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RESEARCH ARTICLE

Field evaluation of *Beauveria brongniartii* and *Metarhizium anisopliae* against white grubs damaging green gram in Assam

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ABSTRACT

Two entomopathogenic fungi *viz.*, *Beauveria brongniartii* and *Metarhizium anisopliae* were evaluated as alone and in combination with insecticides against white grubs in green gram during 2007 and 2008. Experimental results indicated that *B. brongniartii* applied @ 5×10^{13} conidia/ml in combination with imidacloprid 200 SL @ 48 g *a.i.*/ha was effective in reducing plant mortality (12.82 and 14.25 %) caused by white grubs with a grain yield of 6.75 and 7.59 q/ha during 2007 and 2008, respectively. Likewise the combined application of *M. anisopliae* @ 5×10^{13} conidia/ml and imidacloprid 200 SL @ 48 g *a.i.*/ha resulted in lowest plant mortality (9.05 and 11.36 %) with highest yield (6.91 and 7.71 q/ha) during 2007 and 2008, respectively. The highest benefit cost ratio was registered in *M. anisopliae* @ 5×10^{13} conidia/ml combined with imidacloprid 200 SL @ 48 g *a.i.*/ha treated plots (5.69 and 5.32) followed by imidacloprid 200 SL @ 48 g *a.i.*/ha (5.21 and 5.10), *B. brongniartii* @ 5×10^{13} conidia/ml combined with imidacloprid 200 SL @ 48 g *a.i.*/ha (4.69 and 4.57) and chlorpyriphos 20 EC @ 400 g *a.i.*/ha (4.70 and 4.73).

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INTRODUCTION

Green gram [*Vigna radiata* (L.) Wilczek] is an important pulse crop of Assam and grown both as summer and *Kharif* crop. The reason for poor yield of green gram can be attributed to the heavy infestation of the insect pests coupled with the growing of low yielding varieties without taking adequate plant protection measures. More than 200 species of insect pests belonging to 48 families have already been reported to infest green gram in India (Swaminathan *et al.*, 2012). In Assam, more than seventeen insect pests have been reported to attack green gram during its growth stages, out of which about four have major significance (Rahman and Sharifullah, 1995). However, during the recent years, 'white grub' or 'root grub' has emerged as an important insect pest of green gram causing extensive damage right from the vegetative stage and remains throughout the crop period (Bhattacharyya *et al.*, 2008). The light trap catches and scouting conducted in the infested field revealed the presence of three important species of whitegrubs *viz.*, *Adoretus* sp., *Apogonia* sp. and *Anomala* sp. Therefore, an attempt was made to explore the possibility of using two entomopathogenic fungi *viz.*, *B. brongniartii* and *M. anisopliae* applied as alone and in combination with insecticides for the management of white grubs damaging green gram in Assam.

MATERIAL AND METHODS

Two entomopathogenic fungi *viz.*, *B. brogniartii* and *M. anisopliae* applied alone and in combination with insecticides *viz.*, chlorpyriphos and imidacloprid were evaluated against the white grubs infesting green gram during *Kharif* 2007-08. The crop was raised at the Instructional-cum-Research Farm of Assam Agricultural University, Jorhat by following all recommended agronomic practices. The sowing of seed was done on 3rd and 9th September during 2007 and

2008, respectively. Fungal formulations were obtained from National Bureau of Agriculturally Important Insects (NBAII), ICAR, Bangalore. Each of the microbial formulations was tested as single application (1×10^{14} conidia ml^{-1}), double applications (each 5×10^{13} conidia/ml) and also in combination with insecticides *viz.*, chlorpyriphos 20 EC @ 200 g *a.i.*/ha and imidacloprid 200 SL @ 48 g *a.i.*/ha.

The trial was conducted in a Randomized Block Design with three replications with plot size of 5 m × 2.5 m. All the treatments were applied at the time of sowing. Observation on initial plant population and per cent plant damage was taken at weekly interval. The data so obtained was subjected to analysis of variance. The grub population was recorded at the time of harvest of the crop and for this purpose three pits ($50 \times 50 \times 50$ cm^3) were dug randomly in each plot. The data on grub population and yield were also subjected to analysis of variance.

RESULTS AND DISCUSSION

The efficacy of two entomopathogenic fungi *viz.*, *B. brongniartii* and *M. anisopliae* applied alone and in combination with two insecticides was assessed on the basis of per cent plant mortality caused by the grubs, number of grubs per pit after harvest of the crop, grain yield and benefit cost ratio (BCR).

