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Bioefficacy of various biopesticides against brown planthopper, *Nilaparvata lugens* stal.

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Abstract
Experiment under glass house was conducted to evaluate the bio-efficacy of various entomofungus biopesticides against brown planthopper (BPH), To assess efficacy of insecticides and biopesticides, the treatments were diluted to specified doses with water and sprayed on 30-day old potted TN1 rice plants with the help of fine atomizer, where 2nd and 3rd instar nymphs of BPH were released on to each treated plant. Observations on BPH mortality were recorded at 1st,2nd,3rd, and 4th week after spraying. The results revealed that all the treatments were found to be significantly superior over untreated control (plain water). After the 1st week of treatment, plants treated with Dinotefuran @20% SG showed significant reduction whereas there was a negligible reduction in nymph population of the plants that were treated with biopesticides. Dinotefuran
@20% SG, was found to be most effective in comparison to all other treatments where it showed the reduction percentage of 58%. At the end of 4th week, it was noted that among the entomofungal biopesticides the most effective treatment registered was *Metarhizium anisopliae* followed by *Beauveria bassiana, Nomuraea rileyi, Lecanicilium lecanii* and *Fusarium equiseti* where they suppressed the population by about 14-24%.

Keywords: Bioefficacy, brown planthopper, Dinotefuran and entomofungal biopesticides

Introduction
Rice (*Oryza sativa* L.) is one of the world's most important crops providing a staple food for more than half of the global population (Kulagod *et al.* (2011) [6]. Rice occupies prime position in agriculture scenario. Rice forms the backbone of millions of people's diets as it contains decent amounts of fiber, protein, vitamin B, iron and manganese. India is famous as a rice growing country in the world. Among the top ten rice producing countries in the world, India ranks 2nd after China.

According to USDA, Foreign Agricultural Service, Production, Supply and Distribution database; India's average annual rice production is 120.544 million tonnes during the year 2021-2022. India is one of the largest exporters of rice to the world, exporting nearly 10 million metric tonnes every year.

But as mentioned above, rice is grown predominantly in our country is affected by more than 200 insect pests of which about a few are economically important (Litsinger, 2009) [1]; The insect pest complex of rice crop includes, Species like green leafhopper, white-backed planthopper, brown planthopper, armyworm, caseworm, leaf-folder, whorl maggot and thrips.

Among the plant hoppers, Brown planthopper is the number-one insect pest of rice in Asia today, primarily because of the unpredictability of the infestation and the severe damage that it causes. Brown planthopper, is a phloem-sap-sucking insect pest of rice (Sogawa, 1982) [4] causes enormous plant mortality referred to as 'hopper burn' symptom. BPH also transmits rice grassy stunt virus (GSV) and ragged stunt virus (RSV) as a vector. The loss in grain yield ranges from 10% in moderately affected fields to 70% in those severely affected (Kulshreshtha, 1974) [7].

It is well-known that the strategy for controlling BPH has depended on chemical insecticides for a long time (Chung *et al.*, 1982, Liu *et al.*, 2003) [4, 16]. Pesticide application was found to be ineffective as the infestation is rapid and hidden somehow in the early stages due to damage at the plant base level (Sarao, 2015) [17] and because of the level of the damage that it causes, uninformed farmers tend to apply higher doses of pesticides in the fields (Sarao and Mangat, 2014) [15] leading to severe repercussions like resurgence, resistance to pesticides, destruction of natural enemies, secondary pest outbreak and because of all this, the ecological balance between BPH and natural enemies have been disrupted leading to pest resurgence in a no. of

Asian countries such as Vietnam, China, India, Philippines and Japan (Horgan, 2009) [5]. Hence, switching to non-chemical biological approaches such as entomopathogens (Burges, 1981) [3] or cultural approaches like resistant cultivars has substantial potential for curtailing the losses.
Entomogenous fungi are potentially the most versatile biological control agents, thanks to their wide host range that often results in natural epizootics. Outbreaks of pests are due to a number of reasons and are symptomatic for unsustainable agricultural practices.
More than 700 species of fungi, mostly Deuteromycetes and Entomophorales from about 90 genera are pathogenic to insects. A complex of fungal pathogens has been identified from pests of rice. Moreover, the fungal diseases were favoured by high humidity, the microclimate available in the rice fields would be most suitable for the spreading of the disease and these fungi have a better prospect in the microbial control of insect pests of rice.

Materials and Methods

Bio-efficacy of various biopesticides were evaluated as per the method adopted by Mohan *et al*. (2016) [10]. The experiment was carried out under controlled glass house conditions at a temperature of 30±50 °C and RH of 60±5%.

