eggs of *C. cephalonica*. The one-day-old *C. cephalonica* eggs are sterilized under a UV lamp for 20 min and pasted on white cardboard (4000 eggs in 8 × 2 cm card), using 10% acacia gum. Each egg card, containing 18,000 to 20,000 eggs is contained in a polythene bag (35 cm × 26 cm) after exposing to both species of *Trichogramma* separately at 1:6 ratio and maintained in a plastic tray (45 × 30 × 10 cm) till emergence (7-8 days after exposure). *Trichogramma* cultures are maintained at 27 ± 1 °C, 70 to 80% RH (Fig. 6).

Pasting of *Corcyra* eggs UV irradiation of *Corcyra* eggs Tricho cards

Fig 6. Mass-culture of *Trichogramma* spp.

6.3. Production and supply of Trichogramma spp.

The production of *T. japonicum* and *T. chilonis* was started during March 2021, following standard protocols. During 2011, 880 cc of *T. japonicum* and 747 cc of *T. chilonis* (1627 cc) were produced and supplied to stakeholders for management of crop pests under DBT Biotech KISAN project. Similarly, during 2022, 808 cc, consisting of 426 cc of *T. japonicum* and 382 cc of *T. chilonis* were supplied (Fig. 7).

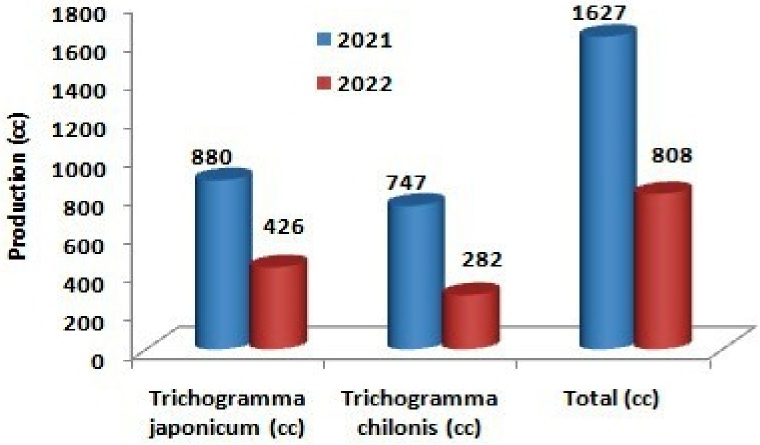

Fig 7. Supply of *Trichogramma* spp., to stakeholders

6.4. Production capacity of Trichogramma production unit

The production capacity of the *Trichogramma* lab was 162.7cc/month and 73.5 cc/month during 2021 and 2022, respectively with an average capacity of 115.0 cc/month (Fig. 8).

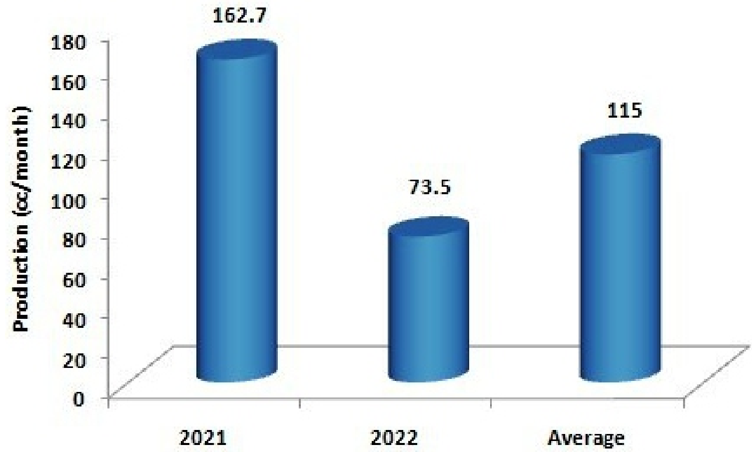

Fig 8. Production capacity of DBT Kisan *Trichogramma* production unit

6.5. Area covered under different crops

A total of 974 ha areas of rice, maize, pigeonpea, greengram, wheat, chickpea, lathyrus, vegetables, flower crops etc., were covered during 2021 and 2022 for the pests management in Mahasamund and Baloda Bazar (Kasdol) of Chhattisgarh through supply of *Trichogramma* spp., from DBT Kisan *Trichogramma* laboratory, NIBSM, Raipur (Fig. 9).

