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Evaluation of microbial pesticide against the major foliage feeder on soybean

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Abstract

Field trial was conducted during Kharif season in two consecutive years with twelve microbial treatments against the foliage feeder of soybean crop. On the basis of two years pooled data per cent larval reduction of larval population of *Spodoptera litura* among the different treatment were found significant over control. Among these treatment *Beauveria bassiana* 5 g/l recorded 63.62 per cent larval reduction was found to be the most effective treatment followed by *B. bassiana* 4 g/l recorded 51.90 per cent larval reduction and was at par with *B. thuringiensis* 3 g/l, *B. thuringiensis* 2 g/l and *N. rileyi* 6 g/l which recorded 51.76, 50.45 and 49.11per cent larval reduction. Similarly per cent reduction of *Thysanoplusia orichalcea* also varied significantly after 3rd, 7th and 14th days of spraying. The highest larval reduction was exhibited by *B. bassiana* 5 g/l with 65.29 per cent reduction after 7th day of spraying followed by *B. thuringiensis* 3 g/l, *B. bassiana* 3 g/l and *B. bassiana* 4 g/l recording 53.94, 53.95 and 52.33 per cent reduction respectively. All the treatment recorded significantly higher yield over control. It was highest in the treatment *B. bassiana* 5 g/l (23.77 q/h) with highest incremental cost benefit ratio of 13.44 over the control.

Keywords: *Beauveria bassiana, Spodoptera litura, Thysanoplusia orichalcea,* soybean

Introduction

Soybean [*Glycine max* (L.) Merrill] ranks first in the world for production of edible oil, while India ranks third in the world in respect of area and fifth in terms of production (Padiwal *et al.*, 2008) [8]. Soybean is the most useful and the cheapest source of protein (42%), fat (21%) carbohydrates (4.6%) and phospholipids (2%).

Soybean crop having a luxuriant growth with succulent leaves attracts a number of insect pests for feeding, oviposition and shelter. About 150 insect pests cause damage to soybean in various parts of Maharashtra, out of which about a dozen of insect pests cause serious damage to the crop from sowing to harvest (Singh and Singh, 1992) [13]. Among them green semilooper, *Thysanoplusia orichalcea* (Fab), and tobacco caterpillar, *Spodoptera litura* (Fabricius) are major foliage feeder insects which voraciously feed on foliage, flower and pods causing significant yield loss (Singh and Singh, 1990) [14]. To control these insect pests, number of chemical insecticides are used injudiciously which results in resistance in the insects, pest resurgence, adverse effect on natural enemies and creation of other residual effect on environment. Thus, it is an urgent need to advocate ecofriendly insecticides to mitigate the adverse effects of chemical pesticides causing environmental problems. Entomopathogens as biocontrol agents offer good and effective alternative to conventional insecticides. Keeping the above facts in mind this study was carried out to evaluate some eco-friendly microbial insecticides against foliage feeder insect pests to minimize the infestation and making the soybean cultivation more profitable without environmental hazard.

Materials and Methods

A field experiment was conducted on soybean crop during two consecutive *Kharif* seasons using variety JS-335 in the field of College of Agriculture Nagpur, (Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola). The experiment was laid out in a randomized block design with thirteen treatments and three replications. Treatments comprises three entomopathogenic fungi viz. *Beauveria bassiana* @ 5, 4 and 3 g/l, *Nomuraea rileyi* @ 6, 5 and 4 g/l, *Metarhizium anisopliae*5, 4 and 3 g/l and *Bacillus thuringiensis* @ 3, 2 and 1 g/l along with water spray as control. First sprays of microbial pesticides (commercial formulation) were applied on test crop on 20 DAE, and thereafter two consecutive sprays at an interval of 15 days. The plot size was kept 13.5 m^2 with a spacing of 45× 5 cm between rows and plants respectively and recommended agronomical practices were followed. Observations of larval population were recorded at 24 hours before treatment and 3rd, 7th and 14th days after treatment on one meter row length (mrl) at 5 different places in each plot. The seed yield was recorded for each treatment and computed for hectare in q/ha.

Data recorded on insect pest population was tested by 'F' test. When 'F' test showed the significance difference between the treatment mean values were further tested with critical difference (CD) at 5% level of significance. Similarly, data on seed yield were also subjected to statistical analysis.

