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Study on the efficacy of some entomogenous fungi against brown plant hopper, *Nilaparvata lugens* Stal in irrigated rice

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ABSTRACT

A field trial was conducted for three consecutive *kharif* seasons of 2010, 2011 and 2012 to study the efficacy of certain entomopathogenic fungi *viz., Beauveria bassiana, Metarhizium anisopliae* , *Verticilium lecani* @ 5 g/l having 1x10^8 CFU along with standard check - Acephate 75% SP @ 1.5 g/l against brown plant hopper, *Nilaparvata lugen* Stal and predators (mirid bugs and spiders). The results clearly indicated that Acephate 75 SP @ 1.5g/l was highly effective against BPH, but highly toxic to predators with higher grain yield and higher benefit cost ratio. However, *B. bassiana,* and *M. anisopliae* @ 5 g/l though found to be ineffective at 5 days after first spray, their efficacy against BPH increased with increase in days after spray and found to be at par with Acephate at 10 days after second spray. Among the entomopathogens, *B. bassiana,* and *M. anisopliae* were found to be relatively more effective against BPH and relatively less toxic to predators, followed by *V. lecani*.
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INTRODUCTION

The brown plant hopper (BPH), *Nilaparvata lugens* Stal (Homoptera: Delphacidae) is one of the major rice pests that sometimes cause huge economic losses. 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). Both nymphs and adults of BPH damage rice plants through extensive feeding. The increased use of conventional insecticides over the years has not only contributed to an increase in food production, but also has resulted in adverse effects on the environment and non-target organisms. There is now clear evidence of resistance development to some of the recently introduced pesticides such as imidacloprid and other group of chemicals used in rice fields. The large scale use of these compounds has caused BPH to develop resistance and detrimental impact on natural enemies (Tanaka *et al.,* 2000; Preetha *et al.,* 2010). Natural parasitoids and predators in rice fields are more sensitive to most chemical insecticides than the plant hoppers (Croft and Brown, 1975; Croft, 1990). So there is an urgent need to find alternative measures that may be friendly to the environment. In view of these side effects, the necessity for sustainable crop production through eco-friendly pest management technique is being largely felt in recent times. 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. Amongst the unsustainable practices are the excessive and indiscriminate pesticide applications that impact upon beneficial organisms through ecological disruptions and resistance of the target pests to the applied pesticide.

More than 700 species of fungi, mostly Dueteromycetes and Entomophorales from about 90 genera are pathogenic to insects. A complex of fungal pathogens has been identified from pests of rice. (Rombach *et al*,1986). 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 insects pests of rice. The present study searched for potential bio control candidates of BPH from three entomogenous fungi.

MATERIALS AND METHODS

Field trials were conducted for three consecutive seasons of *kharif* 2010, 2011 and 2012 at Regional Agricultural Research station, Acharya N.G. Ranga Agricultural University, Warangal, A.P in a randomized block design with five treatments *i.e.*, three entomopathogenic fungi – (*Beauveria bassiana, Verticilium lecani ,Metarhizium anisopliae* @ 5 g/l), one standard check insecticide (Acephate @ 1.5 g/l) and an untreated control (Table 1). There were four replicates. The brown plant hopper (BPH) susceptible variety, BPT-5204 was used. The entomopathogens were obtained from All India Coordinated Research Project on Biological Control Unit, Acharya N.G. Ranga Agricultural University, Rajendranagar, Hyderabad.

The treatments were applied twice at 10 days interval with knapsack sprayer using 500 l/ha spray fluid at panicle emergence stage that coincided with moderate level infestation of BPH. The brown plant hopper (*N. lugens* Stal) population was recorded one day before and five and ten days after each spray on ten randomly selected hills in each treatment. The predatory mirid bugs (*Cyrtorhinus lividipennis* Reuter) and spiders population were also recorded one day before and ten days after each spray on ten randomly selected hills in each treatment. The plant hopper population and predatory population recorded was expressed as number per hill and percent reduction over control. The yield per plot was recorded and computed on hectare basis. The cost effectiveness in terms of benefit : cost ratio was also calculated. The mean data of three years pertaining to effect of treatments on BPH, predators, grain yield and benefit: cost ratio was recorded.

