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Eco-friendly management of pod borer complex infesting dolichos bean, *Lablab purpureus* (L.) sweet by using biopesticides

MN Kengare, KV Naik and VN Jalgaonkar

Abstract
A field experiment was carried out to bio-efficacy of different insecticides against pod borer complex infesting dolichos bean, *Lablab purpureus* (L.) Sweet during *rabi* season of 2018-19 at Central Experiment Station, Wakawali, Dist- Ratnagiri. During this experiment total six insecticides tested viz., *Beauveria bassiana* @ 5ml/lit, *Lecanicillium lecanii* @ 5ml/lit, *Bacillus thuringiensis* @ 2ml/lit, Azadirachtin 1000 ppm 0.003% @ 3ml/lit, *Metarrhizium anisopliae* @ 2.5ml/lit, Chloropyriphos 20 EC 0.06% @ 3ml/lit, respectively. The results regarding overall mean of two sprays against pod borer complex revealed that chlorpyriphos 20 EC @ 0.06 per cent was the best treatment which was recorded minimum (12.74%) mean pod infestation and was at par with *Bacillus thuringiensis* (14.03%).

Keywords: bio-efficacy, pod borer complex, dolichos bean, insecticides

Introduction
The grain legumes occupy a unique position in the world of agriculture by virtue of their high protein content and capacity of fixing atmospheric nitrogen. *Lablab purpureus* (L.) Sweet usually called as Dolichos bean, Hyacinth bean or Field bean is one of the most ancient crops among the cultivated plants. It is a multipurpose crop grown for pulse, vegetable and forage. It is one of the major sources of protein in diets in southern states of India. In India, the total area under beans is 228 thousand hectare with an annual production of 2277 thousand MT while in Maharashtra the total area under beans is 5.50 thousand hectare with an annual production of 55.48 thousand MT (Anon., 2018) [1].
The crop is attacked by a number of insect pests during its life span. Govindan (1974) [4] recorded as many as 55 species of insects and one species of mite feeding on the crop from seedling stage till the harvest of the crop in Karnataka. However, only a few of them such as pod borers were considered to be most destructive and they appeared regularly causing economic loss, whereas others were considered as minor pests.
The larvae of pod borer are known to cause considerable damage to lablab bean attacking various parts viz., buds, flowers, pods and seeds. Its nature of damage is exhibited by weaving unopened buds and flowers. The larva further damages the reproductive parts of flower leading to poor pod setting and pod formation. In the later period of crop growth, it behaves as a pod borer and completes its larval and pupal development inside the pod. This leads to poor pod formation, reduction in grain yield as well as adverse effect on market value of green pods.
The several insecticides are being used to manage pod borer complex on dolichos bean but because of development of many fold resistance to existing insecticides, it has become difficult to manage the pest population effectively. Considering the seriousness of pod borer complex infesting dolichos bean in the *Konkan* region, some new molecules need to be evaluated against this pest so that this pesticides can be incorporated in the spray schedule for management of pod borer complex infesting dolichos bean. Hence, the present investigation was undertaken to study the bio-efficacy of different insecticides against pod borer complex infesting dolichos bean, *Lablab purpureus* (L.) Sweet which can be suitably acceptable in pest management programme.

Materials and Methods
A field experiment was conducted during *rabi* season of 2018-19 to study bio-efficacy of insecticides against pod borer complex infesting dolichos bean.

Experimental details

The details of experiment are given below, while the treatment details are given in Table 1.

Table 1: Experimental details

Location	:	CES, Wakawali, DBSKKV, Dapoli, Dist. Ratnagiri
Period of study	:	November 2018 to April 2019
Variety	:	Konkan Bhushan
Spacing	:	30 cm × 30 cm
Size of treatment plot	:	1.5m × 1.2m
Total plot size	:	37.8m
Date of sowing	:	22nd November, 2018
Method of planting	:	On raised beds
Design	:	Randomized Block Design (RBD)
Number of replication	:	Three
Number of treatment	:	Seven

Spraying methodology

The quantity of spray suspension required for each treatment was calibrated by spraying water over three plots in the experiment prior to the application of insecticide. Spray suspension of desired strength of each insecticide was prepared against pod borer complex in the field.

