RESEARCH ARTICLE

COMPARATIVE EVALUATION OF ENTOMOPATHOGENIC FUNGI AND CHEMICAL INSECTICIDES AGAINST WHITE GRUB (*HOLOTRICHIA* SP.) IN SUGARCANE

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Received-06.05.2017, Revised-20.05.2017

Abstract: Field trials were conducted in sugarcane crop for management of white grub (*Holotrichia* sp.) using talc based formulations of entomopathogenic fungi *Metarhizium anisopliae* and *Beauveria bassiana* and chemical insecticides namely carbofuran 3G, Chloropyriphos 20 EC and Fipronil 40%+ Imidaclorpid 40% WG. Pretreatment count of white grub larvae was taken for every individual microplot. Fipronil 40%+ Imidaclorpid 40% WG @ 375 gm/ha proved to be the best treatment against white grub and provided up to 100% control of white grub. Chloropyriphos was second most effective treatment and checked 100% soil population of white grub followed by *M. anisopliae* which resulted in 80.97% decrease in soil population of white grub. After economic analysis *M. anisopliae* appeared to be significantly cost effective as compare to Fipronil 40%+ Imidaclorpid 40% WG. Net return of Rs. 31153/ha was recorded in this treatment whereas, net return of Rs. 27816/ha was recorded in case of *M. anisopliae.*

Keywords: White grub, *M. anisopliae*, *B. bassiana*, Biological control, Chemical control

INTRODUCTION

Sugarcane (*Saccharum officinarum* L.) is the most important crop and plays main role in Indian economy. More than 200 insect pests has been reported causing damage to sugarcane crop (David *et al*., 1986). Among them, white grub has become the most important polyphagous pest causing serious threat to sugarcane crop since 1960 (Mohalkar *et al*., 1977). Their infestation has been reported throughout the country, and the magnitude of the problem has been wide spread over the past years. Nearly 20 species of white grubs are reported to attack sugarcane in India. Of these, *Holotrichia* sp., *Anomala varicolor* (GryII), *A. viridis* (F), *Apogonia destructor* (Bos.), *Cyclocephala parallela* (Casey), *Dermolepidia pica* (Arrow), *Lepidota stigma*, *Ligyrous subtropicus* (Blench), *Leucopholis* sp. (F.), *Phyllophaga helleri* (Brsk), and *Schizonycha* sp. have been reported to assume pest status in sugarcane-growing regions (Yubak Dhoj, 2006). Among these pests the subterranean white grub has potential to cause 80-100% damage to sugarcane cane. White grubs (Coleoptra-Scarabaeidae) are soil inhibiting and root feeding immature stages of scarab beetles. The white grub family, Scarabaeidae is the second largest and omnipresent family within the order coleoptra (Mishra and Singh, 1999). In a majority of the farming situation, Control of these pests has become increasingly difficult because of the lack of control over damages they cause. In general the management strategy depends primarily on the use of highly poisonous poor graded chemical pesticides. Application of chemical is practically uneconomical, difficult and associated with high cost and environmental pollution and other problems. Hence there is a strong need for the development of alternative strategies for the control of white grubs, which are ecofriendly and economically feasible. The success of control tactics is governed by the seasonality of adults and the susceptible stage of the grub. The chemical insecticides so far evaluated against the grub stage proved less effective since the pests are subterranean (Patil *et al*., 1986). The use of biological control agents in general and fungal based myco-insecticides in particular are lacking in the country (Manisegaran *et al*., 2011). The entomopathogenic fungi occupy the vital role in control of insect pests, some of the important entomopathogenic fungi genrea are *Metarhizium anisopliae* (Metschnikoff) Sorokin, *Beauveria bassiana* (Balsamo) Vuillrmin etc. are commonly used in microbial control (Agarwal and Rajak, 1985). The entomopathogenic fungi *M. anisopliae* and *B. bassiana* have been successfully utilized as potential biological control agents for many soil inhibiting insect pests (Milner *et al*., 1993; Robertson *et al*., 1997; Sharma and Gupta, 1998; Bhagat *et al*., 2003; Gupta *et al*., 2003; Mane and Mohite 2014).
Therefore present study was undertaken to explore the comparative efficacy of *M. anisopliae*, *B. bassiana*, and chemical insecticides for the management of white grubs in field conditions.