RESULTS AND DISCUSSION

Against Brown Plant Hopper

There was no significant difference in plant hopper population among the treatments one day before the application of the treatments (Table 1). Among all the treatments, the standard check-Acephate 75% SP recorded significantly lowest hopper population (19.3, 14.9 /hill) and the highest percent reduction of hoppers over control (70.9, 81.2 %) respectively at five and ten days after first spray. All the three entomo pathogenic fungi, *B. bassiana, V. lecani* and *M. anisopliae* showed inferior efficacy against hoppers at five days after first spray by recording higher hopper population of 55.6, 63.7, 54.4 per hill respectively and found to be significantly at par with untreated control (66.3/hill). However, among the pathogenic fungi, at ten days after first spray, *M. anisopliae* @ 5 g/l recorded least hopper population (22.2/hill) and highest percent reduction of hoppers (72.0%), followed by *B. bassiana* @ 5 g/l (33.3/hill, 58.1%) and were found to be at par with each other. The least effective treatment was *V. lecani* @ 5 g/l which had a higher hopper population (46.7/hill) and the lowest percent reduction (41.2%). However, *V. lecani* was found to be significantly superior to control (79.4/hill).

Among all the treatments, at five days after second spray, the standard check, Acephate 75 SP @ 1.5 g/l recorded significantly the lowest hopper population of 15.5 per hill and the highest percent reduction (80.3%). The next best treatments were *M. anisopliae* and *B. bassiana* @ 5 g/l which had a hopper population of 27.3 and 35.6 per hill with a percent reduction of 65.3 and 54.7 percent and were significantly superior to untreated control (78.6/hill). The least effective treatment was *V. lecani* which had a hopper population of 50.0/hill and the lowest percent reduction of hoppers (36.4%), but significantly superior to control. At ten days after second spray *i.e.*, twenty five days after first spray, again the standard check - Acephate showed superior efficacy against hoppers by recording the least hopper population (10.5/hill) and the highest percent reduction (87.2%), followed by *B. bassiana* (17.2/hill, 78.9%) and *M. anisopliae* (18.8/hill, 77.0%) which were found to be at par with the standard check – Acephate. Least efficacy was noticed with *V. lecani* which had a hopper population of 35.8/hill, but significantly superior over untreated control (81.8/hill).

The results obtained from the above study clearly revealed that among all the treatments, the standard check – Acephate 75% SP @ 1.5 g/l was significantly the best treatment against hoppers up to 5 and 10 days after 1st spray and 5 days after 2nd spray, but at 10 days after second spray, its efficacy was not significantly different from that with *B. bassiana* and *M. anisopliae.*

Table 1. Cumulative mean efficacy of entomopathogenic fungi against brown plant hopper, *N. lugens*

Treatments	Dosage (g/l)	DBS (No. hoppers/ hill)	1st spray		2nd spray		Grain yield (kg/ha)	B: C Ratio
			5 DAS	10 DAS	5 DAS	10 DAS		
Beauveria bassiana- 1×10^8 CFU	5.0	45.5	55.6	33.3	35.6	17.2	4631	
Verticilium lecani- 1×10^8 CFU	5.0	55.1	63.7	46.7	50.0	35.8	3951	1.3
Metarhizium anisopliae- 1×10^8 CFU	5.0	46.0	54.4	22.2	27.3	18.8	4506	1.7
Acephate 75%SP	1.5	50.5	19.3	14.9	15.5	10.5	5755	2.1
Untreated control	**0.0**	48.3	66.3	79.4	78.6	81.8	3458	1.1
C.D (0.05%)	-	NS	12.2	12.0	10.8	10.0	247.9	
S.Em±	-	4.5	5.6	5.5	5.0	4.6	85.4	

DBS= Day Before Spray, CFU= Colony Forming Units

The efficacy of entomopathogens, *B. bassiana and M. anisopliae*, increased with increase in the number of days after spray and reached the highest efficacy at 10 days after second spray and were found to be at par with standard check – Acephate. Among the entomopathogens, *V. lecani* was the least effective. Aguda *et al.* (1984) reported that *B. bassiana* is a very good potential bio control agent against brown plant hopper in rice. The results obtained in the present study are in conformity with the findings of several other researchers (Aguda *et al*, 1987; Rammohan Rao, 1989). Kiran and Veeranna (2012) reported that the efficacy of *M. anisopliae* was not significantly different from treatments Thiomethoxam and Imidacloprid. 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 of Maoye *et al* (2012), Li Mao-Ye *et al*., (2012) and Rombach *et al.*, (1986.) It was reported that these entomopathogenic fungi appeared to be efficient against plant hoppers because of the ease of their mass production, storage, virulence and application (Taledo *et al.*, 2010). The paddy field ecosystem dependant on routine irrigation, may provide high moisture that is required for the successful use of fungal biocontrol agents (Bateman *et al*, 1993; Feng *et al*., 1994).

