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FIELD EFFICACY OF *Lecanicillium lecanii* AND COMBINATION OF ENTOMOPATHOGENIC FUNGI AGAINST RICE STEM BORER (*Scirpophaga incertulas* L.) AND LEAF FOLDER (*Cnaphalocrocis medinalis* L.) UNDER NATURAL FIELD CONDITION

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ABSTRACT

Entomopathogenic fungi are considered the most versatile groups of bioagents which reduce the insect's population as well as safe guard to environments, considering these facts the EPF was isolated from soils and insects. A field experiment was conducted at research farm of BTC, College of Agriculture and Research Station, Bilaspur, (C.G.) during *kharif* 2021-2022, to test the efficacy of isolated fungi, among them most effective isolates of *Lecanicillium lecanii* and combination with other bioagents were tested under natural field condition against rice leaf hopper (*Cnaphalocrocis medinalis*) and rice stem borer (*Scirpophaga incertulas*) in two different rice cv. Rajeshwari and zincorice. Three different spore suspension loads (1 x 10^7, 1 x 10^8 and 1 x 10^9 spore ml^{-1}) of *L.lecanii* and combination with other bioagents *i.e. B. bassiana*, *Paecilomyces spp.* and *BT* were sprayed @10 $ml\,l^{-1}$ with standard check chemical insecticides. Standard check (Novaluron 5.25% + Indoxacarb 4.5% SC) @ 1.65 $ml\,l^{-1}$ found most effective among all treatments and recorded highest % reduction of leaf infestation *i.e.* 82.5 % and 76.9% and among biopesticide highest mean % reduction recorded from *B. bassiana*-10% (65.5%) followed by *L. lecanii*-10% (62.8) in cv. Zinco rice and similarly in Rajeshwari highest % reduction recorded from *B. bassiana*-10% (64.4%) followed by *Beauveria* 50% +BT 50%-10% (62.9%). In case of stem borer, the highest % reduction of stem borer infestation *i.e.* 98.6 % and 97.0 % recorded in Novaluron 5.25% + Indoxacarb 4.5% SC. Among biopesticide highest reduction recorded in *B. bassiana*-10% (75.6 %) (73.7%) followed by *L. lecanii*-10% (72.3) (70.3%) in Rajeshwari and Zinco rice, respectively.

(Key words: *Lecanicillium lecanii*, leaf folder, *Cnaphalocrosis medinalis*, Stem borer and *Scirpophaga incertulas*)

INTRODUCTION

Microbial control is important tool in Integrated Pest Management (IPM) and is an ecologically favourable strategy compared to conventional chemical control of insect (Barranco-Florido *et al.*, 2002). Among the different organisms, use of entomopathogenic fungi (EPF) are the most vital inputs to be employed as biocontrol agents in reducing pest populations and their damage in different agro-ecosystems (Inglish *et al.,* 2001). Among EPFS, *Lecanicillium lecanii* is one of the highly promising fungal bioagent causing infections mostly to members of Homoges including whiteflies, coccids and aphids. This species complex exhibits a very wide host range, including insects, mites, nematodes and phytopathogenic fungi (Askary *et al*., 1998; Rekha *et al*.,2020). According to Pathak and Dhaliwal (1981) the losses caused by insect pests in paddy is considered as 24 %. Among the different insect pests damaging paddy, a group of leaf defoliators play an important role in reducing the yield of the crop. Insect pests prevalent on rice in the Chhattisgarh district of India, are usually Tana chedak (Stemborer), Chitari banki (Caseworm), Katuwa (Cutworm), Gangai (Gall midge), Bhura maho (BPH), Maho (hopper), Gundhi bug (Rice bug), Hara kida (Green-horned caterpillar), Hara maho (GLH), Safed maho (WBPH) and Termite (Litsinger and Sahu, 2008; Kaushik and Nirmalkar, 2020)). Insect pest cause reduction in yield, Among the major yield limiting factors pests are said to be an important one. Pest causes 33% production loss in India, the major pest weed causes 12.5 % whereas insect 9.5 % and disease 6.5 % besides other pests 4.5 % (Mondal *et al.,* 2017).