Results and Discussion

Spodoptera litura

Two year pooled data obtained from three sprays against larval population of *S. litura* and *Spilarctia oblique* /mrl at 24 hrs before and 3rd, 7th and 14th days after treatments were analyzed (Table 1). The percent reduction of larval population of *S. litura* /mrl on the third day after treatment was found significant over control plot. Among the different treatment *B. bassiana* 5 g/l recorded 25.50 per cent reduction and found significantly superior over all the treatments which was followed by *Bacillus thuringiensis, B. bassiana* 3 g/l and *B. bassiana* 4 g/l and *N. rileyi* 5 g/l which was recorded in the range of 20.37 to 24.01 per cent. The rest of the treatment exhibited lower percent of reduction whereas on the seventh day after the treatment mean larval population among different treatments were significantly reduced over control plots. Among these treatments, *Beauveria bassiana* 5 g/l was found to be the most effective as it recorded the highest percent of larval reduction (63.62 per cent) followed by *B. bassiana* 4 g/l recorded 51.90 per cent larval reduction and was at par with *B. thuringiensis* 3 g/l, *B. thuringiensis* 2 g/l and *N. rileyi* 6 g/l which recorded 51.76, 50.45 and 49.11per cent larval reduction.

The moderate percent reduction were recorded with, *N. rileyi* 4 g/l, *M. anisopliae* 5 g/l, *B. thuringiensis* 1 g/l and *M. anisopliae* 4 g/l which exhibited 41.66, 41.16, 40.36 and 41.01 per cent reduction, respectively and were at par with each other. The minimum per cent larval reduction was exhibited by the lower dose i.e *B. bassiana* 3 g/l and *M. anisopliae* 3 g/l which were 35.48 and 35.38. Similar trends of results were also observed at 14 DAS with maximum percent reduction of 46.34 per cent by *Beauveria bassiana* 5 g/l followed by *B. thuringiensis* 3 g/l caused larval reduction of 42.36 per cent.

On the basis of overall performance in reduction of larval population among different treatments were significant as compared to control plot. Among these treatments, *B. bassiana 5 g/l* was found to be the most effective as it recorded the highest larval reduction population, followed by *B. bassiana 4* g/l, *B. thuringiensis* 3 g/l, *N. rileyi* 6 g/l, *B. thuringiensis* 2 g/l and *M. anisolpliae* 4 g/l. Similar findings of effectiveness of entomopathogenic fungi *B. bassiana* have been reported by (Ahirwar *et al.* 2013; Purwar and Yadav, 2003) [9] against the larvae of tobacco leaf eating caterpillar, *Spodoptera litura* in soybean. The different degree of mortality caused by *B. bassiana* had also reported by (Sivasankaran *et al.* 1990; Alobaidi and Samir, 2011) [15, 2] The treatment *B. thuringiensis* 3 g/l performed next to the *B. bassiana* and recorded 51.76 per cent larval reduction these finding are in corroboration with the findings reported by Lalitha *et al.* (2012) [7] against the *S. litura* in groundnut.

Thysanoplusia orichalcea

In case of *T. orichalcea* also the larval population was reduced over control on the third day after spraying (Table 2). The highest reduction of larval population was recorded in the treatment, *B. bassiana* 5 g/l (26.40 Per cent) and was statistically at par with *B. thuringiensis* 3 g/l and B. bassiana 4 g/l and *B. thuringiensis* 2 g/l which recorded 24.54, 23.35 and 22.40 per cent larval reduction. The next effective result was given by *M. anisopliae* 4 g/l, *M. anisopliae* 5 g/l, *N. rileyi* 6 g/l and *B. thuringiensis* 1g/l with reduction in larval population as 21.27, 20.97, 20.93 and 20.64 per cent reduction after 3 days of spray. The lower per cent of reduction in the larval population was exhibited by *B. bassiana* 3 g/l, *N. rileyi* 5 g/l, *M. anisopliae* 3 g/l and *N. rileyi* 4 g/l. At 7th and 14th days after spray the per cent of larval population between the treatments were significantly reduced as compared to control plots Among these treatment *B. bassiana* 5 g/l was found to be the most effective with the highest larval reduction of 65.29 per cent, 56.79 per cent. The next effective treatment were *B. thuringiensis* 3 g/l (53.94, 47.06) *B. bassiana* 3 g/l (53.95, 49.20) and *B. bassiana* 4 g/l (52.33, 44.32) per cent larval reduction respectively after 7th and 14th day and found statistically at par with each other.

These were followed by *B. thuringiensis* 2 g/l, *M. anisopliae* 4 g/l, *M. anisopliae* 5 g/l, *B. thuringiensis* 1 g/l, *N. rileyi* 6 g/l, *N. rileyi* 4 g/l and *M. anisopliae* 3g/l which recorded in the range of 46.92 to 44.38 after 7th day of spray. After 7 DAS, *N. rileyi* 5 g/l recorded 40.88 per cent reduction in larval population and was lowest amongst all the biopesticidal treatments while the minimum per cent of larval reduction was recorded by *M. anisopliae* 3 g/l (40.99), *N. rileyi* 5g/l (40.59) and *M. anisopliae* 5 g/l (41.31) after 14 DAS.