Culture of Entomofungal pathogens

Ever since in the glasshouse BPH population was infected by entomofungal pathogens where it was evident that some of the population was infected by white fungus and some were infected by green fungus. Simply by visual observations, one cannot go through the confirmation of pathogen. so, in order to make sure the pathogenicity and potentiality of the entomofungal pathogen infected BPH population, samples were collected from the glasshouse and extracted the culture by the following procedure in Bio control lab, Department of Entomology, IGKV, C.G.
Firstly, PDA (Potato Dextrose Agar) media was prepared. Potato Dextrose Agar (PDA) is used for the cultivation of fungi.
After this, the infected samples were inoculated into the PDA poured petri dishes. After 10- 15 days there was growth of fungus i.e., White and green fungal growth in the respective petri dishes. A small portion of the spores from each petri dish were taken and observed under the compound microscope. From each specimen it was identified as *Fusarium equiseti* and *Nomuraea rileyi* based on their morphological characters.
From this fungal culture, spray formulations were prepared in order to know their pathogenicity and potentiality against BPH population.

Table 1: Composition of PDA used in the preparation of fungal culture

Composition	Quantity (gm/ml)
Potato	200 gm
Dextrose	20 gm
Agar	20 gm
Distilled water	1 litre

1. Peeled potato slices of 200 g were boiled in 1-liter distilled water for 30 min.
2. The extract is filtered and
3. Mixed with Dextrose, Agar and Water and boiled to dissolve.
4. Autoclave for 15 min at 121 °C.
5. Dispensed 20-25 ml portions into sterile 15 × 100 mm petri dishes.

Therefore, 'TN1' plants were cultivated in plastic trays as nurseries in glasshouse and then transferred into clay pots when they were 15 days old. Seven treatments along with one control and with four replications were maintained. Each plant was covered with transparent hallow plastic tube and the top portion with muslin cloth. 20 BPH nymphs per plant, second and third instar nymphs were released on 30 days old plants. After a week of release, recommended doses of five biopesticides and one check insecticide were mixed with water and mixed thoroughly and then the solution is sprayed into the mylar tubes on the plants using a hand atomizer.
Water spray served as untreated control and Dinotefuran 20 SG was sprayed as check insecticide. Untreated control line was maintained for calculating the reduction percentage. Washing of sprayer was done before the application of another pesticide, by flushing sufficient clean water. Counts were taken 1st, 2nd, 3rd, and 4th week thereafter. At each count live insects were counted.

Table 2: Details of insecticides and biopesticides used in present study

Sl. No.	Treatments	Formulation	Dose (gm/ml)	Dose/liter (gm/ml)
1	*Beauveria bassiana*	10% SL (1×107 CFU/ml)	10 ml/lt	10 ml/lt
2	*Metarhizium anisopliae*	10% SL (1×102 CFU/ml)	10 ml/lt	10 ml/lt
3	*Lecanicilium lecanii*	10% SL (1×107 CFU/ml)	10 ml/lt	10 ml/lt
4	*Nomuraea rileyi*	10% SL (1×109 spores/ml)	10 ml/lt	10 ml/lt
5	*Fusarium equiseti*	10% SL (1×107 CFU/ml)	10 ml/lt	10 ml/lt
6	*Dinotefuran*	20 SG	200 gm/ha	0.4 gm
7	*Control (Plain water)*	---	---	---

The mean original data of percentage reduction was calculated reduction over with the following formula (Abbott's 1925)

$$\text{Percent reduction} = \frac{C - T}{C} \times 100$$

Where, T = Insect population reduction in treated replication

C = Insect population reduction in control(untreated) replication

Statistical analysis

The reduction data was converted into mean values then trans- formed into square root values for one- way ANOVA in

CRD design.

Results and Discussions

The prepared entomofungal spray formulations were sprayed along with other formulations. After a few days of treatment, it was found that every tested biopesticide considerably reduced the population of BPH better than the control (plain water).

Observation after 1 DAS

Onto each replication 20 nymphs were released and after one day of the spray, the average population of BPH nymphs ranged from 16.75 to 20.00 in various treatments. Among all the, treatments Dinotefuran @20% SG was found to be most effective against population reduction, which recorded an average of 16.75 nymphs per replication. However, there is no significant results were shown by the biopesticides. Likewise, there is no change in the BPH population on the replicants which were treated with the plain water (control).