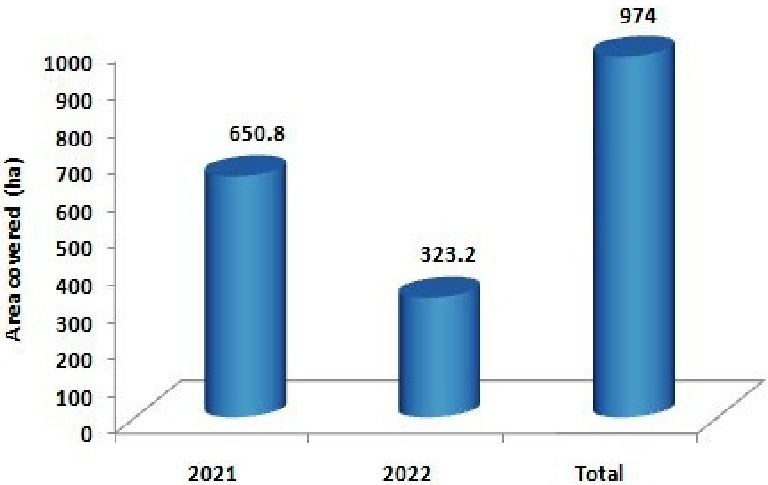

Fig 9. Area covered under various crops due to *Trichogramma* spp., release

7. Field evaluation of native *Trichogramma* spp.

7.1. Monitoring of yellow stem borer to optimize release of Trichogramma spp., in Chhattisgarh Plains

7.1.1. Kharif and summer season trials

In order to find out the time and number of releases of *Trichogramma* spp., for the management of rice yellow stem borer (YSB) during *kharif* and *rabi* seasons, brood formation was monitored using pheromone traps. Two broods on 32nd and 46th day after transplanting during *kharif* and two broods on 14th and 35th day after transplanting during summer were recorded (Fig. 10) (Murali-Baskaran et al. 2019).

Light trap catches of rice yellow stem-borer during *kharif* 2016

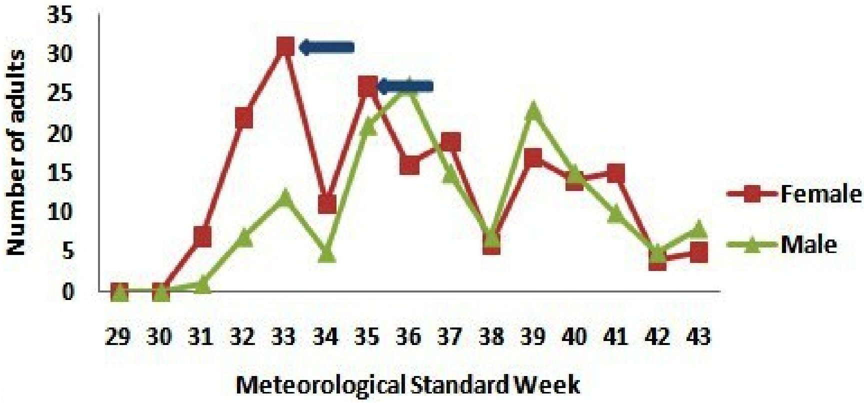

Fig 10. Broods of yellow stem borer in rice during *kharif*

Light trap catches of rice yellow stem-borer during summer 2017

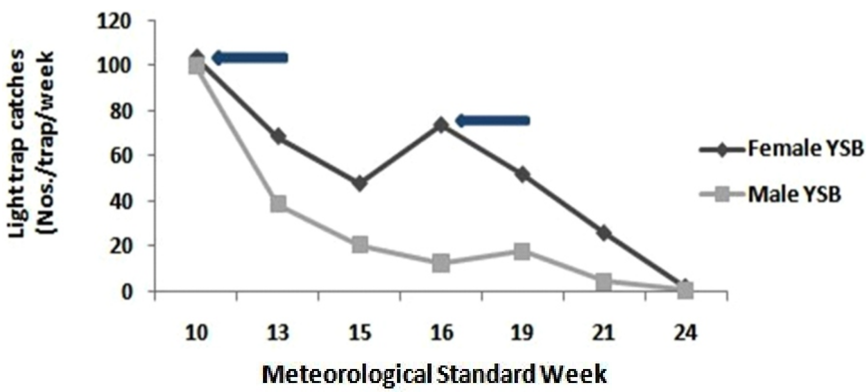

Fig 11. Broods of yellow stem borer in rice during summer

7.1.2. Optimization of Trichogramma japonicum release for management of rice yellow stem borer during kharif

Out of three schedule of releases of *T. japonicum* @ 50,000 wasps/ha at weekly interval, four releases of wasps on 32nd, 39th, 46th, 51st day after transplanting reduced the dead heart symptom by 54.7% and white ear symptom by 66.1%, besides recording the highest grain yield of 6.01 ton/ha (Table 12) (Murali-Baskaran et al., 2021a).