MATERIAL AND METHOD

A field survey was conducted during 2010-11. White grub infested sugarcane field in Qurar village of Tahsil-Milak, Rampur, Uttar Pradesh, India was selected as the test site to conduct field experiment

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by using different treatments for management of white grub. Two year trials were conducted in the year 2011-12 and 2012-13. A field was selected in which white grubs were found to occur at a density of 10-12 grubs/m^2. The sugarcane variety CoS 767 was planted during last week of April in the year 2011 and 2012 with a 60 cm row to row distance and bunds were made to demarcate small plots of plot size 13×15 m^2 and all the recommended package of practices were adopted except for white grub management. There were five treatments as described under details of treatments. Treatments were replicated thrice in a randomized block design. Talc formulations of entomopathogenic fungi were procured from biological control Laboratory, SVPUA&T, Meerut whereas chemical insecticides were purchased from local market. First application of treatments was done during mid June by making 10 cm. Wide and 10 cm. Deep furrow parallel to sugarcane plants. Before application formulations of *B. bassiana* and *M. anisopliae* were impregnated in well decomposed FYM for seven days. Chloropyriphos 20 EC and Fipronil 40% + imidaclorpid 40% WG were sprayed in furrows whereas, *B. bassiana* and *M. anisopliae* and carbofuran 3G were broadcasted in furrows. Treatments were applied in furrows extending front to back. The raised soil behind the furrow was pushed back to cover the chemical or biocontrol agent. Thereafter irrigation was done as per requirement Second application of treatments was done at 45 days after first application of treatments. No biopesticide or chemical insecticide was applied in control plot.

Treatment 1: *Beauveria bassiana* @ 5 kg/ha (2×10^9 cfu/g)

Treatment 2: *Metarhizium anisopliae* @ 5 kg/ha (2×10^9 cfu/g)

Treatment 3: Carbofuran 3G @ 33 kg/ha

Treatment 4: Chloropyriphos 20 EC @ 3 lit/ha

Treatment 5: Fipronil 40% + imidaclorpid 40% WG @ 375 g/ha

Treatment 6: Untreated control

Observations on the number of dead and alive white grubs per meter row in the root zone, were recorded a day before implementation of first application of treatments and after that at every 15 days after first application of treatments. Observations on cane/m^2, and damaged cane/m^2 were also recorded. Data on yield/ha was recorded at harvest of crop. Percent decrease in number of white grub, percent cane damage and percent increase in yield was calculated over control. Economics of treatments was calculated.

Statatistical analysis

The data on the number of grubs was subjected to square root transformation. These transformed values and data on other parameters was subjected to analysis of variance (Panse and Sukhatme, 1967) and Duncans multiple range test (Gomez and Gomez, 1984) was used to determine the significance among different treatments.

RESULT AND DISCUSSION

All the treatments were effective in checking the population of *Holotrichia* sp. Which ranged from 75.60-100.00 percent at 60 days after treatment. At 45 days after first application of treatments, all the treatments significantly checked soil population of *Holotrichia* sp. After second application of treatments, sharp decrease in soil population of *Holotrichia* sp. was recorded. This can be attributed to weakened and infected larvae which are prone for pathogenic and toxic effects of different treatments. Keller, 1998 suggested that repeated application of the entomopathogenic fungal formulations enhanced the pest control process and white grubs could be controlled in field situations in various crops, *H. consanguinea* infesting potatoes were controlled by *M. anisopliae* (Kulye and Pokharkhar, 2009). Similar results of repeated application of chemical insecticides were reported by Mane and Mohite (2014). Mohoiddein *et al.* (2006) tested the pathogenecity of nine fungi in the laboratory against *Holotrichia* spp. All the fungi proved to be pathogenic at a spore concentration of 1×10^8 spore/ml to grub with varying mortality. *B. bassiana* (local), *B. bassiana* (commercial) and *M. anisopliae* were found to be the most effective.

Fipronil 40% + imidaclorpid 40% WG and chloropyriphos 20 EC were most effective in controlling white grub soil population and provided 100% control. These findings are in conformity with that of Patel *et al.* (2010). However the dose they applied was quite low i.e. 187 g/ha (Fipronil 40% + imidaclorpid 40% WG) in groundnut for the control of white grub. *M. anisopliae* and carbofuran 3G which caused 80.97% and 79.12% reduction in white grub soil population. Reduction in white grub population caused but *B. bassiana* was significantly low (75.60%) as compare to *M. anisopliae*. Similar findings were reported by Manisegaran *et al.* (2011) and Bhagat *et al.* (2003).

From table 2, it is evident that the millable cane and sugarcane yield varied significantly among the treatments and was significantly superior to untreated check. In control plots white grub infestation caused 33% yield loss. Fipronil 40% + imidaclorpid 40% WG caused maximum control of damage caused by white grub, only 9% damage was recorded in microplots receiving above treatments followed by chloropyriphos (13%). *M. anisopliae* and carbofuran 3G application resulted in (78%) reduction in cane damage caused by white grub larvae. *B. bassiana* appeared to be least effective against damage caused by white grub but it was significantly at par with *M. anisopliae* and carbofuran 3G. Maximum yield (655.37 qt/ha) was recorded in plots receiving soil application of Fipronil 40% + imidaclorpid 40% WG

in this treatment 22.5% increase in yield was recorded followed by chloropyriphos 20EC, carbofuran 3G and *M. anisopliae* which caused 18.3%, 16.5% and 16.3% increase in yield respectively. *B bassiana* caused least (13%) increase in yield.