The combined application of *B. brongniartii* @ 5×10^{13} conidia/ml and imidacloprid 200 SL @ 48 g *a.i.*/ha was found to be significantly superior in protecting the green gram crop against white grub and registered 12.82 and 14.25 per cent plant mortality as against untreated control (29.56 and 31.14 %). This treatment was found to be at par with imidacloprid 200 SL @ 48 g *a.i.*/ha and chloropyriphos 20 EC @ 400 g *a.i.*/ ha and registered 13.03 and 15.23 and 13.76 and 15.34 per cent plant mortality during 2007 and 2008, respectively (Table 1). The application of *B. brongniartii* (1×10^{14} conidia/ml) alone registered 19.25 and 21.16 per cent plant mortality during 2007 and 2008, respectively and this treatment was found to be at par with the double applications of *B. brongniartii* (each 5×10^{13} conidia/ml) (23.00 and 25.13 %).

Experimental results indicated that the lowest plant mortality (9.05 and 11.36 %) was recorded in combined application of *M. anisopliae* @ 5×10^{13} conidia/ml and imidacloprid 200 SL @ 48 g *a.i.*/ ha and this treatment was found to be at par with imidacloprid 200 SL @ 48g *a.i.*/ha (13.03 and 15.23 %) and chloropyriphos 20 EC @ 400 g *a.i.*/ha (13.76 and 15.34 %). The application of chloropyriphos 20 EC @ 200 g *a.i.*/ha, single application of *M. anisopliae* @ 1×10^{14} conidia/ml and double application of *M. anisopliae* (each 5×10^{13} conidia/ml) registered 15.69 and 17.14, 24.06 and 24.72 and 21.59 and 23.07 per cent plant mortality during 2007 and

Table 1: Plant mortality as affected by application of *B. brongniartii* and *M. anisopliae* against white grubs infesting green gram during 2007 -08

Treatments	Initial plant population		Per cent plant damage		Number of grubs per pit	
	2007	2008	2007	2008	2007	2008
B. brongniartii @ 1×10^{14} conidia/ml	214.33	233.33	19.25 (26.02)	21.16 (27.38)	8.33	9.67
M. anisopliae @ 1×10^{14} conidia/ml	219.03	234.67	24.06 (29.36)	24.72 (29.79)	9.00	10.33
Chlorpyriphos 20 EC @ 200 g *a.i.*/ha	213.67	231.33	15.69 (23.29)	17.14 (24.45)	8.00	9.33
Chlorpyriphos 20 EC @ 400 g *a.i.*/ha	213.00	232.67	13.76 (21.77)	15.34 (23.05)	6.00	7.33
Imidacloprid 200SL @ 48 g *a.i.*/ha	219.17	229.33	13.03 (21.13)	15.23 (23.15)	6.33	7.67
B. brongniartii + one more application of *B. brongniartii* ($5 \times 10^{13} + 5 \times 10^{13}$ conidia/ml)	211.42	231.67	23.00 (28.65)	25.13 (28.41)	8.00	9.33
M. anisopliae.+ one more application of *M. anisopliae* ($5 \times 10^{13} + 5 \times 10^{13}$ conidia/ml)	213.00	231.00	21.59 (27.69)	23.07 (28.70)	8.33	9.67
B. brongniartii @ 5×10^{13} conidia/ml+chlorpyriphos 20 EC @ 200 g *a.i.*/ha	214.00	230.33	20.18 (26.68)	29.16 (32.46)	7.00	8.33
M. anisopliae @ 5×10^{13} conidia/ml + chloropyriphos 20EC @ 200 g *a.i.*/ha	215.67	234.00	13.33 (21.37)	15.66 (23.30)	5.67	7.00
B. brongniartii @ 5×10^{13} conidia/ml + imidacloprid 200SL @ 48 g *a.i.*/ha	211.00	231.33	12.82 (20.95)	14.25 (22.17)	4.33	5.67
M. anisopliae @ 5×10^{13} conidia ml^{-1} + imidacloprid 200 SL @ 48 g *a.i.*/ha	214.67	231.00	9.05 (17.01)	11.36 (19.66)	3.00	4.33
Untreated control	217.23	229.33	29.56 (32.93)	31.14 (33.92)	10.67	12.00
S. Ed ±			3.59	1.95	1.60	1.68
CD (P=0.05)			4.87	4.02	3.30	3.476

Figures in parentheses are angular transformed values

2008, respectively. These three treatments were found to be significantly superior over control (29.56 and 31.14 %) but at par with each other.

The number of grubs per pit varied from 3.00 to 12.00 during 2007-08. The lowest grub population of 3.00 and 4.33 numbers was recorded in combined application of *M. anisopliae* @ 5×10^{13} conidia/ml and imidacloprid 200 SL @ 48 g *a.i.* /ha followed by combined application of *B. brongniartii* @ 5×10^{13} conidia /ml and imidacloprid 200 SL @ 48 g *a.i.*/ha where number of grubs was found to be 4.33 and 5.67 number grubs per pit during 2007 and 2008, respectively. However, the highest numbers of grubs were recorded in control plots (10.67 and 12.00 grubs).