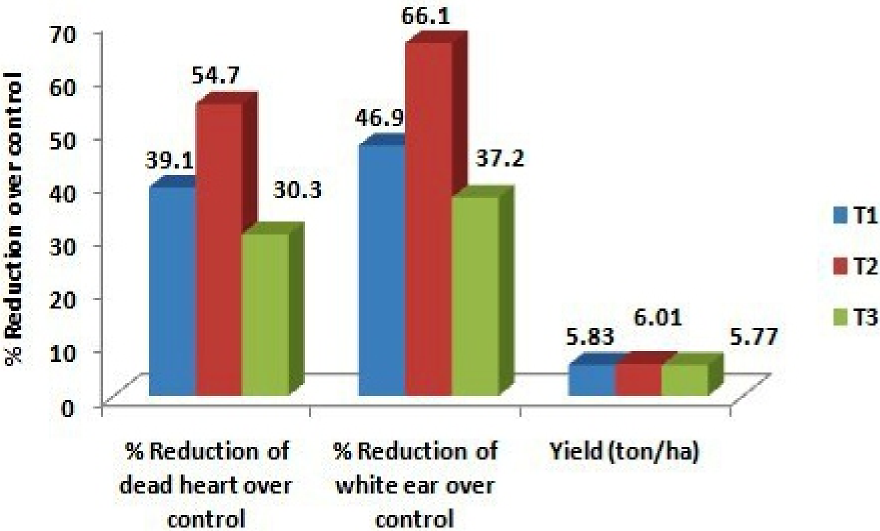

Fig 12. Per cent reduction of symptoms induced by rice yellow stem borer

T_1: Four releases of *T. japonicum* @ 200,000 wasps/ha at weekly interval on 25th, 32nd, 39th and 46th DAT

T_2: Four releases of *T. japonicum* @ 200,000 wasps/ha at weekly interval on 32nd, 39th, 46th and 53th DAT

T_3: Four releases of *T. japonicum* @ 200,000 wasps/ha at weekly interval on 39th, 46th, 53th and 60th DAT

T_4: Untreated control

7.1.3. Optimization of Trichogramma japonicum release for management of rice yellow stem borer during summer

Four releases of *T. japonicum* @ 50,000 wasps/ha at weekly interval, on 14th, 21st, 28th, 35th day after transplanting reduced the dead heart symptom by 44.51% and white ear symptom by 48.65%, beside increasing grain yield by 20.86%.

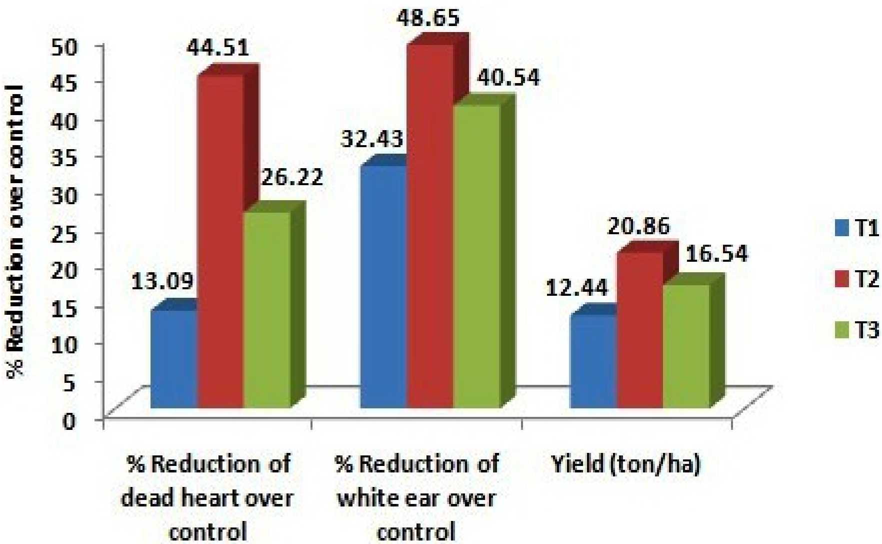

Fig 13. Per cent reduction of symptoms induced by rice yellow stem borer

T_1: Four releases of *T. japonicum* @ 200,000 wasps/ha at weekly interval on 25th, 32nd, 39th and 46th DAT

