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Field efficacy of *Beauveria bassiana* (Bals.) Vuill. and *Metarhizium anisopliae* (Metsch.) Sorok. against white grubs in Assam

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ABSTRACT: **In the present study, efforts were made to explore the possibility of using *Beauveria bassiana* and *Metarhizium anisopliae* alone or in combination with different insecticides for the management of white grubs in green gram. *B. bassiana* formulation applied @ $5x10^{13}$ conidia ml^{-1} in combination with imidacloprid 200SL at 48g a.i. ha^{-1} was found to be effective exhibiting lowest plant mortality (1.66%) and lowest grub population (1.60 / pit), which resulted in highest yield of 6.83q ha^{-1}. Likewise *M. anisopliae* when applied @ $5x10^{13}$ conidia ml^{-1} in combination with imidacloprid 200SL at 48g a.i. ha^{-1} resulted in lowest plant mortality (2.28%) and grub population (1.12 / pit) and highest yield of 6.79q ha^{-1}.**

KEY WORDS: *Beauveria bassiana*, green gram, *Metarhizium anisopliae*, white grub

INTRODUCTION

Green gram, *Vigna radiata* (L.) Wilczek, is an important pulse crop of Assam and it is grown both in summer as well as in *kharif* season. The reason for poor yield of green gram can be attributed to heavy infestation of pests coupled with the growing of low yielding varieties without taking adequate plant protection measures. More than seventeen insect pests have been known to attack green gram during its growth stages, out of which about four have major significance in Assam (Rahman and Sharifullah, 1995). However, during the recent years, white grub has emerged as an important insect pest of green gram causing extensive damage right from the vegetative stages and remains throughout the crop period (Anonymous, 2005). The light trap catches and scouting conducted in the infested fields revealed the presence of two important species of whitegrubs, *viz.*, *Adoretus aerial, Apogonia* spp. in Assam. The farmers seldom take control measures against these pests, which are rarely visible and whose damage is sporadic in nature. Insecticidal treatments have so far not come out with suitable control of these pests. Two entomopathogenic fungi, *Beauveria bassiana* and *Metarhizium anisopliae*, have been successfully utilized as potential biological control agents for many soil inhabiting insect pests (Milner *et al.*, 1993; Robertson *et al.*, 1997; Sharma *et al.*, 1998, Bhagat *et al.*, 2003; Gupta *et al.*, 2003). Therefore, it was thought desirable to explore the possibility of using *B. bassiana* and *M. anisopliae* for the management of whitegrubs and its efficacy in integration with different insecticides.

MATERIALS AND METHODS

The two entomopathogenic fungi, *viz.*, *B. bassiana* and *M. anisopliae* alone and in combination with different insecticides were evaluated against white grub in *kharif* green gram (variety SG 1) in 2005.

The crop was raised at the Instructional Cum Research farm of Assam Agricultural University, Jorhat, by following all recommended agronomic practices. Fungal formulations (conidial) of both the fungi were obtained from Project Coordinating Cell, All India Network Project on white grubs and other soil arthropods at Agricultural Research Station, Durgapura, Jaipur (Rajasthan). Each of the formulations was tested as single application ($1x10^{14}$ conidia ml^{-1}), two applications ($5x10^{13}$ conidia ml^{-1}), bioagent ($5x10^{13}$ conidia ml^{-1}) along with chlorpyriphos 20EC and bioagent ($5x10^{13}$ conidia ml^{-1}) along with imidacloprid 200SL. These treatments were compared with chlorpyriphos 20EC (200 & 400g a.i. ha^{-1}) and imidacloprid 200SL (48g a.i. ha^{-1}). An untreated check was also included in the experiment. The trial was conducted in a randomized block design with three replications with a plot size of 5mx2.5m. All the treatments were applied at the time of sowing. Observations on initial plant population and per cent plant mortality were 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 ($50\times50\times50cm^3$) were dug randomly in each plot. The data on grub population and yield were also subjected to analysis of variance.