Against predators

There was no significant difference in the population of predatory mirid bug, *Cyrtorhinus lividipennis* and spiders at one day before first spray (Table 2). The population of mirid bug at one day before spray ranged from 15.0 to 20.5 per hill and the population of spiders at one day before first spray ranged from 8.0 to 11.0 per hill. The predators' population recorded at ten days after first spray indicated significant variation among the treatments. Significantly higher predator population was noticed in plots treated with entomopathogens compared to standard check-Acephate 75% SP. At ten days after first spray, the highest mirid bug population was recorded in *V. lecani* (22.6/hill) followed by *M anisopliae* (20.0/hill) and *B. bassiana applied @ 5g/l* (18.2/hill) and were found to be at par with each other. The standard check-Acephate 75% SP @ 1.5 g/l recorded significantly lowest mirid bug population of 9.7/hill and spider population of 4.3/hill at ten days after first spray

Table 2. Cumulative mean effect of entomopathogenic fungi on *C. lividipennis* and spiders

Treatments	Dosage (g/l.)	Mean number of mirid bugs/hill			Mean number of spiders/hill		
		1st spray		2nd spray	1st spray		2nd spray
		DBS	10 DAS	10DAS	DBS	10 DAS	10DAS
B. bassiana- 1×10^8 CFU	5.0	15.5	18.2	20.5	8.5	9.1	10.0
V. lecani- 1×10^8 CFU	5.0	20.0	22.6	23.5	10.1	10.8	11.4
M. anisopliae- 1×10^8 CFU	5.0	18.6	20.0	21.8	8.0	9.5	10.5
Acephate 75%SP	1.5	15.0	9.7	4.0	11.0	4.3	2.5
Untreated control	-	20.5	25.6	30.7	9.5	10.8	14.5
C.D (0.05%)	-	NS	4.5	3.7	NS	2.5	2.3
S.Em±	-	2.6	2.1	1.7	1.7	1.2	1.1

DBS= Day Before Spray, CFU= Colony Forming Units

compared to the untreated control (25.6, 10.8/hill). Almost similar trend was noticed at 10 days after second spray.

Among all the treatments, at ten days after first spray, significantly lower spider population (4.3/hill) was noticed with Acephate 75 SP compared with the untreated control. All the three entomopathogenic fungi: *B. bassiana, V. lecani* and *M. anisopliae* recorded significantly higher spider population of 9.1, 10.8 and 9.5 per hill and were found to be at par with each other and untreated control. Similar trend of higher spider population in plots treated with fungi and lower population in standard check-Acephate was recorded at ten days after second spray. The higher toxicity of synthetic insecticides and safety of entomopathogenic fungi to predators existing in rice-ecosystem has been reported by several workers. Preetha *et al.* (2010) indicated that the organophosphophate insecticides were highly toxic to mirid bugs. The safety of entomopathogenic fungi against bugs and spiders found in this study was in conformity with the findings of Chi *et al* (2005) who indicated that the population of predatory spiders and water bugs were higher in fungal treatments than in chemical treatments. Similar finding of the safety of entomogenous fungi especially *M. anisopliae* against natural enemies of brown plant hopper was also reported by Kiran and Veeranna (2012.)

Yield

Significantly higher grain yield was obtained in standard check-Acephate 75% SP @ 1.5 g/l (Table 1) (5755 kg/ha) and recorded higher benefit : cost ratio of 2.1 compared to other treatments. Among the entomopathogens, the highest grain yield was achieved in *B. bassiana* (4631 kg/ha) with a benefit : cost ratio or 1.9 followed by *M. anisopliae* (4506 kg/ha) and benefit : cost ratio of 1.7 and were on a par with each other. The lowest grain yield and lowest benefit : cost ratio was achieved in untreated control (3458 kg/ha, 1.1) which was found to be on a par with *V. lecani* (3951 kg/ha, 1.3).

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