As regards to grain yield, the highest grain yield (6.91 and 7.71 q/ha) was registered in combined application of *M. anisopliae* @ 5×10^{13} conidia/ml and imidacloprid 200 S @ 48 g *a.i.*/ha and this treatment was at par with *B. brongniartii* @ 5×10^{13} conidia/ml combined with imidacloprid 200 SL @ 48 g *a.i.*/ha (6.75 and 7.59 q/ha), imidacloprid 200SL @ 48g *a.i.*/ha (6.71 and 7.54 q/ha) and chloropyriphos 20 E @ 400 g *a.i.*/ha (6.58 and 7.42 q /ha) treated plots but significantly superior over rest of the treatments. The highest BCR (5.69 and 5.32) was recorded in combined application of *M. anisopliae* @ 5×10^{13} conidia/ml and imidacloprid 200 SL@ 48 g *a.i.*/ha followed by application of imidacloprid 200 SL @ 48 g *a.i.*/ha (5.21 and 5.10). The BCR registered in *B. brongniartii* @ 5×10^{13} conidia/ml combined with imidacloprid 200 SL @ 48 g *a.i.*/ha and chlorpyriphos 20 EC (400 g *a.i.*/ha) treated plots were each 4.69 and 4.57 during 2007 and 2008, respectively (Table 2). Field trail on efficacy of *B. brongniartii* against white grubs was conducted by Vyas *et al*. (1990) and it was reported that the fungus caused 41.5 and 45.5 per cent mortality in grubs of *Holotrichia serrata* and*H. consanguinea*, respectively when the fungus was applied at 10^{15} conidia/ml. Bhattacharyya *et al*. (2008) reported that *B. bassiana* formulation when applied as $5x10^{13}$ conidia/ml in combination with imidacloprid 200SL at 48g *a.i.*/ha was found to be effective exhibiting lowest plant mortality (1.66%) and lowest grub population (1.60 numbers), which resulted in highest yield of 6.83q/ha. Likewise *M. anisopliae* when applied @ 5×10^{13} conidia/ml in combination with imidacloprid 200SL at 48g *a.i.*/ha resulted in lowest plant mortality (2.28%) and grub population (1.12 numbers) and highest yield of 6.79 q/ha. The bioefficacy of *M. anisopliae* and *B. bassiana* in combination with imidacloprid and chlorpyriphos have also been reported by Pandey (2010). Bednarek *et al*. (2004) studied the effect of insecticides on entomopathogenic fungi and entomophilic nematodes. They found that insecticides *viz*., carbosulfan and carbofuran did not inhibit the pathogenicity of fungi (*B. bassiana* and *B. brongniartii*) and nematodes (*Heterorhabditis megidis*, *Steinernema feltiae* and *S. glaseri*).

It can be concluded that the conidial formulations of both *B. brongniartii* and *M. anisopliae* were found to be superior when combined with insecticides. Furthermore, the integration of these fungi with insecticide did not show any synergistic effect for grub mortality; however decreased population was noted as compared to sole application of the bioagents.

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Table 2 : Effect of *B. brongniartii* and *M. anisopliae* in grain yield (q/ha) by reducing white grub complex infesting green gram during 2007-08

Treatments	Grain yield (q/ha)		BCR	
	2007	2008	2007	2008
B. brongniartii @ 1×10^{14} conidia/ml	6.00	6.90	1.66	3.43
M. anisopliae @ 1×10^{14} conidia/ml	6.04	6.88	2.33	4.15
Chlorpyriphos 20 EC @ 200 g *a.i.*/ha	6.41	6.93	4.70	4.73
Chlorpyriphos 20 EC @ 400 g *a.i.*/ha	6.58	7.42	4.69	4.57
Imidacloprid 200SL @ 48 g *a.i.*/ha	6.71	7.54	5.21	5.10
B. brongniartii + one more application of *B. brongniartii* (5×10^{13} + 5×10^{13} conidia/ml)	6.18	7.03	1.83	2.50
M. anisopliae.+ one more application of *M. anisopliae* (5×10^{13} + 5×10^{13} conidia/ml)	6.26	7.10	2.50	3.00
B. brongniartii @ 5×10^{13}conidia/ml + chlorpyriphos 20 EC @ 200 g *a.i.*/ha	6.49	6.90	3.64	3.70
M. anisopliae @ 5×10^{13} conidia/ml + chloropyriphos 20EC @ 200 g *a.i.*/ha	6.41	7.25	3.07	3.23
B. brongniartii @ 5×10^{13} conidia/ml + imidacloprid 200SL @ 48 g *a.i.*/ha	6.75	7.59	4.69	4.57
M. anisopliae @ 5×10^{13} conidia ml^{-1} + imidacloprid 200 SL @ 48 g *a.i.*/ha	6.91	7.71	5.69	5.32
Untreated control	5.84	6.44	-	-
S. Ed ±	0.20	0.22	-	-
CD (P=0.05)	0.41	0.45	-	-

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