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Field evaluation of liquid and wettable powder formulations of *Metarhizium anisopliae* against *Spodoptera litura* in *Vigna mungo* (Linn.)

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Abstract

During *Rabi* 2021, field experiments were undertaken in blackgram to evaluate commercial liquid and wettable powder formulations of *Metarhizium anisopliae* against *Spodoptera litura* in Blackgram. Field trial were carried out in Randomized Block design (RBD) with six treatments and four replications at Department of Entomology, Annamalai University. Pre-treatment count were taken at 1 m^2 area. Both liquid and wettable powder formulations of *M. anisopliae* were mixed in water and sprayed during early morning and evening hours. Two sprays of each formulation of *M. anisopliae,* were given against *S. litura* at an interval of 15 days. Mean larval population of *S. litura* were assessed at 5, 10 and 15 DAT respectively. Collected data were subjected to square root transformation. Liquid formulations of *M. anisopliae* were found to be effective against *S. litura*.

Keywords: *Metarhizium anisopliae, Spodoptera litura,* blackgram, liquid and wettable powder formulations

Introduction

Black gram (*Vigna mungo* (L.) Hepper) is an important legume crop cultivated worldwide in tropical as well as subtropical regions of the world. They are rich in protein and occupies the second most important component of diet after cereals. India is the largest producer and consumer of black gram in the world. Black gram is subjected to infestation by an array of insect pests in field as well as in storage (Gajendran *et al.* 2006) [4]. The quantitative avoidable yield loss in black gram by insect pest complex ranges from 7 to 35 percent, depending on agroclimatic conditions (Justin *et al.* 2015) [5]. The tobacco leaf eating caterpillar, *Spodoptera litura* Fab., is a serious polyphagous noctuid pest that is constantly associated with many agricultural crops, causing losses to pulses, oilseeds, vegetables, and other crops. Extensive usage of insecticides has not only resulted in a variety of environmental hazards, but also the build-up of resistance in insect pests against insecticides. This resistance exhibited by *S. litura* has led to sporadic outbreaks and crop failure (Ahmad *et al*. 2005).

Crop protection is possible through microbial biological control, which employs the application of insect harmful pathogens. But these entomopathogenic organisms are viewed as impractical, inefficient in large scale agricultural applications and continued as niche products (Miller *et al*. 1983; Shah and Pell 2003) [7, 15]. Green muscardine fungus, *Metarhizium anisopliae* is an entomopathogenic fungi infecting a wide range of hosts, including *S. litura* and other insect members from the class Insecta. (Roberts and Leger 2004) [13]. *M. anisopliae* infects the host by various stages of life cycle such as adhesion, germination, penetration, invasion, colonization, and dissemination (Alves and Neves 2004) [9]. Loss of appetite, loss of mobility, discolouration and mummification are the symptoms exhibited by the insects infected from *M. anisopliae.* (Indrayanti, 2017). *M. anisopliae* can be utilized as an alternative to the synthetic pesticides due to their eco-friendly in nature and also, their use does not lead to resistance build-up in target pests (Mohitha *et al.* 2022) [8].

Materials and Methods

A field trial was conducted during *Rabi* season 2021 to evaluate the mycological suppression of *Spodoptera litura* in wettable powder and liquid formulations of *Metarhizium anisopliae* in experimental farm, Department of Agriculture, Annamalai University, Annamalai nagar. Commercial liquid formulations and wettable powder formulations of *M. anisopliae* were procured from SAAFS Organics, Pudhucherry. Randomized block design (RBD) is the design in which the field trial is laid out in both wettable powder and liquid formulations with each 5 treatments and one control, replicated 4 times in the plot size (5×4m), with the variety VBN-3 at a spacing of 30×10cm. Except the *S. litura* management measures, all the agronomic practices were undertaken. At the time of spraying, the biopesticide required for spraying was calculated for preparation of spray fluid per plot at various concentrations dissolved in clean water. Two rounds of foliar sprays of both wettable powder and liquid formulations of *M. anisopliae* were undertaken at 15 days interval by using a pneumatic knapsack sprayer.

The treatment details were given below

1. Liquid formulations of *M. anisopliae*

T_1: 1×10^4 spores/ml
T_2: 1×10^6 spores/ml
T_3: 1×10^8 spores/ml
T_4: 1×10^{10} spores/ml
T_5: 1×10^{12} spores/ml
T_6: Control

2. Wettable powder formulations of *M. anisopliae*

T_1: 1×10^4 spores/ml
T_2: 1×10^6 spores/ml
T_3: 1×10^8 spores/ml
T_4: 1×10^{10} spores/ml
T_5: 1×10^{12} spores/ml
T_6: Control

Both liquid and wettable powder formulations were sprayed on blackgram field during early morning and late evening hours when sufficient moisture available in the field. By counting the death cadavers, the observation on mortality of *S. litura* was recorded. The mortality of *S. litura* due to wettable powder and liquid formulations of *M. anisopliae* was recorded at 5, 7 and 10 days after spraying (DAS).

