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Management of girdle beetle (*Oberopsis brevis*) through microbial pesticide in soybean

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Abstract
Field experiment for two consecutive years was taken for management of Girdle beetle (*Oberopsis brevis*) through microbial pesticides in soybean var. JS-335. Four 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 tested at 20 DAE and thereafter two consecutive sprays at an interval of 15 days. Two years pooled data obtained recorded the superiority of treatment *B. bassiana* 5 g/l which cause less per cent damage (17.83). Lower dose of *M. anisopliae* causes high per cent plant damage after 14 DAS. The highest seed yield was obtained in the treatment, *B. bassiana* 5 g/l followed by *B. bassiana* 4 g/l *and M. anisopliae* 5 g/l, *M. anisopliae* 4 g/l.

Keywords: *Beauveria bassiana, Oberopsis brevis,* soybean, entomopathogenic fungi

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

In Maharashtra area sown under soybean was 27,291 ha with estimated yield per hectare and total production of soybean was around 1581Kg/ha and 43158 tonnes/ha, respectively during *kharif* season during 2010-11 while area sown under soybean in Vidarbha region was 15761 ha and estimated yield per hectare was 1366 Kg/ha and total production of soybean was around 22769 tonnes/ha (Anonymous, 2011) [1]. 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) [10].

Injudicious use of number of chemical insecticides 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 eco-friendly 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
Soybean crop was sown during two consecutive *Kharif* seasons using variety JS-335 in the field of College of Agriculture, Nagpur (Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola) to conduct a field experiment.

The experiment was laid out in a randomized block design with thirteen treatments and three replications. Treatments comprises different doses of four 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 cm × 5 cm between rows and plants respectively and recommended agronomical practices were followed.

Observations of plant damage were recorded on 3rd, 7th and 14th days after treatment on one meter row length (mrl) at 5 different places in each plot. The percent plant damage was calculated by counting the damage plant out of the total plants. 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

Percent plant damage by girdle beetle

Two years pooled data obtained from three sprays against the internal borer *Oberopsis brevis* and percent plant damage at 3, 7 and 14 days after treatment were analyzed.

Percent plant damage at 3 DAT

Third day after treatment per cent damage by girdle beetle was found significant over control plot. Among the different treatment *B. bassiana* 5 g/l recorded lowest per cent plant damage of 3.83 per cent which was at par with *B. thuringiensis* 3 g/l *and B. bassiana* 3 g/l with 4.06 and 4.08 per cent plant damage, respectively and significantly superior over remaining all treatments. *B. bassiana* 4 g/l recorded 4.16 per cent plant damage which was at par with *M. anisopliae* 5 g/l and *N. rileyi* 6 g/l which gave 4.66 and 4.78 per cent plant damage, respectively and significantly superior over remaining all treatments. The next effective result was observed in *N. rileyi* 5 g/l with 5.46 per cent plant damage and at par with *B. thuringiensis* 2 g/l, *M. anisopliae* 3 g/l and *N. rileyi* 4 g/l which recorded 5.77, 5.91 and 5.91 per cent plant damage, while untreated control recorded maximum per cent plant damage i.e. 7.97 followed by *B. thuringiensis 1* g/l and *M. anisopliae* 4 g/l with 7.16 and 6.76 per cent plant damage.

Percent plant damage at 7 DAT

Mean percent plant damage among different treatments were significantly reduced over control plots at 7th day after treatment. Among all treatments, *Beauveria bassiana* 5 g/l was found to be the most effective as it recorded the lowest (11.23) per cent plant damage and at par with remaining all treatments except control. Remaining all the treatments ranges per cent plant damage from 12.10 in *B. bassiana* 4 g/l to 14.77 in *M. anisopliae* 3 g/l. The highest per cent plant damage 25.83 per cent was recorded by untreated control.

Percent plant damage at 14 DAT

Significantly lower number of plant damage was recorded by *B. bassiana* 5 g/l (17.83) which was found at par with *M. anisopliae* 5 g/l, *B. bassiana* 4 g/l, *N. rileyi* 6 g/l, *B. thuringiensis* 3 g/l and *B. thuringiensis* 2 g/l which recorded 19.06, 19.33, 19.86, 20.57 and 20.93 per cent plant damage at 14 day after spray. All the remaining treatments *viz. N. rileyi* 4 g/l, *N. rileyi* 5 g/l, *B. thuringiensis* 1 g/l, *B. bassiana* 3 g/l, *M. anisopliae* 3 g/l and *M. anisopliae* 4 g/l showed at par result and recorded per cent plant damage in the range of 22.43 to 23.80 per cent which was significantly superior over control. Highest per cent plant damage was observed in untreated control with 36.17 per cent plant damage.

The result of the experiment after the two seasons clearly recorded the superiority of treatment *B. bassiana* 5 g/l which cause less per cent damage due to *O. brevis*. Lower dose of *M. anisopliae* recorded high per cent of plant damage after 14 DAS. *M. anisopliae* 4 g/l and 3 g/l recorded relatively more per cent plant damage and similar low performance was noticed in treatment *B. thuringiensis* 1 g/l.

Superiority of *B. bassiana* in reducing *O. brevis* population was noticed after 14 DAS and was supported by Shinde (2011) [9] recorded 18.40 per cent plant damage with the plot treated with biocontrol module which performed superior to control and chemical module. This is in agreement with the present finding of 17.83 per cent plant damage by *O. brevis* recorded in the plot treated with *B. bassiana* 5 g/l. The results obtained with experiment with reference to entomopathogenic fungi, *B. bassiana* and *M. anisopliae* has been reported by various workers against coleopteran internal borer. Bhattacharya *et al*. (2008) [3] studied the possibility of using *Beauveria bassiana* and *Metarhizium anisopliae* against white grub. *B. bassiana* formulation applied @ 5 x 10^8 conidia ml^{-1} in combination with imidacloprid 200 ST @ 48 a.i. ha^{-1} and *M. anisopliae* when applied @ 5 x 10^{13} conidia ml^{-1} in combination with imidacloprid 200 ST @ 484.5 ha^{-1} result in lowest grub population.