The insecticides were sprayed twice in case of pod bores because the infestation of pod borers was noticed in the 52th SMW. The First spray of each insecticide was applied when incidence was noticed, while remaining sprays were given at an interval of 15 days with manually operated knapsack sprayer. The observations were recorded in each treatment on randomly selected plants.

Table 2: Treatment details

Treatment No.	Insecticide Name	Conc. (%)	Quantity per litre (ml)
T_1	*Beauveria bassiana*	-	5
T_2	*Lecanicillium lecanii*	-	5
T_3	*Bacillus thuringiensis*	-	2
T_4	Azadirachtin 1000ppm	0.003	3
T_5	*Metarrhizium anisopliae*	-	2.5
T_6	Chloropyriphos	0.06	3
T_7	Untreated control	-	-

Method of recording observations

During the cropping season three different pod borers *viz.*, *Helicoverpa armigera* (Hubner), *Spodoptera litura* (Fabricius) and *Maruca vitrata* (Fabricius) were observed to infest dolichos bean. The observations of pod borers were recorded on five randomly selected plants per plot at each picking *i.e.* number of healthy and infested pods due to pest.

Per cent pod infestation was calculated by the following formula,

Results and Discussion

Bio-efficacy of insecticides against pod borer complex infesting dolichos bean, *Lablab purpureus* (L.) Sweet

First spray

Data on per cent pod infestation of pod borer recorded at 3rd, 7th, 10th and 14th days after first spray are presented in Table 3.

The infestation of the pod borers prior to application of insecticides ranged from 30.50 to 32.65 per cent. The differences among the treatments and replications were non-significant indicating uniform distribution of pest in both treatments and replications.

The observations recorded on third day after first spray indicated that the treatment chlorpyriphos 20EC @ 0.06 per cent was found most effective treatment which recorded minimum (26.81%) pod infestation and was at par with *Bacillus thuringiensis* (29.10%) and Azadirachtin 1000ppm @ 0.003 per cent (29.17%). The next effective treatment *was Beauveria bassiana* (31.73%) and it was at par with *Metarrhizium anisopliae* (31.85%) and *Lecanicillium lecanii* (32.65%). The maximum (42.93%) pod infestation was noticed in untreated control.

On the seventh day after first spraying, the minimum (22.81%) pod infestation was observed in treatment chlorpyriphos 20EC @ 0.06 per cent and was at par with *Bacillus thuringiensis* (26.10%) and Azadirachtin 1000ppm @ 0.003 per cent (27.17%). The next best treatment *Beauveria bassiana* recorded 28.73 per cent pod infestation and was at par with *Metarrhizium anisopliae* (28.85%) and *Lecanicillium lecanii* (29.85%). The maximum (47.43%) pod infestation was found in untreated plot.

On 10th day after first spray, the treatment chlorpyriphos 20EC @ 0.06 per cent recorded the minimum (18.56%) pod infestation and was at par with *Bacillus thuringiensis* (21.60%) and Azadirachtin 1000ppm @ 0.003 per cent (22.50%). The next best treatment *Beauveria bassiana* (25.23%) was at par with *Metarrhizium anisopliae* and *Lecanicillium lecanii* which recorded 25.69 and 29.35 per cent pod infestation, respectively. The maximum (52.93%) pod infestation was observed in untreated control.

At 14th day after first spraying, the minimum (14.31%) pod infestation was recorded in chlorpyriphos 20EC @ 0.06 per cent and it was at par with *Bacillus thuringiensis* and Azadirachtin 1000ppm @ 0.003 per cent which recorded 17.10 and 18.50 per cent pod infestation, respectively. While, the treatment *Beauveria bassiana* (21.73%) was at par with *Metarrhizium anisopliae* and *Lecanicillium lecanii* which recorded 22.52 and 27.85 per cent pod infestation, respectively. The maximum (58.43%) pod infestation was observed in untreated control.