MATERIALS AND METHODS

A field experiment was laid out at Barrister Thakur Chhedilal College of Agriculture and Research Station,

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Bilaspur (altitude 22.1032601 and longitude 82.1389713) during *kharif* 2021-2022 in Randomized Block Design to assess the field-efficacy of *Lecanicillium lecanii* against rice stem borer (*Scirpophaga incertulas*) and leaf folder (*Cnaphalocrocis medinalis*) under natural field condition. Seedlings of paddy cultivar Rajeshwari and Zinco rice transplanted at 20 x 15 cm spacing in last week of July. Standard agronomic practices were followed during experiment. All required liquid formulations were prepared in PDA broth. Insecticides Novaluron 5.25% + Indoxacarb 4.5% SC was used as standard check and only water sprayed in control plot. Infestation of leaf folder was recorded at before spray and 5th, 7th and 10th days after spray. For the observation 5 hills were randomly selected row^{-1} meter in net plot area. Reduction % of leaf infestation (LF) and white ear-head (WE) was assessed by counting leaf infestation and white earhead over control for both Rajeshwari and Zinco rice.

Stem borer damage assessment

The effectiveness of treatments against rice stem borer was assessed on the basis of total number of white ear-head (WE). Stem borer damage was recorded at the harvesting stage as white ear (WE). The following formula was used to calculate the % of damage and data analyzed in simple RBD and transformed by using arcsine data transformation (Nirmalkar *et al*., 2016).

$$\% \text{ White ear} = \frac{\text{No. of whiteears}}{\text{No. of productive tillers}} \times 100$$

Leaf folder damage assessments

The observation was made during the panicle initiating stage (reproductive period) by assessing the number of infected leaves (scraping and rolled green tissue of leaves) and healthy leaves. Their % of damage had been calculated using the following formula and data analyzed in simple RBD and transformed by using arcsine data transformation.

$$\text{Mortality \%} = \frac{\text{Control-Treatment}}{\text{Control}} \times 100$$

RESULTS AND DISCUSSION

Rice leaf folder infestation in cultivar Rajeshwari

Data revealed from Table 1 that the mean % reduction of leaf infestation over control was found maximum 82.5% at standard check treatment Novaluron 5.25% + Indoxacarb 4.5% SC @ 1.65 ml l^{-1} followed by *Beauvaria bassiana*-10% (64.4%) and (*Beauveria* 50% +BT 50%-10%) (62.9%). Least % reduction of leaf infestation was observed 31.4% at *L. lecanii* -1.5%. Among the entomopathogen the mean % reduction of leaf infestation was found maximum at *Beauvaria bassiana*-10% (64.4%) followed by *Beauveria* 50% +BT 50%-10% (62.9%) and (*L. lecanii 50%* +BT 50%)-10% (61.1%). Reduction % of leaf infestation was gradually increase from 37.4 % to 59.0 % and 73.3% over control from 5th to 7th and 10th DAS, respectively. Among the entomopathogens the % reduction of leaf infestation was higher *i.e.* 64.4%,62.9% and 61.1% , when the conidial concentration was higher (1×10^9) and when load of conidia declined then % reduction of leaf infestation was gradually decreased *i.e.* 41.0% and 31.4% at (1×10^8) and (1×10^7), respectively conidial load of *L. lecanii.*

Reduction at 5th DAS

The maximum % reduction of leaf folder infestation was recorded at standard check insecticide Novaluron 5.25% + Indoxacarb 4.5% SC @ 1.65 ml l^{-1} (61.6%) followed by *Beauveria* 50%+ *L. lecanii* 50% at 10% (40.4%) and *Beauveria* 50% +BT 50% (40.4%). Standard check showed significantly differ with all other treatments and performed superior for minimizing leaf folder infestation at 5th DAS. Treatment *L. lecanii* -10%, *Beauveria* 50%+ *L. lecanii* 50% *L. lecanii 50%* +BT 50%-10% and *Beauveria* 50% +BT 50% showed non-significant difference and found at par that mean these all treatments were equally effective against leaf folder of rice. Least % reduction of leaf folder infestation was recorded at treatment *L. lecanii* -1.5% (20.9%). When we use higher spore load formulation of *L. lecanii* or combination of *B. bassiana* and BT or combination *L. lecanii* and *B. bassiana* or *L.lecanii* and *BT* the entomopathogen showed statistically and equally effective against leaf folder of rice.