Maximum net return of Rs. 31153/- was recorded in case of treatment by Fipronil 40% + imidaclorpid 40% WG followed by chloropyriphos 20EC in which net return of Rs. 28012/- was recorded. Whereas, net return of Rs. 27816/- and Rs. 25365/- was recorded after application of *M. anisopliae* and carbofuran 3G respectively. Lowest net return of Rs. 22860/- was recorded in case of *B. bassiana*.

Economic analysis revealed that cost benefit ratio for every rupee investment in pesticide and net return was the highest in case of *M. anisopliae* (1:19.86) followed by *B. bassiana* (1: 16.32) chloropyriphos 20EC, Carbofuran 3G and Fipronil 40% + imidaclorpid 40% WG, recorded 1:6.51, 1:5.91 and 1:4.23 incremental benefit on white grub management respectively. Lowest C:B ratio was recorded in case of Fipronil 40% + imidaclorpid 40% WG.

The higher colony-forming unit counts of *M. Anisopliae* found in association with plant roots and root exudates suggest these fungi may be capable of survival in soil without an insect host (Hu and St. Leger, 2002). As mycopathogens persist in the soil for a long period than chemicals and under suitable conditions they are self perpetuating in nature. Therefore by keeping in the view the high cost of pesticide and significance of economic returns achieved by *M. anisopliae*, this entomopathogenic fungi can also be an ideal choice for the management of white grub in endemic areas.

Table 1. Effect of different treatments on soil population of *Holotrichia* sp. in sugarcane crop

Treatments	White grub larvae/meter row					% decrease over control
	1 DBT	15 DAT	30 DAT	45 DAT	60 DAT	
Beauveria bassiana @ 5kg/ha	10.46[a] (18.81)	10.00[c] (19.28)	5.85[b] (13.94)	4.65[b] (12.39)	2.50[b] (9.10)	75.60
Metarhizium anisopliae @ 5 kg/ha	10.95[a] (19.28)	9.50[c] (17.95)	4.85[b] (12.66)	3.38[a] (10.47)	1.95[b] (7.92)	80.97
Carbofuran 3G @ 33 kg/ha	10.46[a] (18.81)	7.55[b] (15.89)	6.00[b] (14.18)	3.63[a] (10.94)	2.14[b] (8.33)	79.12
Chloropyriphos 20 EC @ 3 lit/ha	10.00[a] (18.44)	6.85[a] (15.12)	4.40[a] (12.11)	2.65[a] (9.28)	0.00[a] (0.00)	100.00
Fipronil 40% + imidaclorpid 40% WG @ 375 g/ha	10.36[a] (18.72)	5.55[a] (13.56)	3.56[a] (10.78)	1.50[a] (7.04)	0.00[a] (0.00)	100.00
Control (untreated)	10.95[a] (19.28)	10.95[c] (19.28)	10.45[c] (18.81)	10.25[c] (18.63)	10.25[c] (18.63)	-
CD (P=0.05)	2.60	1.75	1.36	2.06	1.73	-

DBT: Days before treatment; DAT: Days after treatment

Figures in paranthesis are angular transformed values, In the columns means followed by same letter did not differ significantly (P=0.05) by DMRT.

Table 2. Effect of different treatments on white grub infested sugarcane crop

Treatments	No. Of millable canes/ha	% damage	Infected millable canes/ha	Yield qt/ha	% increase in yield
Beauveria bassiana @ 5kg/ha	108000[e]	18	19080[e]	604.55[b]	13.0
Metarhizium anisopliae @ 5 kg/ha	108500[d]	15	15975[c]	622.20[a]	16.3
Carbofuran 3G	108800[c]	15	16020[d]	623.77[a]	16.5

@ 33 kg/ha					
Chloropyriphos 20 EC @ 3 lit/ha	109300[b]	13	13949[b]	632.90[a]	18.3
Fipronil 40% + imidaclorpid 40% WG @ 375 g/ha	110100[a]	9	9729[a]	655.37[a]	22.5
Control (untreated)	105300[f]	33	34749[f]	535.0[c]	-
CD (P=0.05)	102.60	-	173.81	39.75	-

In the columns means followed by the same letter did not differ significantly (P=0.05) by DMRT.

Table 3. Economics of different treatments against white grub

Treatments	**Cost of pesticide/ha** (2 applications)	**Gross cost of cultivation**	**Gross return**	**Net return**	**CBR of additional income**
Beauveria bassiana @ 5kg/ha	1400.00	146400.00	169260.00	22860.00	1: 16.32
Metarhizium anisopliae @ 5 kg/ha	1400.00	146400.00	174216.00	27816.00	1: 19.86
Carbofuran 3G @ 33kg/ha	4290.00	149290.00	174655.00	25365.00	1: 5.91
Chloropyriphos 20 EC @ 3 lit/ha	4299.00	149200.00	177212.00	28012.00	1: 6.51
Fipronil 40% + imidaclorpid 40% WG @ 375 g/ha	7350.00	152350.00	183503.60	31153.60	1:4.23
Control (untreated)	-	145000.00	149800.00	4800.00	-

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