The results of overall mean per cent pod infestation revealed

that the treatment chlorpyriphos 20EC @ 0.06 per cent was found to be most effective treatment which recorded 20.62 per cent pod infestation and it was at par with *Bacillus thuringiensis* (23.47%) and Azadirachtin 1000 ppm @ 0.003 per cent (24.33%). The next best treatment was *Beauveria bassiana* (26.85%) and it was at par with *Metarrhizium anisopliae* and *Lecanicillium lecanii* recorded 27.22 and 29.92 mean per cent pod infestation, respectively. While, the maximum (50.43%) pod infestation was observed in untreated control.

Table 3: Bio-efficacy of insecticides against pod borer complex infesting dolichos bean after first spray

Sr. No.	Treatment	Conc. (%)	Per cent pod damage per five plants					
			Pre count	3 DAS	7 DAS	10 DAS	14 DAS	Overall Mean
1	*Beauveria bassiana*	-	31.29 (33.99)	31.73 (34.28)	28.73 (32.41)	25.23 (30.15)	21.73 (27.78)	26.85 (31.15)
2	*Lecanicillium lecanii*	-	32.65 (34.83)	32.65 (34.84)	29.85 (33.11)	29.35 (32.80)	27.85 (31.84)	29.92 (33.14)
3	*Bacillus thuringiensis*	-	32.10 (34.51)	29.10 (32.64)	26.10 (30.72)	21.60 (27.69)	17.10 (24.42)	23.47 (28.86)
4	Azadirachtin 1000 ppm	0.003	30.50 (33.52)	29.17 (32.69)	27.17 (31.41)	22.50 (28.31)	18.50 (25.47)	24.33 (29.47)
5	*Metarrhizium anisopliae*	-	32.32 (34.62)	31.85 (34.35)	28.85 (32.47)	25.69 (30.43)	22.52 (28.29)	27.22 (31.38)
6	Chlorpyriphos	0.06	32.14 (34.44)	26.81 (31.08)	22.81 (28.39)	18.56 (25.31)	14.31 (21.89)	20.62 (26.66)
7	Untreated control	-	32.43 (34.68)	42.93 (40.93)	47.43 (43.52)	52.93 (46.68)	58.43 (49.86)	50.43 (45.24)
	S.Em. ±		1.50	0.98	1.03	1.16	1.30	1.11
	CD (P= 0.05)		NS	3.02	3.17	3.57	4.01	3.44

*Figures in parentheses are arcsine transformed values DAS: Days After Spraying

Bio-efficacy of insecticides against pod borer complex infesting dolichos bean recorded at different intervals after second spray

Data on per cent pod infestation of pod borers recorded at 3rd, 7th, 10th and 14th days after second spray are presented in Table 4.

The observations recorded on third day after second spray revealed that the per cent pod infestation in the treatment chlorpyriphos 20EC @ 0.06 per cent was minimum (10.06%) and was at par with *Bacillus thuringiensis* and Azadirachtin 1000 ppm @ 0.003 per cent which recorded 11.60 and 14.50 per cent pod damage, respectively. The next effective treatment was *Beauveria bassiana* which recorded 18.23 per cent pod damage. It was at par with *Metarrhizium anisopliae* which recorded 19.35 per cent pod damage. The treatment *Lecanicillium lecanii* 72 recorded 26.35 per cent pod damage. While, the maximum (60.93%) pod damage was recorded in untreated plot.

At seventh day after second spraying, the minimum (6.10%) pod damage was recorded in *Bacillus thuringiensis* and it was at par with chlorpyriphos 20EC @ 0.06 per cent which recorded 7.81 per cent pod damage. Azadirachtin 1000 ppm @ 0.003 per cent was found to be next best treatment which recorded 10.50 per cent pod damage. The treatment *Beauveria bassiana* recorded 14.73 per cent pod damage and was at par with *Metarrhizium anisopliae* (16.19%). The *treatment Lecanicillium lecanii* recorded 24.85 per cent pod damage. The untreated plot recorded maximum (63.43%) pod damage.