Reduction at 7th DAS

The maximum % reduction of leaf folder infestation was recorded at standard check insecticide Novaluron 5.25% + Indoxacarb 4.5% SC @ 1.65 ml l^{-1} (88.6%) followed by *Beauveria* 50% +BT 50% (69.0%) and *L. lecanii 50%* +BT 50% (68.8%). Treatment *L. lecanii 50%* +BT 50% and *Beauveria* 50% +BT 50% showed non-significant difference with each other that means these both the treatments were equally effective against leaf folder of rice. Least mortality was recorded at treatment *L. lecanii*-1.5% (31.3 %) and when we use higher spore load formulation of combination of *B. bassiana* and BT or combination *L. lecanii* and BT the entomopathogen statistically and equally effective against leaf folder of rice.

Reduction at 10th DAS

The maximum % reduction of leaf folder infestation was recorded at standard check insecticide Novaluron 5.25% + Indoxacarb 4.5% SC @ 1.65 ml l^{-1} (98.7%) followed by *Beauvaria bassiana*-10% (84.9%) and *Beauveria* 50% +BT 50% (79.0%). Treatment *L. lecanii* -10%, *Beauvaria bassiana*-10% *Beauveria* 50% + *L. lecanii* 50% and standard check insecticide showed non-significant difference between each other that mean all treatments were equally effective against leaf folder of rice. Least mortality was recorded at treatment *L. lecanii*-1.5% (41.9%) and when we use higher spore load (1×10^9) formulation of *L. lecanii* or *B. bassiana* and combination of *B. bassiana* and *L.lecanii* or *B. bassiana* and *BT* the entomopathogen statistically and equally effective against leaf folder of rice.

Rice stem borer infestation in cultivar Rajeshwari

Per cent stem borer (White-earhead) infestation recorded before spray and found statistically non-significant

and infestation ranged from 6.7% to 8.0%. Data revealed from Table 3 that the % reduction of stem borer (WE) was found maximum 98.6 % standard check Novaluron 5.25% + Indoxacarb 4.5% SC @ 1.65 ml l^{-1} followed by *Beauvaria bassiana*-10% (75.6%) and *L. lecanii* -10% (72.3%). Treatment *L. lecanii* -10%, *Beauvaria bassiana*-10%, *Beauveria* 50% + *L. lecanii* 50% and *L. lecanii 50%* +BT 50% showed non-significant difference with each other that mean all treatments were equally effective against stem borer of rice. Among the entomopathogen, % reduction of stem borer was found maximum at *Beauvaria bassiana*-10% (75.6%) followed by *L. lecanii* -10% (72.3 %) and *Beauveria* 50%+ *L. lecanii* 50% (70.3%) and least % mortality was observed 40.9 % at *L. lecanii* -1.5%. Per cent reduction of stem borer was higher (75.6%,72.3% and 70.3%) when conidial concentration was higher (1×10^9). When we use higher spore load (1×10^9) formulation of *L. lecanii* or *B. bassiana* or combination of *L. lecanii* and *B. bassiana* or *L. lecanii* and BT, the entomopathogen statistically and equally effective against stem borer of rice. When load of conidia declined then % reduction was gradually decreased *i.e.* 54.6% at (1×10^8) and 40.9% at 1×10^7 conidial load of *L. lecani.*