Similarly, Sasidharan and Verma (2005) [8] conducted laboratory evaluation of *B. bassiana* against *Inderbela quadrinotata* and revealed that the fungal suspension at concentration of 2× 10^6, 2×10^7, and 2× 10^8 spores/ml was able to kill 66.67 per cent larvae. Batta (2003) [2] recorded virulence of *M. anisopliae* by different formulation against *Sitophilus oryzae* L., Coleoptera: Curculionidae and recorded 73.3- 86.7 % mortality of adult after 7 DAS. Sahu and Sharma (2008) [7] recorded the effectiveness of *B. bassiana* and *M. anisopliae* against cashew stem and root borer. Similarly, efficacy of *B. bassiana* against coleopteran were also determined by Meyers *et al.* (2013) [6], Ismail *et al.* (2013) [4], Todd *et al.* (2013) [11], Yasaman *et al.* (2012) [12].

Soybean seed yield and ICBR

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* 5 g/l followed by *B. thuringiensis 3* g/l, *B. bassiana* 4 g/l, *M. anisopliae* 5 g/l, *M. anisopliae* 4 g/l and *N. rileyi* 6 g/l with 23.77, 22.66, 22.37, 21.33, 20.29 and 20.26 q/ha, respectively. These treatments were effective not only in recording higher seed yield but also in reducing the foliage feeder larval population as compared to control. In ICBR *B. thuringiensis* 5 g/l and *B. bassiana* 4 g/l recorded highest ICBR followed by *M. anisopliae* 5 g/l and *M. anisopliae* 4 g/l. However, *B. thuringiensis* 1 g/l and *B. thuringiensis* 2 g/l of 1:1.71 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.

Similar findings were reported by (Kamala Jayanthi and Padmavathamma, 2001) [5]. In terms of seed yield of soybean *B. bassiana* 5 g/l application recorded more yield and ICBR than other biopesticides, Shinde (2011) [9].

Table 1: Effect of different treatments on percent plant damage by girdle beetle (*Oberopsis brevis*) (pooled)

Treat. No.	Treatments	Percent plant damage		
		3 DAS*	7 DAS**	14 DAS**
T1	Nomuraea rileyi 6 g/l	4.78 (2.18)	13.32 (3.79)	19.86 (26.42)
T2	Beauveria bassiana 5 g/l	3.83 (1.96)	11.23 (3.43)	17.83 (24.97)
T3	Metarhizium anisopliae 5 g/l	4.66 (2.15)	12.76 (3.57)	19.06 (25.80)
T4	Nomuraea rileyi 4 g/l	5.91 (2.43)	14.26 (3.78)	22.43 (28.25)
T5	Beauveria bassiana 3 g/l	4.06 (2.02)	13.93 (3.73)	23.33 (28.87)
T6	Metarhizium anisopliae 3 g/l	5.91 (2.43)	14.77 (3.77)	23.43 (28.94)
T7	Nomuraea rileyi 5 g/l	5.46 (2.33)	14.33 (3.79)	22.47 (28.28)
T8	Beauveria bassiana 4 g/l	4.16 (2.04)	12.10 (3.53)	19.33 (26.03)
T9	Metarhizium anisopliae 4 g/l	6.76 (2.60)	14.52 (3.81)	23.80 (29.20)
T10	Bacillus thuringiensis 1 g/l	7.16 (2.68)	14.11 (3.76)	23.13 (28.74)
T11	Bacillus thuringiensis 2 g/l	5.77 (2.40)	14.13 (3.75)	20.93 (27.14)
T12	Bacillus thuringiensis 3 g/l	4.08 (2.02)	12.93 (3.60)	20.57 (26.90)
T13	Water spray (control)	7.97 (2.75)	25.83 (4.97)	36.17 (36.72)
	F test	Sig	Sig	Sig
	S.E.(m)±	0.09	0.13	1.06
	C.D. at 5%	0.26	0.38	3.12
	CV%	11.49	10.44	11.39

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 yield and incremental cost benefit ratio (pooled)

Treat. No.	Treatments	Yield q/ha (Pooled)	Incremental benefit RS/ha	ICBR ratio	Ranks
T1	Nomuraea rileyi 6 g/l	20.26	13820	5.06	VII
T2	Beauveria bassiana 5 g/l	23.77	23801	13.44	I
T3	Metarhizium anisopliae 5 g/l	21.33	17410	9.21	III
T4	Nomuraea rileyi 4 g/l	19.92	13427	6.00	VI
T5	Beauveria bassiana 3 g/l	17.00	6594	4.17	IX
T6	Metarhizium anisopliae 3 g/l	18.85	11277	6.83	V
T7	Nomuraea rileyi 5 g/l	17.11	5965	2.40	X
T8	Beauveria bassiana 4 g/l	22.37	20299	12.12	II
T9	Metarhizium anisopliae 4 g/l	20.29	14857	8.40	IV
T10	Bacillus thuringiensis 1 g/l	16.07	3652	1.71	XII
T11	Bacillus thuringiensis 2 g/l	17.11	5485	1.84	XI
T12	Bacillus thuringiensis 3 g/l	22.66	18908	5.00	VIII
T13	Water spray (control)	13.82			

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