During the present investigation, average per cent reduction of *T. orichalcea* recorded maximum after 7 DAS and slightly lower toward the 14 DAS. The high reduction of population of larvae was maintained by *B. bassiana* 5 g/l with 65.29 per cent larval reduction after 7 DAS followed by *B. thuringiensis* 3 g/l recording 53. 94 per cent which was similar to that of lower concentration of *B. bassiana*. The superiority of *B. bassiana* over other fungus was supported by Purwar and Sachan (2005) [11] who tested toxicity of two isolates of entomogenous fungi *B. bassiana* and *Metarhizium anisopliae* against *Spodoptera litura* and *Spilarctia oblique* indicated that activities decreased with advancement of age of larva and *B. bassiana* was more virulent than *M. anisopliae* to both insects. Similarly the effectiveness of *Beauveria bassiana* was also reported by different worker viz. Bhattachrya *et al.* (2003), Shinde (2011) [17], Sivasankaran *et al.* (1990) [15] etc. against the green semilooper.

The *B. thuringiensis* performed next to *B. bassiana* recording 53.94 per cent reduction and was equal to lower doses of *B. bassiana* after 7 DAS. This was in agreement with the finding of Pawar and Charati (2000) [10]. Effectiveness of Bt has been also supported by Somase (2006) [16, 18] who conducted the field study for the management of major insect pest of soybean with microbial and plant origin insecticide. The high relative humidity (>80%) and temperature of 23-31°c prevailing in August were the most favourable for the rapid multiplication of the microbial control agents. Weather parameters like temperature, pH and light significantly affected the efficacy of *Bacillus thuringiensis* (*Bt*) resulting in feeding inhibition and malformation during adult emergence of *S. litura* reported by (Somasekhar and Krishnayya, 2004) [19]. Similarly, best pathogenicity of entomopathogenic fungus, *B. bassiana* was reported rather than *M. anisopliae* to *S. litura* (Dayakar and Kanaujia, 2003; Purwar and Sachan, 2005; Bhaduria *et al.,* 2011) [5, 11, 4]. Although, the fungus *B. bassiana* acts gradually on insect pests through cuticle infection (Qin *et al.,* 2010). However, these microbial bioagents required congenial environmental conditions for its swift inoculation/multiplication in the host insect and in nature.

Soybean seed yield

The seed yield of net plot area of each plot was recorded and converted into q/ha. All the treatments exhibited positively significant effect on yield. The lowest yield was recorded in the control plot (13.82 q/ha) which was significantly less than rest of the treatments. The highest seed yield was obtained in the treatment, *B. bassiana 5g/l* followed by *B. bassiana* 4 g/l and *Metarhizium anisopliae* 5 g/l, *Metarhizium anisopliae* 4 g/l These treatments were effective not only in reducing the foliage feeder larval population but also recorded higher seed yield as compared to control. Similarly, findings were reported by (Kamala Jayanthi and Padmavathamma, 2001) [6]. In the present study the best treatment in terms of seed yield was *B. bassiana* 5g/l application of which resulted yield of 23.77 with highest incremental cost benefit ratio of 13.44 over the control. This finding were supported Shinde (2011) [17]. However, *B. thuringiensis* 3 g/l and 2g/l recorded lower ICBR of 1:50 and 1:1.84 as compared to other treatment due to high cost of Bt even though these were recorded higher yield and effective against management of pest of soybean.

Table 1: Effect of different treatments on per cent reduction in larval population of *S. litura* (pooled)

Treat. No.	Treatments	Average per cent reduction in larval population		
		3 DAS*	7 DAS**	14 DAS**
T_1	*Nomuraea rileyi* 6 g/l	19.93 (4.45)	49.11 (44.49)	37.50 (37.76
T_2	*Beauveria bassiana* 5 g/l	25.50 (5.05)	63.62 (52.90)	46.34 (42.90)
T_3	*Metarhizium anisopliae* 5 g/l	18.02 (4.25)	41.16 (39.90)	33.74 (35.51)
T_4	*Nomuraea rileyi* 4 g/l	19.50 (4.42)	41.86 (40.31)	34.12 (35.74)
T_5	*Beauveria bassiana* 3 g/l	20.81 (4.56)	35.38 (36.50)	31.82 (34.33)
T_6	*Metarhizium anisopliae* 3 g/l	18.11 (4.26)	35.48 (36.56)	29.70 (33.12)
T_7	*Nomuraea rileyi* 5 g/l	20.37 (4.51)	45.31 (42.31)	38.01 (38.05)
T_8	*Beauveria bassiana* 4 g/l	20.39 (4.52)	51.90 (46.10)	39.64 (39.02)
T_9	*Metarhizium anisopliae* 4 g/l	18.61 (4.31)	39.52 (38.87)	33.25 (35.21)
T_{10}	*Bacillus thuringiensis* 1 g/l	21.05 (4.59)	40.36 (39.44)	36.55 (37.15)
T_{11}	*Bacillus thuringiensis* 2 g/l	22.38 (4.73)	50.45 (45.27)	40.15 (39.26)
T_{12}	*Bacillus thuringiensis* 3 g/l	24.01 (4.90)	51.76 (46.01)	42.36 (40.60)
T_{13}	Water spray (control)	12.21 (3.27)	14.60 (20.72)	14.41 (21.09)
	F test	Sig	Sig	Sig
	S.E.(m)±	0.14	1.19	1.08
	C.D. at 5%	0.41	3.50	3.16
	CV %	9.55	8.83	8.98