Grain yield

Maximum yield recorded from chemical treatment Novaluron 5.25% + Indoxacarb 4.5%SC (46.29 q ha^{-1}) and among entomopathogen, the highest yield recorded from *Beauvaria bassiana*-10% (43.98 q ha^{-1}) followed by *Beauveria* 50% *+BT* 50% (43.05 q ha^{-1}) and these treatments *i.e.* Novaluron 5.25% + Indoxacarb 4.5%SC (46.29 q ha^{-1}), *Beauvaria bassiana*-10% (43.98 q ha^{-1}) and *Beauveria* 50% *+BT* 50% (43.05 q ha^{-1}) were found at par with each other. In rest of the treatments *i.e. L. lecanii 50%* +BT 50% (42.80 q ha^{-1}), *L. lecanii* -10% (42.72 q ha^{-1}), *Beauveria* 50% + *L. lecanii* 50% (42.47 q ha^{-1}), *L. lecanii* 50% +*Paecilomyces* 50% (41.53 q ha^{-1}) and *L. lecanii* -5% (40.78 q ha^{-1}) found at par with each other and the minimum yield recorded from treatments *L. lecanii* -1.5% (38.29 q ha^{-1}), which was greater than control plot yield (32.82 q ha^{-1}).

Rice leaf folder infestation in cultivar Zinco rice

Leaf folder infestation recorded before spray and found statistically non-significant and infestation ranged from11.0 % to 13.9%. Data revealed from Table 2 that the mean % reduction of leaf folder infestation was found maximum i.e. 76.9% at standard check Novaluron 5.25% + Indoxacarb 4.5% SC @ 1.65 ml l^{-1}followed by *Beauvaria bassiana*-10% (65.5%) and *L. lecanii* -10% (62.8%). Among the entomopathogen the % reduction of leaf folder infestation was found maximum at *Beauvaria bassiana*-10% (65.5%) followed by *L. lecanii* -10% (62.8%) and *Beauveria* 50%+ *L. lecanii* 50% (58.8%) and least reduction *i.e.* 29.1% recorded from *L. lecanii* -1.5%. Reduction % of leaf folder infestation was gradually increased from 38.2 % to 55.2 % and 70.6% over control from 5th to 7th and 10th DAS, respectively. Among the entomopathogen the reduction % was higher (65.5%,62.8% and 58.8%) when conidial concentration was higher (1×10^9) and when load of conidia declined, the reduction % was also gradually decreased *i.e.* 41.1% at 1×10^8 and 29.1% at 1×10^7 conidial load of *L. lecanii.*

Mortality at 5th DAS

The maximum reduction per cent of leaf folder infestation recorded at standard check insecticide indoxacarb and novaluron @ 1.65 ml ha^{-1} (52.5%) followed by *Beauvaria bassiana*-10% (49.3%) and *L. lecanii*-10% (44.2%). Treatment *Beauveria* 50% + *L. lecanii* 50% and *L. lecanii 50%* +BT 50% showed non-significant difference with each other. Least reduction % of leaf folder infestation was recorded by treatment *L. lecanii*-1.5% (18.3 %) and when we use higher spore load combination of *B. bassiana* and *L. lecanii* or *L. lecanii* and *BT* the entomopathogen performed statistically and equally effective against leaf folder of rice.

Mortality at 7th DAS

The maximum reduction per cent of leaf folder infestation was recorded at standard check insecticide indoxacarb and novaluron @ 1.65 ml ha^{-1} (82.26%) followed by *Beauvaria bassiana*-10% (67.3%) and *L. lecanii*-10% (65.6%) and these both the treatments were found at par. Least reduction per cent of leaf folder infestation recorded by treatment *L. lecanii*-1.5% (29.6 %) and when we use higher spore load formulation of *L. lecanii* or *B. bassiana* the entomopathogen found statistically and equally effective against leaf folder of rice.