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T_3: Four releases of *T. japonicum* @ 200,000 wasps/ha at weekly interval on 39th, 46th, 53th and 60th DAT

T_4: Untreated control

8. Kairomone mediated Biological Control

Biological control has been advocated one of the options for the management of Lepidoptera pests, particularly using *Trichogramma* spp. Natural enemies use the plant volatiles induced by herbivoure attack as chemical cues to locate various immature stages of herbivoures. Such plant volatiles are inter-specific, technically called kairomone which can be used indirectly to enhance the biocontrol potential of natural enemies against Lepidoptera pests (Fig. 14) (Murali-Baskaran et al., 2018).

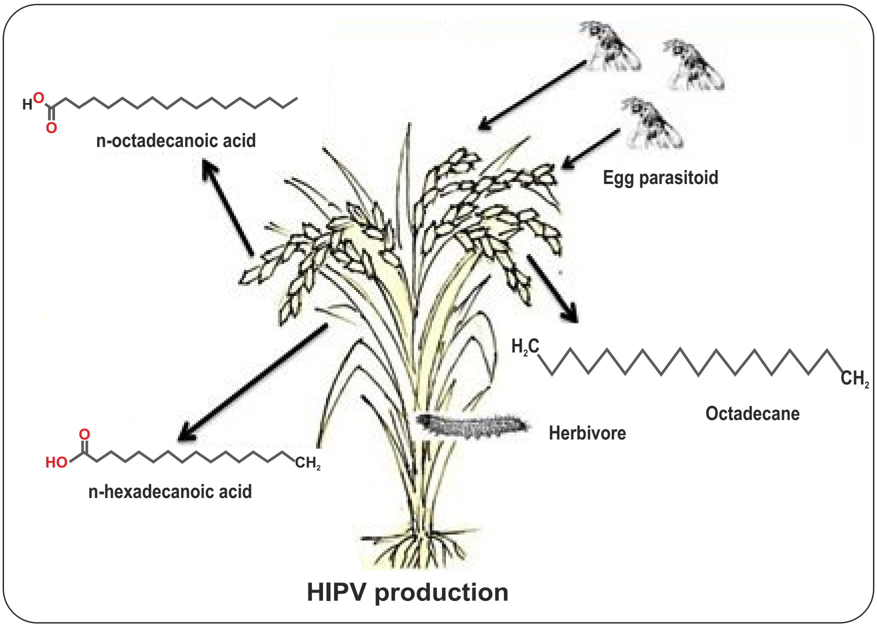


Fig 14. Kairomone mediated biocontrol of rice yellow stem borer

Approximately 2000 herbivoure induced plant volatiles (HIPVs) have been reported from 900 plant families to mediate indirect plant defense against biotic stresses across the world which belong to terpenoids, aldehydes, alcohols and their acetates, sesquiterpenoids, alkanes, sulfur containing compounds *etc*. The efficacy of such chemicals have primarily only been studied under laboratory conditions (Fig. 15) (Murali-Baskaran et al., 2022).