Statistical analysis

In-vivo experiments were conducted in RBD with required replications (Panse and Sukhatme, 1978) [10]. Square root transformation were done. The obtained data were analyzed by using computer based OPSTAT analysis developed by, CCS HAU, Hisar, Haryana.

Results and Discussion

In this study, the results revealed that liquid formulations of *M. anisopliae* @ 1×10^{12} spores/ml resulted in better larval mortalities of *S. litura* in blackgram field when compared to other treatments of wettable powder formulations of *M. anisopliae*. Liquid formulations of *M. anisopliae* @ 1×10^{12} spores/ml resulted in comparatively higher percent reduction over control as 55% after first spray. This was followed by 1×10^{10} spores/ml, 1×10^8 spores/ml and 1×10^6 spores/ml which resulted in percent reduction over control as 45.2%, 44.44% and 33.91%. Lowest percent reduction over control was noticed on 1×10^4 spores/ml as 33.44% after first spray (Table 1).After second spray, liquid formulations of *M. anisopliae* @ 1×10^{12} spores/ml resulted in higher percent reduction over control as 65.09% when compared with other treatments. This was followed by 1×10^{10} spores/ml, 1×10^8 spores/ml and 1×10^6 spores/ml which resulted in percent reduction over control as 54.17%, 51.5% and 46.43%. Lowest percent reduction over control was noticed on *M. anisopliae* @ 1×10^4 spores/ml as 40.05% after second spray (Table II). These results coincided with Thamarai chelvi *et al.* (2011) [3] who stated that liquid formulations of *M. anisopliae* resulted in better mortality of sugarcane grub *Holotrichia serrata* when compared to talc, lignite formulations of *M. anisopliae*. Bugeme *et al*. (2015) [2] found that oil and liquid formulations of *M. anisopliae* was as effective as insecticide abamectin in reducing the population density of *Tetranychus urticae* when applied in higher concentration. *M. anisopliae* @ 1×10^{12} spores/ml resulted in reduction of mean larval population as 2.47, 2.32, 1.12 after 5, 7 and 10 DAT respectively. These findings coincided with Shoaib and Pandurang (2014) who stated that during both sprays reduction in mean population of brown plant hopper, *Nilaparvata lugens* after 1, 2, 7 and 10DAT of liquid formulation of *M. anisopliae* applied at higher concentration. Effiacy of liquid formulations of *M. anisopliae* increases with increase in number of days after treatment. These results are in consonance with Reddy *et al*. (2013) [11] who reported that higher concentration of *M. anisopliae* exhibited increased efficacy with increase in number of days after treatment against brown plant hopper, *N. lugens*.

Among the evaluated liquid and wettable powder formulations of *M. anisopliae* against *S. litura* in blackgram, liquid formulations resulted in better efficacy against *S. litura* when compared to wettable powder formulations. Liquid formulations found to have better viability of spores, ease of application when compared to other formulations, thereby resulting higher larval mortalities (Ritu *et al*. 2012) [12].

Among the evaluated wettable powder treatments, *M. anisopliae* @ 1×10^{12} spores/ml resulted in comparatively higher percent reduction over control as 46.63% after first spray. This was followed by 1×10^{10} spores/ml, 1×10^8 spores/ml and 1×10^6 spores/ml which resulted in percent reduction over control as 44.1%, 36.13% and 28.18%. Lowest percent reduction over control was noticed on 1×10^4 spores/ml as 10.68% after first spray (Table III)

After second spray, wettable powder formulations of *M. anisopliae* @ 1×10^{12} spores/ml resulted in higher percent reduction over control as 62.71% when compared with other treatments. This was followed by *M. anisopliae* @ 1×10^{10} spores/ml, 1×10^8 spores/ml and 1×10^6 spores/ml which resulted in percent reduction over control as 51.27%, 44.27% and 36.6%.Lowest percent reduction over control was noticed on 1×10^4 spores/ml as 26.00% after second spray (Table IV).These results are in consonance with Maketon *et al*. (2008) [6] who reported that wettable powder formulation of *M. anisopliae* displayed an better and increased efficacy with increase in number of days after application against cotton jassid *Amrasca biguttula biguttula* in aubergine.