DAS- Days after spray

*Figures in parentheses are corresponding square root transformed values** Figures in parentheses are corresponding arcsine transformed values

Table 2: Effect of different treatments on per cent reduction in larval population of *T. orichalcea* (pooled)

Treat. No.	Treatments	Average per cent reduction in larval population		
		3 DAS*	7 DAS**	14 DAS**
T_1	*Nomuraea rileyi* 6 g/l	20.93 (4.58)	44.54 (41.86)	42.82 (40.87)
T_2	*Beauveria bassiana* 5 g/l	26.40 (5.14)	65.29 (53.90)	56.79 (48.90)
T_3	*Metarhizium anisopliae* 5 g/l	20.97 (4.58)	46.71 (43.11)	41.31 (39.10)
T_4	*Nomuraea rileyi* 4 g/l	16.10 (4.01)	44.52 (41.85)	42.09 (40.44)
T_5	*Beauveria bassiana* 3 g/l	18.48 (4.30)	53.95 (47.26)	49.20 (44.54)
T_6	*Metarhizium anisopliae* 3 g/l	16.22 (4.03)	44.38 (41.77)	40.99 (39.79)
T_7	*Nomuraea rileyi* 5 g/l	16.66 (4.08)	40.88 (39.74)	40.59 (39.57)
T_8	*Beauveria bassiana* 4 g/l	23.35 (4.83)	52.33 (46.33)	44.32 (41.74)
T_9	*Metarhizium anisopliae* 4 g/l	21.27 (4.61)	47.46 (43.17)	41.37 (40.03)
T_{10}	*Bacillus thuringiensis* 1 g/l	20.64 (4.54)	44.59 (41.89)	41.98 (40.38)
T_{11}	*Bacillus thuringiensis* 2 g/l	22.40 (4.73)	46.92 (43.23)	43.70 (41.38)
T_{12}	*Bacillus thuringiensis* 3 g/l	24.54 (4.95)	53.94 (47.26)	47.06 (43.31)
T_{13}	Water spray (control)	14.35 (3.47)	13.09 (19.68)	14.49 (20.88)
	F test	Sig	Sig	Sig
	S.E.(m)±	0.17	0.96	1.15
	C.D. at 5%	0.50	2.83	3.38
	CV %	11.58	6.86	8.64

DAS- Days after spray

*Figures in parentheses are corresponding square root transformed values

** Figures in parentheses are corresponding arcsine transformed values

Table 3: Effect of different treatments on yield and incremental cost benefit ratio (pooled)

Treat. No.	Treatments	Yield kg/ha (Pooled)	Increa-mental benefit RS/ha	ICBR ratio	Ranks
T_1	*Nomuraea rileyi* 6 g/l	2026	13820	5.06	VII
T_2	*Beauveria bassiana* 5 g/l	2377	23801	13.44	I
T_3	*Metarhizium anisopliae* 5 g/l	2133	17410	9.21	III
T_4	*Nomuraea rileyi* 4 g/l	1992	13427	6.00	VI
T_5	*Beauveria bassiana* 3 g/l	1700	6594	4.17	IX
T_6	*Metarhizium anisopliae* 3 g/l	1885	11277	6.83	V
T_7	*Nomuraea rileyi* 5 g/l	1711	5965	2.40	X
T_8	*Beauveria bassiana* 4 g/l	2237	20299	12.12	II
T_9	*Metarhizium anisopliae* 4 g/l	2029	14857	8.40	IV
T_{10}	*Bacillus thuringiensis* 1 g/l	1607	3652	1.71	XII
T_{11}	*Bacillus thuringiensis* 2 g/l	1711	5485	1.84	XI
T_{12}	*Bacillus thuringiensis* 3 g/l	2266	18908	5.00	VIII
T_{13}	Water spray (control)	1382			

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