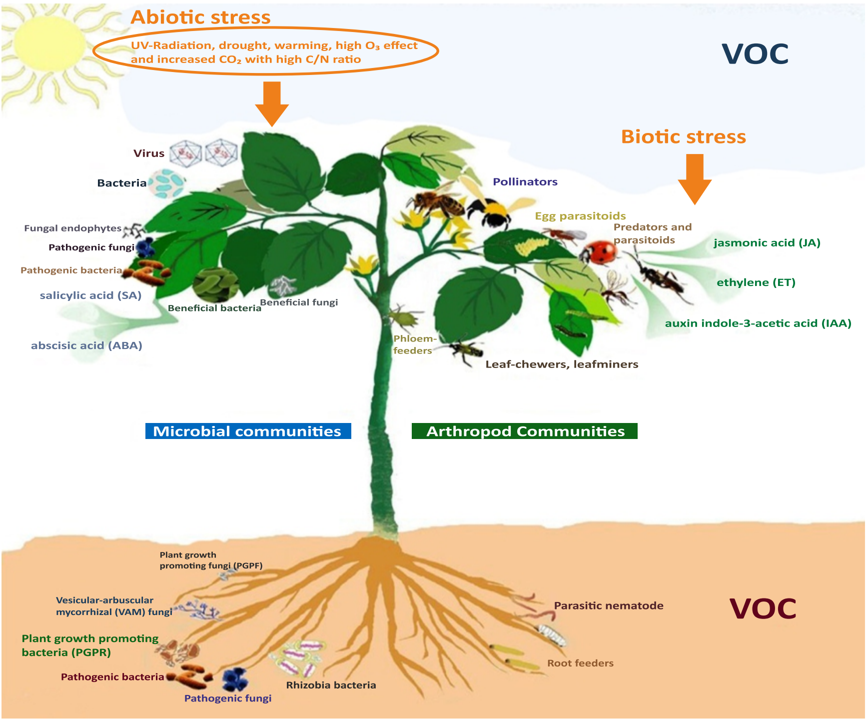


Fig 15. Graphical representation of possible way of relations between insects (both beneficial and harmful), plant and microbes and their signaling pathway. Plants system is immediately triggered after herbivore attack through their molecular responses to the communication with an excess of organisms with different habitat. Microbes and insects are interacted and can affect or benefit of each other's on plant health through their variety of plant responses. Two different pathways represented the two-way interactions are represented, namely volatile organic compounds (VOCs), jasmonic acid (JA), salicylic acid (SA), abscisic acid (ABA), and ethylene (ET) and auxin indole-3-acetic acid (IAA).

8.1. Identification of kairomone for enhanced biocontrol of rice yellow stem borer

Out of six kairomones evaluated, octadecane 500 ppm treated hexane washed *Corcyra* eggs were preferred by *T. japonicum* and caused 96.5% parasitism while it was 16.7% in hexane washed eggs and 87.3% in control eggs (Fig. 16) (Murali-Baskaran et al. 2020).

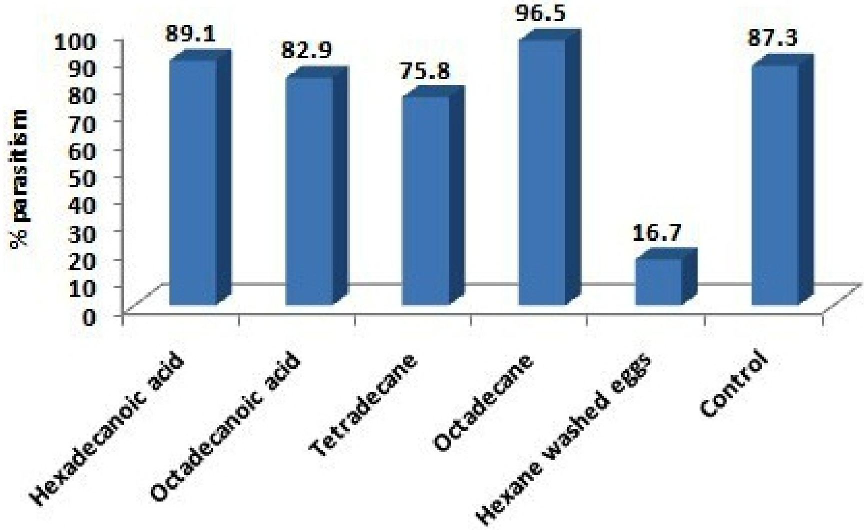


Fig 16. Per cent parasitism by *T. japonicum* on *Corcyra* eggs, treated with kairomones

8.2. Preparation of gel based octadecane

The plant volatiles including n-hexadecanoic acid, n-octadecanoic acid, and octadecane identified to enhance the foraging activity of *Trichogramma* spp. under laboratory conditions were used as test kairomones for field experiments against wheat PSB and CPB.A synthetic form of kairomones, palmitic acid (n-hexadecanoic acid), stearic acid (n-octadecanoic acid), and octadecane (Hi-Media India Ltd.) was used for kairomone gel formulation preparation. Twenty and fifty mg of palmitic acid, stearic acid, and octadecane were weighed and dissolved in one mL of hexane, respectively (HPLC grade). The gel was made by dissolving 2.5 gamm of carbopol 940 (Hi-Media India Ltd.) in 100 mL distilled water and stirring thoroughly to produce the gel. Hexane-containing kairomones were mixed separately in 100 ml of gel and stirred to get uniform kairomone gel formulations. For each formulation, four mL were dispensed in 7.5 cm diam. Whatman® filter paper and kept in polythene lock bags to avoid evaporation of formulations. The filter paper impregnated with kairomone gel formulations (200 ppm and 500 ppm of palmitic acid, stearic acid, and octadecane) were used under field condition for further evaluation.