RESULTS AND DISCUSSION

Effect of *B. bassiana*

The application of imidacloprid 200 SL (48g a.i. ha^{-1}) in combination with *B. bassiana* ($5x10^{13}$ conidia ml^{-1}) was found to be significantly superior in protecting the green gram crop against whitegrub and registered minimum plant mortality (1.66%) over untreated control (7.04%) (Table1). This treatment was found to be on par with the application of chlorpyriphos 20EC (400g a.i. ha^{-1}) and imidacloprid 200SL (48g a.i. ha^{-1}) where the plant mortality was 2.44 and 3.14%, respectively, but superior to other treatments. The application of *B. bassiana* ($1x10^{14}$ conidia ml^{-1}) alone and two applications (each $5x10^{13}$ conidia ml^{-1}) did not show any effect against the pest and registered 4.55 and 4.69% plant mortality, respectively. As regards to grain yield, no significant differences were observed among the treatments and the yield ranged between 4.42 to 6.83 q ha^{-1}. The maximum yield (6.83 q ha^{-1}) was recorded in combined application of imidacloprid 200SL (48g a.i. ha^{-1}) + *B. bassiana* ($5x10^{13}$ conidia ml^{-1}), followed by chlorpyriphos 20EC (400g a.i. ha^{-1}) (6.12q ha^{-1}) as against untreated control (4.42q ha^{-1}). The highest B: C ratio (4.83) was obtained in the treatment of chlorpyriphos 20EC (400g a.i. ha^{-1}) followed by combined application of imidacloprid 200SL (48g a.i. ha^{-1}) + *B. bassiana* ($5x10^{13}$ conidia ha^{-1}) where the B: C ratio was 4.46. The number of grubs / pit varied from 1.60 to 2.46 grubs / pit. The lowest grub population of 1.60 grubs / pit was recorded in imidacloprid 200SL (48g a.i. ha^{-1}) + *B. bassiana* ($5x10^{13}$ conidia ml^{-1}) followed by chlorpyriphos 20EC (400g a.i. ha^{-1}) (1.87 grubs / pit). However, the highest numbers of grubs were recorded in control plots (2.46 grubs /pit). Field trial on efficacy of *B. bassiana* against potato white grubs conducted by Bhagat *et al.* (2003) reported that *B. bassiana* formulation applied along with chlorpyriphos (200g a.i. ha^{-1}) showed the lower mean plant mortality of 2.70 and 3.85 per cent than the application of *B. bassiana* alone.

Effect of *M. anisopliae*

Experimental results indicated that the treatments with imidacloprid 200SL + *M. anisopliae* ($5x10^{13}$ conidia ml^{-1}), imidacloprid 200SL (48g a.i. ha^{-1}), chlorpyriphos 20EC (400g a.i. ha^{-1}), and chlorpyriphos 20EC (200g a.i. ha^{-1}) registered 2.28, 2.49, 3.13, 3.27% plant mortality, respectively, and these were significantly superior over control (5.91%). However, the other treatments were on par with control (Table 2). No significant differences

Table 1. Field evaluation of *B. bassiana* against white grubs damaging green gram in Assam

Treatments	Mean initial plant population (12.5 Sq. m)	% Plant mortality	No of grubs per pit	Yield (q / ha)	B: C ratio
B. bassiana ($1x10^{14}$ conidia ml^{-1}) at sowing	233.33	4.55 (12.14)	2.20	4.72	2.13
Chlorpyriphos20EC at sowing (200g a.i. ha^{-1})	234.67	3.82 (11.06)	2.13	5.03	4.41
Chlorpyriphos 20EC at sowing (400 gm a.i. ha^{-1})	231.33	2.44 (8.82)	1.87	6.12	4.83
Chlorpyriphos20EC + *B. bassiana* (200gm *a.i./* ha + $5x10^{13}$ conidia ml^{-1})	232.67	3.43 (10.17)	2.27	5.64	3.82
B. bassiana +one more application of *B. bassiana* (5×10^{13} + $5x10^{13}$ conidia ml^{-1})	229.33	4.69 (13.16)	2.27	4.91	0.82
Imidacloprid 200SL (48g a.i. ha^{-1} at sowing)	231.67	3.14 (9.02)	2.27	5.92	4.43
Imidacloprid 200SL + *B. bassiana* (48g a.i. ha^{-1} + 10^{13} conidia ml^{-1})	231.00	1.66 (7.22)	1.60	6.83	4.46
Control	230.33	7.04 (15.30)	2.46	4.42	-
S. Ed ±		1.77		0.15	
LSD (P=0.05)		3.78		NS	