Mortality at 10th DAS

The reduction per cent of leaf folder infestation was recorded at standard check insecticide indoxacarb and novaluron @ 1.65 ml ha^{-1} (96.3%) followed by *Beauvaria bassiana*-10% (80.0%) and *L. lecanii*-10% (78.6%). Treatments *Beauvaria bassiana*-10% (80.0%), *L. lecanii*-10% (78.6%), *Beauveria* 50% + *L. lecanii* 50% (75.5%) and *L. lecanii 50%* +BT 50% (74.0%) showed non-significant difference between each other that mean all treatments were equally effective against leaf folder of rice. Least reduction % of leaf folder infestation was recorded by treatment *L. lecanii*-1.5% (39.4%) and when we use higher spore load (1×10^9) formulation of *L. lecanii* or *B. bassiana* or combination of *B.bassiana* and *L. lecanii* or *L. lecanii* and *BT* the entomopathogen statistically and equally effective against leaf folder of rice. Venkateshalu *et al.* (2021) also reported combinations of *B. bassiana* (6 g l^{-1}) + *L. lecanii* (6 gl^{-1}) caused highest mean nymphal mortality (57.64%) and among individual treatments *L. lecanii* at 6 g l^{-1} (51.63%) followed by *L. lecanii* at 4 g l^{-1} (50.18%) found best against grape mealybug (*M. hirsutus*) under laboratory condition. *L. lecanii* and neem oil (sole and in combination with other compatible bioagents) proved significantly better for the management against *M. hirsutus* with an efficacy of 90.21% and 96.67 % mortality, respectively.

Rice stem borer infestation in cultivar Zinco rice

Stem borer (WE) % infestation recorded before spray and found statistically non-significant and infestation

Table 1. Field efficacy of *Lecanicillium lecanii* against rice leaf folder (*Cnaphalocrosis medinalis*) in cultivar Rajeshwari

	Treatments	Dose (ml l^{-1})	cfu ml^{-1}	% Leaf infestation	% Reduction of leaf infestation over control			Mean	Yield (q ha^{-1})
				BS	5th DAS	7th DAS	10th DAS		
T_1	***L. lecanii* -1.5%**	10	1×10^7	16.7	20.9 (27.1)	31.3 (33.9)	41.9 (40.3)	31.4	38.2
T_2	***L. lecanii*-5%**	10	1×10^8	15.6	29.6 (32.9)	42.3 (40.5)	51.2 (45.6)	41.0	40.7
T_3	***L. lecanii*-10%**	10	1×10^9	15.0	37.8 (37.9)	60.0 (50.7)	81.2 (64.7)	59.6	42.7
T_4	***Beauvaria bassiana*-10%**	10	1×10^9	17.8	39.0 (35.7)	74.3 (59.5)	84.9 (67.3)	64.4	43.9
T_5	**Novaluron 5.25% + Indoxacarb 4.5% SC**	1.65 ml l^{-1}	1×10^9	16.1	61.6 (51.7)	88.6 (70.5)	98.7 (84.4)	82.5	46.2
T_6	**(*Beauveria* 50%) + (*L.lecanii*50%) 10%**	10	1×10^9	15.0	40.4 (39.4)	51.2 (45.7)	78.6 (62.6)	56.8	42.4
T_7	**(*L. lecanii 50*% +BT 50%)-10%**	10	1×10^9	17.2	39.3 (38.8)	68.8 (56.0)	75.5 (61.2)	61.1	42.8
T_8	**(*Beauveria* 50% +BT 50%)-10%**	10	1×10^9	16.7	40.4 (39.4)	69.0 (56.2)	79.0 (60.8)	62.9	43.0
T_9	**(*L. lecanii*50% +*Paecilomyces*50%)-10%**	10	1×10^9	16.1	32.7 (34.7)	45.8 (45.5)	69.7 (56.8)	49.4	41.5
T_{10}	**Control (Water Spray)**	-	-	15.0	-	-	-	-	32.8
	Mean				**37.4**	**59.0**	**73.3**		37.8
	SE±(m)			0.52	1.60	2.39	2.46		1.7
	CD at (0.05%)				4.8	7.2	7.4		5.3
	CV%				7.3	9.7	8.9		10.7

DAS- Days after spray; BS- Before spray; Data given in parenthesis shows arcsine % transformation