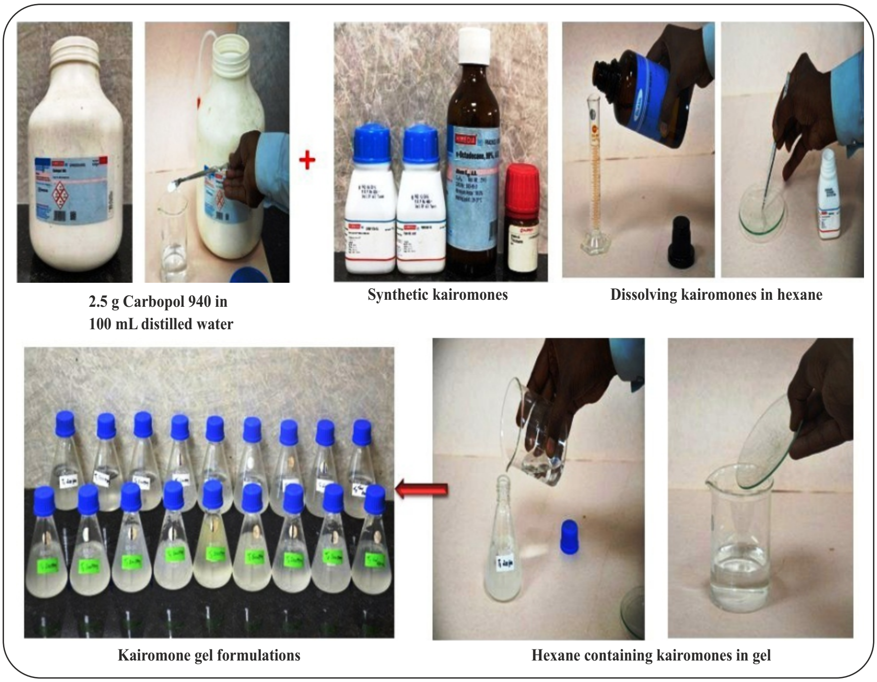


Fig 17. Kairomone gel formulation

8.3. Device for application of gel formulation

A simple set-up was devised to apply kairomone formulation, called kairomone application station in which a cone-shaped arrangement was made from two Whatman® filter paper No. 1 (7.5 cm dia.) containing absorbent cotton as a receptacle to gel formulation. The filter paper cone after dispensing 4 mL of the formulation fit on the inner side of the inverted plastic container using a plastic label beneath the cone. The filter paper cone after dispensing 4 mL of the formulation fit on the inner side of the inverted plastic container using a plastic label beneath the cone. The plastic label could help to catch hold of a cone with kairomone formulation from falling down, leading to gradual dispense of kairomone, and also mention the treatment name. The whole step up was tied at the tip of 3 feet high plastic pole and installed in wheat treatment plots. Approximately 100 mL of each formulation was dispensed in 25 places/ac @ 4 mL/station (Fig. 18).