Table I: Field evaluation of liquid formulations of *M. anisopliae* against *S. litura* – I spray

S. No	Treatments (spores/ml)	Mean larval population				Mean	% Reduction over control
		Pre-count	5 DAT	10 DAT	14 DAT		
1	1×10^6	4.22	4.17 (2.27)^b	4.12 (2.26)^b	4.07 (2.24)^b	4.12	33.44
2	1×10^7	3.87	3.80 (2.18)^c	3.75 (2.17)^c	3.70 (2.16)^c	3.75	33.91
3	1×10^8	3.57	3.50 (2.11)^d	3.45 (2.10)^d	3.37 (2.08)^d	3.44	44.44
4	1×10^9	3.55	3.47 (2.11)^e	3.40 (2.09)^e	3.32 (2.07)^e	3.39	45.20
5	1×10^{10}	2.91	2.91 (1.97)^f	2.81 (1.94)^f	2.62 (1.89)^f	2.78	55.00
6	Control	5.87	6.00 (2.64)^a	6.15 (2.67)^a	6.30 (2.70)^a	6.19	0.00
C.D ($p= 0.05$)			0.179	0.175	0.182		
S.E (d)			0.083	0.088	0.085		

Each value is mean of four replications
Figures in parentheses are transformed square root values; DAT = Days after treatment

Table II: Field evaluation of liquid formulations of *M. anisopliae* against *S. litura* – II spray

S. No	Treatments (spores/ml)	Mean larval population				Mean	% Reduction over control
		Pre-count	5 DAT	10 DAT	14 DAT		
1	1×10^6	4.07	4.05 (2.24)^b	3.92 (2.21)^b	3.80 (2.18)^b	3.92	40.05
2	1×10^7	3.70	3.65 (2.15)^c	3.52 (2.12)^c	3.42 (2.09)^c	3.53	46.43
3	1×10^8	3.37	3.30 (2.06)^d	3.20 (2.04)^d	3.07 (2.01)^d	3.19	51.50
4	1×10^9	3.32	3.22 (2.05)^e	3.00 (1.99)^e	2.85 (1.96)^e	3.02	54.17
5	1×10^{10}	2.62	2.47 (1.85)^f	2.32 (1.81)^f	2.12 (1.75)^f	2.30	65.09
6	Control	6.30	6.42 (2.72)^a	6.66 (2.75)^a	6.77 (2.78)^a	6.59	0.00
C.D (p =0.05)			0.183	0.170	0.186		
S.E (d)			0.085	0.079	0.087		

Each value is mean of four replications
Figures in parentheses are transformed square root values; DAT = Days after treatment

Table III: Field evaluation of wettable powder formulations of *M. anisopliae* against *S. litura* – I spray

Sl. No	Treatment (spores/ml)	Mean larval population				Mean	% Reduction over control
		Pre-count	5 DAT	10 DAT	14 DAT		
1	1×10^6	4.2	4.02 (2.24)^a	3.92 (2.21)^b	3.85 (2.19)^b	3.93	10.68
2	1×10^7	3.35	3.25 (2.05)^b	3.15 (2.03)^c	3.10 (2.01)^c	3.16	28.18
3	1×10^8	2.95	2.90 (1.97)^c	2.80 (1.94)^d	2.75 (1.93)^d	2.81	36.13
4	1×10^9	2.7	2.65 (1.90)^d	2.57 (1.88)^e	2.55 (1.84)^e	2.59	41.10
5	1×10^{10}	3	2.92 (1.97)^e	2.55 (1.88)^f	1.97 (1.72)^f	2.48	46.63
6	Control	4.2	4.30 (2.29)^a	4.42 (2.32)^a	4.50 (2.33)^a	4.40	0.00
C.D (p =0.05)			0.221	0.241	0.210		
SE (d)			0.103	0.112	0.097		

Each value is mean of four replications
Figures in parentheses are transformed square root values; DAT = Days after treatment

Table IV: Field evaluation of wettable powder formulations of *M. anisopliae* against *S. litura* – II spray

Sl. No	Treatment (spores/ml)	II spray – Mean larval population				Mean	% Reduction over control
		Pre-count	5 DAT	10 DAT	14 DAT		
1	1×10^6	3.82	3.50 (2.13)^b	3.52 (2.12)^b	3.47 (2.11)^b	3.49	26.00
2	1×10^7	3.10	3.05 (2.00)^c	3.00 (1.99)^c	2.92 (1.97)^c	2.99	36.6
3	1×10^8	2.75	2.70 (1.91)^d	2.62 (1.90)^d	2.57 (1.88)^d	2.63	44.27
4	1×10^9	2.55	2.35 (1.83)^e	2.32 (1.82)^e	2.25 (1.80)^e	2.32	51.27
5	1×10^{10}	1.97	1.87 (1.69)^f	1.77 (1.66)^f	1.65 (1.62)^f	1.77	62.71
6	Control	4.50	4.60 (2.35)^a	4.72 (2.38)^a	4.85 (2.41)^a	4.72	0.00
CD (p = 0.05)			0.193	0.195	0.189		
S.E (d)			0.090	0.091	0.088		

Each value is mean of four replications
Figures in parentheses are transformed square root values; DAT = Days after treatment

Conclusion

From these findings, it shall be concluded that liquid formulations of *M. anisopliae* @ 1×10^{12} spores/ml was found as a potential biocontrol agent against *S. litura* in blackgram. Also, *M. anisopliae* can play an inevitable role in management of *Spodoptera litura* in blakgram, cheap and eco-friendly when compared to chemical insecticides and serve as an important component in Integrated Pest Management (IPM).

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