Table 2. Field efficacy of *Lecanicillium lecanii* against rice leaf folder (*Cnaphalocrosis medinalis*) in cultivar Zinco rice

Treatments	Dose (ml l^{-1})	cfu ml^{-1}	% Leaf infestation	% Reduction of leaf infestation over control			Mean	Yield (q ha^{-1})
			BS	5th DAS	7th DAS	10th DAS		
L. lecanii -1.5%	10	1×10^7	11.70	18.3(25.3)	29.6 (32.9)	39.4(36.9)	**29.1**	34.2
L. lecanii-5%	10	1×10^8	13.90	29.5(32.8)	42.3 (40.5)	51.5(45.8)	**41.1**	37.7
L. lecanii-10%	10	1×10^9	12.80	44.2(41.6)	65.6 (54.2)	78.6(62.4)	**62.8**	42.7
Beauvaria bassiana-10%	10	1×10^9	11.70	49.3(44.5)	67.3 (55.1)	80.0(63.4)	**65.5**	43.3
Novaluron 5.25% + Indoxacarb 4.5% SC	1.65 ml l^{-1}	1×10^9	12.20	52.5(46.2)	82.2 (65.0)	96.3(81.9)	**76.9**	45.7
(*Beauveria* 50%) + (*L.lecanii*50%) 10%	10	1×10^9	12.20	42.5(40.6)	58.3(49.7)	75.5(60.6)	**58.8**	40.3
(*L. lecanii* 50% + BT 50%)-10%	10	1×10^9	13.30	38.2(38.1)	52.5(46.5)	74.0(69.5)	**54.9**	40.0
(*Beauveria* 50% + BT 50%)-10%	10	1×10^9	13.90	36.9(37.2)	50.2(45.1)	69.7(56.4)	**52.2**	39.8
(*L. lecanii*50% + *Paecilomyces* 50%)-10%	10	1×10^9	12.80	32.4(34.7)	48.7(44.2)	70.4(57.9)	**50.5**	38.7
Control (Water Spray)	-	-	11.00	-	-	-		32.2
Mean				**38.2**	**55.2**	**70.6**		39.5
SE±(m)			0.56	1.4	2.1	2.5		1.6
CD at (0.05%)			—	4.4	6.4	7.6		5.1
CV%			—	7.5	8.6	7.6		10.2

DAS- Days after spray; BS- Before spray; Data given in parenthesis shows arcsine % transformation

Table 3. Field efficacy of entomopathogenic fungi *Lecanicillium lecanii* against rice stem borer (*Scirpophaga incertulas)*

Treatments	Dose (ml l^{-1})	cfu ml^{-1}	Rajeshwari			Zinco Rice		
			% Stem borer (WE)	% Reduction of stem borer over control	Yield (q ha^{-1})	% Stem borer (WE)	% Reduction of stem borer over control	Yield (q ha^{-1})
			BS	7th DAS		BS	7th DAS	
L. lecanii -1.5%	10	1×10^{7}	7.7	40.9(39.671)	38.2	4.4	38.6(38.2)	34.2
L. lecanii-5%	10	1×10^{8}	7.0	54.6(47.672)	40.7	3.9	52.7(46.5)	37.7
L. lecanii-10%	10	1×10^{9}	7.3	72.3(58.24)	42.7	3.3	70.3(57.1)	42.7
Beauvaria bassiana-10%	10	1×10^{9}	8.0	75.6(60.3)	43.9	4.4	73.7(59.1)	43.3
Novaluron 5.25% + Indoxacarb 4.5% SC	1.65	1×10^{9}	8.0	98.6(83.281)	46.2	5.0	97.0(80.6)	45.7
(*Beauveria* 50%) + (*L.lecanii*50%) 10%	10	1×10^{9}	8.0	70.3(56.9)	42.4	4.4	69.3(56.5)	40.3
(*L. lecanii* 50% + BT 50%)-10%	10	1×10^{9}	7.3	69.4(56.3)	42.8	3.9	68.0(55.6)	40.0
(*Beauveria* 50% + BT 50%)-10%	10	1×10^{9}	7.7	61.8(51.7)	43.0	5.0	63.7(52.9)	39.8
(*L. lecanii*50% + *Paecilomyces*50%)-10%	10	1×10^{9}	6.7	56.3(48.6)	41.5	3.9	58.7(49.5)	38.7
Control (Water Spray)			7.0		32.8	5.0		32.2
Mean				**66.6**			**65.7**	**39.5**
SE±(m)			0.56	2.5	1.7	0.54	2.4	1.7
CD at (0.05%)				7.6	5.3		7.4	5.1
CV%				8.2	10.7		7.7	10.2