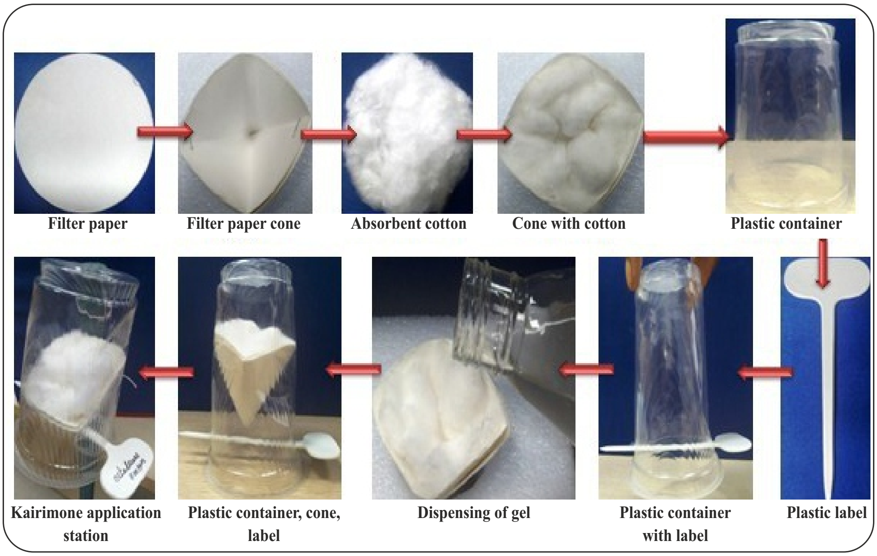


Fig 18. Preparation of gel carrier

8.4. Kairomone technology for biocontrol of rice yellow stem borer, Scirpophaga incertulas

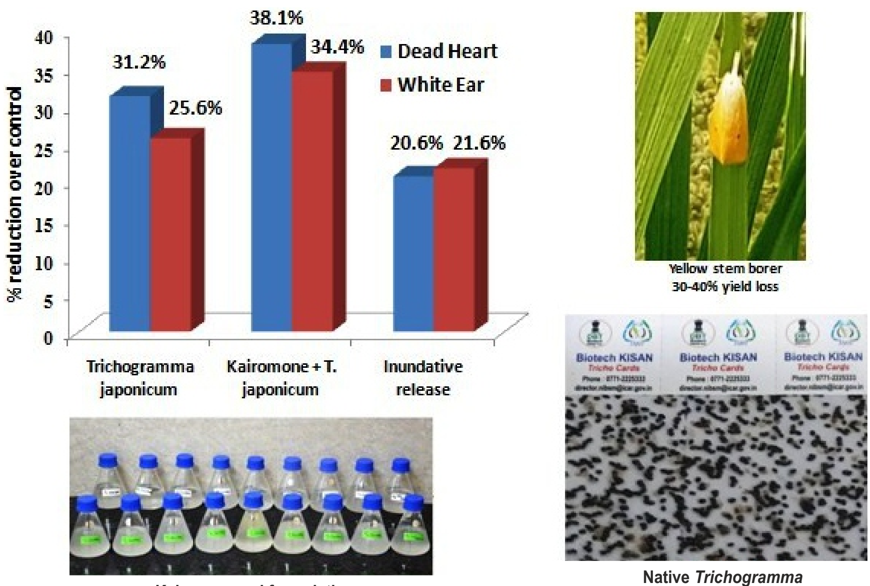


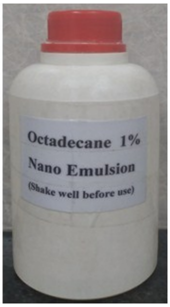
Fig 19. Per cent parasitisation by *T. japonicum,* as influenced by kairomone gel formulation

Application of octadecane 500 ppm enhances the parasitic activity of *Trichogramma japonicum* by reducing the damage caused by rice yellow stem borer from 34.4 to 38.1%, as compared to control (Fig. 19) (Murali-Baskaran et al. 2021b).

8.5. Comparative efficacy of gel and nanoemulsion of octadecane on biocontrol potential of T. japonicum against rice yellow stem borer

Application of Gel formulation of octadecane enhanced biocontrol potential of *T. japonicum* by 11.83% to 14.86% against rice yellow stem borer during summer 2021 while Nanoemulsion enhanced from 18.81% to 18.81% during summer 2022, besides increasing yield from 8.70% to 11.18%

Treatment	Summer 2021			Summer 2022		
	% decrease/increase			% decrease/increase		
	Dead heart	White ear	Yield	Dead heart	White ear	Yield
Gel + *T. japonicum*	14.86	11.83	8.70	--	--	--
Nanoemulsion 1% + *T. japonicum*	--	--	--	18.68	18.81	11.18



8.6. Efficacy of kairomone gel formulations on biocontrol potential of T. chilonis against wheat pink stem borer

Application of octadecane gel formulation at 200 ppm and 500 ppm 24 hr after each release of *T. chilonis* on the 40th, 47th, 54th, 61st day after sowing (DAS) of seeds at weekly interval reduced the overall PSB induced dead heart symptom by 47.54% (3.21% dead heart) and 48.53% (3.14% dead heart), respectively over control plots (6.12% dead heart). In *T. chilonis* alone released wheat plots, dead heart was suppressed by 32.52% (4.13% dead heart). The overall reduction of white ear symptoms was maximum in plots applied with octadecane 500 ppm (47.46% reduction; 4.13% white ear), as compared to control (7.86% white ear). In *T. chilonis* alone released wheat plots, the reduction in white ear symptom was by 25.57% (5.85% white ear). The reduction of damage caused by PSB in octadecane 500 ppm + *T. japonicum* treatment increased the wheat grain yield by 25.06% while it was 10.30% in wasp alone released wheat plots (Fig. 20).