Figures in parentheses are angular transformed values

Table 2. Field evaluation of *M. anisopliae* against white grub damaging green gram in Assam

Treatments	Mean initial plant population (12.5 Sq. m)	% Plant damage	No of grubs per pit	Yield (q / ha)	B: C ratio
M. anisopliae ($1x10^{14}$ conidia ml^{-1}) at sowing	214.33	3.89 (11.25)	2.67	4.62	2.19
Chlorpyriphos 20EC at sowing (200g a.i. ha^{-1})	219.03	3.27 (10.38)	2.20	6.04	5.49
Chlorpyriphos 20EC at sowing (400g a.i. ha^{-1})	213.67	3.13 (9.93)	1.44	6.38	4.98
Chlorpyriphos 20EC + *M. anisopliae* (200g a.i. ha^{-1} + $5x10^{13}$ conidia ml^{-1})	213.00	3.82 (11.08)	2.20	4.87	3.09
M. anisopliae.+ one more application of *M. anisopliae* ($5x10^{13}$ + $5x10^{13}$ conidia ml^{-1})	214.00	4.36 (11.98)	2.07	5.05	0.74
Imidacloprid 200SL (48g a.i. ha^{-1} at sowing)	215.67	2.49 (8.94)	2.07	6.65	5.10
Imidacloprid 200SL + *M. anisopliae* (48g a.i. ha^{-1} + $5x10^{13}$ conidia ml^{-1})	211.00	2.28 (8.55)	1.12	6.79	4.30
Control	214.67	5.91 (14.02)	2.67	4.54	-
S. Ed ±		1.66		0.20	
PSD (P = 0.05)		3.54		NS	

Figures in parentheses are angular transformed values were observed in yield among the treatments. However, the maximum yield (6.79 q ha^{-1}) was recorded in combined application of imidacloprid 200SL (48g a.i. ha^{-1}) + *M. anisopliae* ($5x10^{13}$ conidia ml^{-1}) followed by 6.65q / ha in imidacloprid 200SL (400g a.i. ha^{-1}) than the control plots (4.54q / ha). The highest B: C ratio (5.49) was obtained in chlorpyriphos 20EC (200g a.i. ha^{-1}), followed by in imidacloprid 200SL (48g a.i.ha^{-1}) (5.10). The numbers of grubs / pit varied between 1.12 to 2.67 grubs / pit. The lowest grub population (1.12 grubs / pit) was recorded in imidacloprid 200SL (48g a.i. ha^{-1}) + *M. anisopliae* ($5x10^{13}$ conidia ml^{-1}) treated plots followed by chlorpyriphos 20EC (400g a.i. ha^{-1}) (1.44 grubs / pit) than the untreated control (2.67 grubs / pit). This confirms the results of Logan *et al.* (1999) according to whom an isolate of *M. anisopliae* @ $1x10^{10}$ conidia ml^{-1} reduced the number of grey back cane grubs (*Demolepida albohirtum*) by 45-60% after six months along with a significant increase of sugarcane yield in Australia. While evaluating the efficacy of *M. anisopliae* against potato white grub in Himachal Pradesh, Bhagat *et al.* (2003) found that *M. anisopliae* formulation applied @ $5x10^{13}$ conidia ml^{-1} along with chlorpyriphos 20EC at 200g a.i. ha^{-1} was effective in exhibiting maximum reduction in plant mortality (75-80%) and tuber damage (63.7%) by way of controlling grub population (56.5%) and resulted in highest tuber yield.

It can be concluded that the conidial formulations of both *B. bassiana* and *M. anisopliae* were superior when combined with insecticides. Further, the integration of bioagents with insecticides did not show any synergistic effect on grub mortality, though decreased population was noted as compared to sole application of the bioagents.

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