Observation after 7 DAS

After one week of the spray, the average population of BPH nymphs ranged from 8.25 to 20.00 in different treatments. Among all tested insecticides, Dinotefuran @20% SG was found to be most effective, which recorded 8.25 nymphs per replication but, nymph population varied significantly in *Metarhizium anisopliae* @10% SL (19.25) and *Nomuraea riley* @10% SL(19.25) followed by *Beauveria bassiana* @10%SL(19.50) and *Lecanicilium lecanii* @10% SL (19.50) whereas *Fusarium equiseti* @10%SL was recorded as (19.75). However all the biopesticide treatments recorded no significant change in average nymph population when compared with 1 DAS observations. All the treatments showed comparative reduction in nymph population against control treatment.

Observation after 14 DAS

After two weeks of the spray, the average population of BPH nymphs ranged from 5.75 to 19.50 in different treatments. Among all tested insecticides, Dinotefuran @20% SG was found to be most effective, which recorded average of 5.75 nymphs per replication and nymph population varied significantly in *Metarhizium anisopliae* @10% SL (12.50) followed by *Beauveria bassiana* @10% SL (13.25), *Nomuraea riley* @10%SL (15.00), *Lecanicilium lecanii* @10%SL (16.50) whereas *Fusarium equiseti* @10%SL was recorded as (17.25). whereas average maximum population (19.50) was recorded in untreated control replications.

Observation after 21 DAS

After three weeks of the spray, the average population of BPH nymphs ranged from 2.00 to18.75 in different treatments. Among all tested insecticides, Dinotefuran @20% SG was found to be most effective, which recorded average of 2.00 nymphs per replication and nymph population varied significantly in *Metarhizium anisopliae* @10% SL (7.50) and *Beauveria bassiana* @10% SL (8.25) followed by *Nomuraea riley* @10%SL (9.00), *Lecanicilium lecanii* @10%SL and *Fusarium equiseti* @10%SL recorded the average nymphal population of (10.75). whereas average maximum population (18.75) was recorded in untreated control replications.

Mean nymphal population

Over all mean nymphal population of BPH varied in various treatments from 8.18 to 19.56 per four replications. It was recorded that check insecticide Dinotefuran @20% SG recorded the lowest average population of nymphs among all the treatments that is (8.81). After that bio pesticide *Metarhizium anisopliae* @10% SL (14.81 nymphs) recorded the lowest nymphal population among all the biopesticides and *Beauveria bassiana* @10% SL (15.18 nymphs) recorded as the second-best treatment. Followed by *Nomuraea riley* @10%SL (15.68), *Lecanicilium lecanii* @10%SL (16.62) and *Fusarium equiseti* @10%SL (16.81) Maximum population was recorded with 19.56 nymphs in untreated control replications, hence making it the least effective treatment out of the seven treatments.

Percent reduction of Brown planthopper nymphal population over control

Percent reduction of BPH nymph population was ranged from 58 to 14 percent in various treatments. The overall maximum nymphal population reduction percentage was recorded in T6-Dinotefuran @20% (58%), followed by T2-*Metarhizium anisopliae* @10%SL (24%), T1- *Beauveria bassiana* @@10%SL (22%), T4-*Nomuraea riley* @10%SL (20%), T3-*Lecanicilium lecanii* @10%SL (15.00) and the lowest was recorded in T5-*Fusarium equiseti* @10%SL (14.00).

The observations so recorded were found similar to the work done by Atta (2019) who selected three species of EPF, *Beauveria bassiana*, *Metarhizium anisopliae* and *Lecanicillium lecanii*, and were tested against *N. lugens*. The results indicated that all tested EPF, *B. bassiana, anisopliae* and *L. lecanii* were effective against *N. lugens* but *M. anisopliae* was more effective than *B. bassiana* and *L. lecanii.* and the results obtained were also in conformity with the findings of several other researchers (Aguda *et al*, 1987; Rammohan Rao, 1989) [10].

The increased efficacy of *M. anisopliae* and *B. bassiana* with increase in the number of days after application against brown plant hopper in the present study was in conformity with the findings.

Table 3: Bio-efficacy of biopesticides against brown planthopper in rice crop in glasshouse conditions

S.N.	Average no. of nymphs survived					Mean no. of nymphs	Percent reduction of population over control	
	TREATMENT	1DAS	7DAS	14DAS	21DAS			
	19.50							
	Beauveria	19.75*	(4.52)	13.25		8.25		
1	*bassiana*	(4.55)**		(3.77)		(3.03)	15.1875	22%
	Metarhizium	20.00	19.25	12.50		7.50		
2	*anisopliae*	(4.58)	(4.50)	(3.67)		(2.90)	14.8125	24%
	Lecanicilium	19.75	19.50	16.50		10.75		
3	*lecanii*	(4.55)	(4.52)	(4.18)		(3.42)	16.625	15%
		19.50	19.25	15.00		9.00		
4	*Nomuraea rileyi*	(4.52)	(4.49)	(3.99)		(3.16)	15.6875	20%
		19.50	19.75	17.25		10.75		
5	*Fusarium equiseti*	(4.52)	(4.55)	(4.27)		(3.42)	16.8125	14%
		16.75	8.25	5.75		2.00		
6	Dinotefuran	(4.21)	(3.03)	(2.59)		(1.72)	8.1875	58%
	control (plain	20.00	20.00	19.50		18.75		
7	water)	(4.58)	(4.58)	(4.52)		(4.44)	19.5625	---
	C.D.@5%	0.09	0.12	0.22		0.30	---	---
	SE(m) ±	0.03	0.04	0.07		0.10	---	---