Fig 20. Field testing of kairomone gel formulation

8.7. Efficacy of kairomone gel formulations on biocontrol potential of T. chilonis against chickpea pod borer

Mean number of chickpea pod borer larva was significantly reduced when chickpea plots were applied with octadecane gel formulation at 200 ppm and 500 ppm which recorded 34.28% (30.24 larvae/10 plants) and 35.99% (29.45 larvae/10 plants), respectively. In *T. chilonis* alone released chickpea plots, the reduction in larval population was 17.69% (37.87 larvae/10 plants). In control plots, pod borer larval population was 46.04 larvae/10 plants. Mean pod damage in chickpea plots applied with octadecane gel 500 ppm + *T. chilonis* release was reduced by 31.22% (10.20% pod damage) while it was 15.64% (12.51% pod damage) in *T. chilonis* alone released plots and 14.83% pod damage in control plots Octadecane gel 500 ppm + *T. chilonis* treatment increased the chickpea grain yield by 14.41% while in *T. chilonis* alone released plots, the increase was 8.76% (Fig. 21).

Fig 21. Field testing of kairomone gel formulation in chickpea

9. Progress made for promotion of native *Trichogramma* in Chhattisgarh

9.1. Mass demonstration of eco-friendly pest management through Tricho cards

Number of Districts covered - 05

- ❖ Raipur
- ❖ Mahasamund
- ❖ Baloda Bazar
- ❖ Rajnandgaon
- ❖ Surguja

Total Number of Village Covered

- ❖ Raipur:06
- ❖ Mahasamund: 05
- ❖ Baloda Bazar: 05
- ❖ Rajnandgaon: 05
- ❖ Surguja: 03

Total *Trichogramma* distributed

- ❖ 2021: 1627 cc
- ❖ 2022: 808 cc

Total area covered

- ❖ 2021: 650 ha.
- ❖ 2022: 323 ha.

Total farm families benefited: 740

9.2. Major Crop covered and their pest controlled

Major Crop Covered	**Major Pest Controlled**
 Rice	 Yellow Stem Borer and Leaf Folder

 Wheat	 Pink Stem Borer
 Chickpea	 Pod Borer
 Tomato	 Fruit Borer
 Brinjal	 Shoot and Fruit Borer

 Maize	 Fall Army Worm
 Chilli	 *Spodoptera* and *Helicoverpa*
 Okra	 Early shoot borer

9.3. Projects Involved

DBT Biotech-KISAN Hub Project

Farmer FIRST Project

9.4. Capacity building programme organized

S. No.	Projects	Number of activities	No. of Villages covered	No. of beneficiaries
1	DBT Biotech KISAN Project	47	10	1420
2	Farmer FIRST Project	32	05	482

9.5. Glimpses of capacity building programme in DBT Biotech KISAN and FFP Project sites








10. Conclusions

Chhattisgarh state is potential for natural resources including biocontrol agents as 43% of its landscape is occupied with undisturbed forest ecosystem. Due to less numerous human interventions at these areas, many biocontrol agents and microbial are abundant in the undisturbed areas. However, the awareness of Chhattisgarh farmers towards the field applications of biocontrol agents in the biotic stress management is lacking as huge populations belonging to SC and ST do not have access to aware on biocontrol agents. Lacking in service of biocontrol laboratories for timely supply of biocontrol agents is considered as an another impediment for its infancy in Chhattisgarh. In order to enhance the visibility of biological control, an exploration was made through making several surveys in three different agroclimatic zones of Chhattisgarh, covering 22 districts during which 20 ecotypes of *Trichogramma* were recovered. With the help of funding from DBT Biotech KISAN project, a separate laboratory was established during 2021 for mass production and supply of two species of *Trichogramma* in which approximately 2500 cc of tricho cards were supplied for pest management in rice, wheat, maize, chickpea, vegetables, flowers etc. During this venture, around 1000 ha areas belonging to Mahasamund district and Baloda Bazar district (Kasdole) of Chhattisgarh were benefited. Several field experiments were conducted in rice, wheat and chickpea to optimize the time and number of releases of *Trichogramma.* Suitable kairomone and its formulation was identified and developed and evaluated under field conditions to enhance the parasitic activities of parasitoids. Such kind of exploration in identifying the efficient ecotypes and further augmentation strategies for other biocontrol agents need to be continued in future for sustainable likelihood and livelihood of farmers of Chhattisgarh.

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Trichogramma Production Unit

DBT Biotech-KISAN Project

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