DAS- Days after spray; BS- Before spray; WE- White -ear head; Data given in parenthesis shows arcsine % transformation.

ranged from 3.3% to 5.0%. Data from Table 3 revealed that the % reduction of stem borer infestation was found maximum 97.0% at standard check treatment Novaluron 5.25% + Indoxacarb 4.5% SC @ 1.65 ml l^{-1}followed by *Beauvaria bassiana*-10% (73.7%) and *L. lecanii* -10% (70.3%). Treatment *L. lecanii* -10% (70.3%), *Beauvaria bassiana*-10% (73.7%), *Beauveria* 50% + *L. lecanii* 50% (69.3%) and *L. lecanii 50%* +BT 50% (68.0 %) showed non-significant difference that mean all treatments were equally effective against stem borer of rice. Among the entomopathogen % reduction of stem borer infestation was found maximum by *Beauvaria bassiana*-10% (73.7%) followed by *L. lecanii* -10% (70.3%) and *Beauveria* 50%+ *L. lecanii* 50% (69.3%) and least % mortality was observed *i.e.* 38.6 % by *L. lecanii* -1.5%. Among the entomopathogen the % reduction of stem borer was higher (73.7%, 70.3%, 69.3% and 68.0%) when conidial concentration was higher (1×10^9). When we use higher spore load (1×10^9) formulation of *L. lecanii* or *B. bassiana* or combination of *L. lecanii* and *B. bassiana* or *L. lecanii* and BT, the entomopathogen statistically and equally effective against stem borer of rice. When load of conidia declined, the per cent reduction of stem borer infestation was gradually decreased *i.e.* 52.7% at (1×10^8) and 38.6% at 1×10^7conidial load of *L.lecani.* Ghelani *et al.* (2006) reported per cent pest reduction between 50% and 70 % of *Aphis gossypii* on Bt cotton under natural field conditions and concluded *L. lecanii*, as an effective treatment for *A. gossypii* management.

Grain yield

Maximum yield recorded from chemical treatment Novaluron 5.25% + Indoxacarb 4.5%SC (45.72 q ha^{-1}) and among entomopathogen, the highest yield recorded from *Beauveria bassiana*-10% (43.38 q ha^{-1}) followed by *L. lecanii* -10% (42.78 q ha^{-1}) and these treatments *i.e.* Novaluron 5.25% + Indoxacarb 4.5%SC (45.72 q ha^{-1}), *Beauveria bassiana*-10% (43.38 q ha^{-1}) and *L. lecanii* -10% (42.78 q ha^{-1}) were found at par with each other. In rest of the treatments *Beauveria* 50% + *L. lecanii* 50% (40.39 q ha^{-1}), *L. lecanii 50%* +BT 50% (40.05 q ha^{-1}), *Beauveria* 50% +BT 50% (39.80 q ha^{-1}), *L. lecanii* 50% +*Paecilomyces* 50% (38.70 q ha^{-1}) and *L. lecanii* -5% (37.78 q ha^{-1}) were found at par with each other and the minimum yield recorded from treatments *L. lecanii* -1.5% (34.29 q ha^{-1}), which was greater than control plot yield (32.29 q ha^{-1}).

It is inferred from field efficacy study of *L. lecanii* and combination of different microbial biopesticides that *Beauveria bassiana*-10% and *L. lecanii* -10% were highly effective in suppressing the rice leaf folder and stem borer.

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