* Average of four replications

** Figure in the parenthesis is square root transformed value

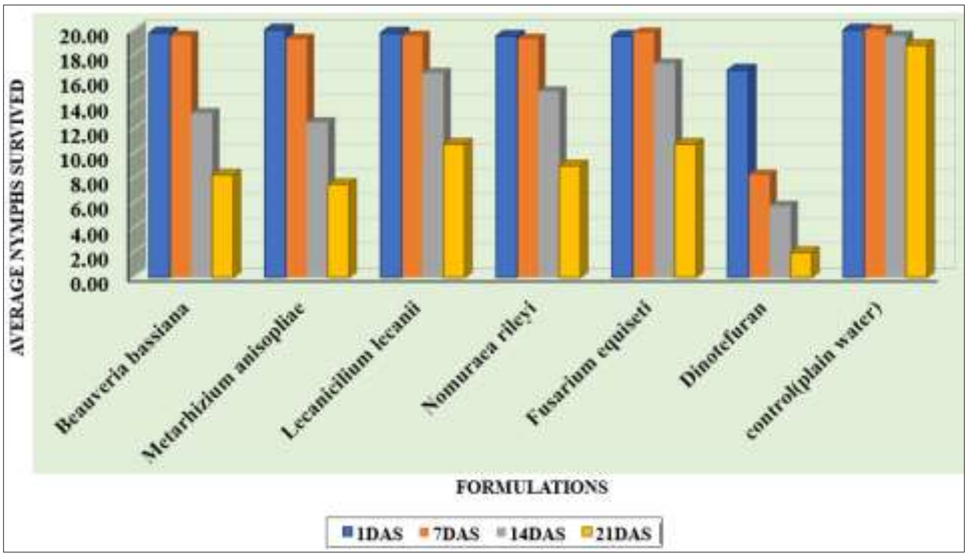

Fig 1: Bio-efficacy of biopesticides against BPH

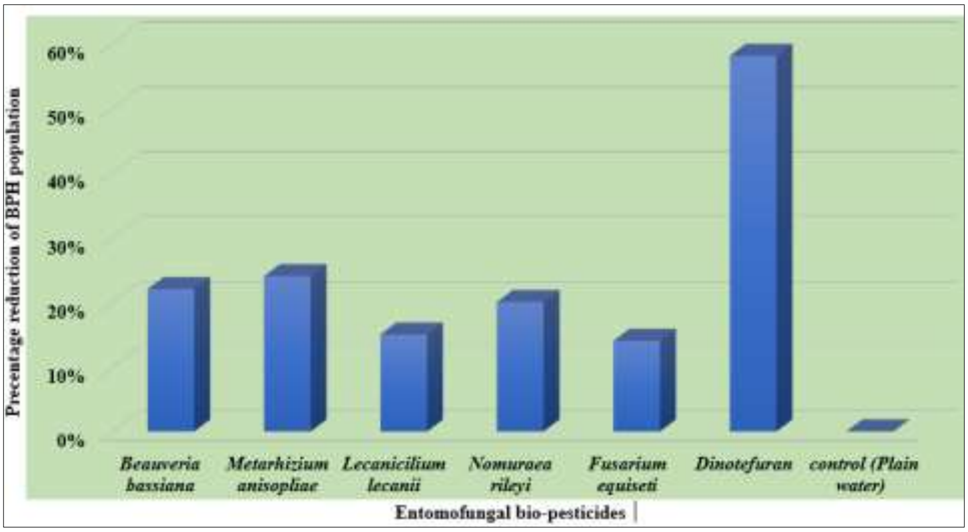

Fig 2: Percent reduction of BPH over the control

Conclusion

Thus, From the experiment of bio efficacy under the glass house conditions it was concluded that all the treatments were found to be significantly superior over untreated control (plain water). Dinotefuran @20% SG, was found to be most effective in comparison to all other treatments. Among the entomofungal biopesticides the most effective treatment registered was Metarhizium anisopliae followed by Beauveria bassiana, Nomuraea rileyi, Lecanicilium lecanii and Fusarium equiseti.

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