The observations recorded on 10th day after second spray revealed that the treatment *Bacillus thuringiensis* recorded 0.60 per cent pod damage and was at par with chlorpyriphos 20EC @ 0.06 per cent (1.19%). The next effective treatment Azadirachtin 1000 ppm @ 0.003 per cent recorded 5.50 per cent pod damage. The treatment *Beauveria bassiana* was at par with *Metarrhizium anisopliae* which recorded 10.23 and 10.29 per cent pod damage, respectively. The treatment *Lecanicillium lecanii* recorded 22.35 per cent pod damage. While, the maximum (60.93%) pod damage was recorded in untreated plot.

At 14th day after second spraying, data indicated that the treatment *Bacillus thuringiensis* was found to be most effective which recorded 0.12 per cent pod damage and it was at par with chlorpyriphos 20EC @ 0.06 per cent (0.45%). The next effective treatment Azadirachtin 1000 ppm @ 0.003 per cent recorded 2.00 per cent pod damage. The treatment *Beauveria bassiana* recorded 5.73 per cent pod damage and was at par with *Metarrhizium anisopliae* (5.79%). The treatment *Lecanicillium lecanii* was recorded 18.85 per cent pod damage. The maximum (52.43%) pod damage was recorded in untreated plot.

The data on overall mean per cent pod damage after second spray indicated that among the all treatments, *Bacillus thuringiensis* recorded minimum (4.60%) pod damage and was at par with chlorpyriphos 20EC @ 0.06 per cent (4.87%). The next effective treatment Azadirachtin 1000ppm @ 0.003 per cent recorded 8.12 per cent pod damage. The treatment *Beauveria bassiana* (12.23%) was at par with *Metarrhizium anisopliae* which recorded 12.90 per cent pod damage. The treatment *Lecanicillium lecanii* recorded 23.10 per cent pod damage. The maximum (59.43%) mean per cent pod damage was recorded in untreated plot.

Table 4: Bio-efficacy of insecticides against pod borer complex infesting dolichos bean after second spray

Sr. No.	Treatment	Conc. (%)	Per cent pod damage per five plants					
			Pre count	3 DAS	7 DAS	10 DAS	14 DAS	Overall Mean
1	*Beauveria bassiana*	-	21.73 (27.78)	18.23 (25.26)	14.73 (22.55)	10.23 (18.62)	5.73 (13.76)	12.23 (20.04)
2	*Lecanicillium lecanii*	-	27.85 (31.84)	26.35 (30.88)	24.85 (29.89)	22.35 (28.20)	18.85 (25.71)	23.10 (28.67)
3	*Bacillus thuringiensis*	-	17.10 (24.42)	11.60 (19.91)	6.10 (14.29)	0.60 (4.42)	0.12 (1.92)	4.60 (10.13)
4	Azadirachtin 1000 ppm	0.003	18.50 (25.47)	14.50 (22.39)	10.50 (18.89)	5.50 (13.53)	2.00 (7.94)	8.12 (15.68)
5	*Metarrhizium anisopliae*	-	22.52 (28.29)	19.35 (26.04)	16.19 (23.64)	10.29 (18.67)	5.79 (13.82)	12.90 (20.54)
6	Chlorpyriphos	0.06	14.31 (21.89)	10.06 (17.81)	7.81 (16.09)	1.19 (6.11)	0.45 (3.60)	4.87 (10.90)
7	Untreated control	-	58.43 (49.86)	60.93 (51.32)	63.43 (52.80)	60.93 (51.32)	52.43 (46.39)	59.43 (50.45)
	S.Em. ±		1.30	1.56	1.01	0.87	1.04	1.12
	CD (P= 0.05)		4.01	4.82	3.12	2.70	3.22	3.46

*Figures in parentheses are arcsine transformed values DAS: Days after Spraying

Cumulative bio-efficacy of insecticides against pod borer complex infesting dolichos bean

The data pertaining to the cumulative bio-efficacy of insecticides against pod borer complex infesting dolichos bean are presented in Table 5.

Based on overall mean of two sprays, it was revealed that chlorpyriphos 20 EC @ 0.06 per cent was the best treatment which recorded minimum (12.74%) mean pod infestation and was at par with *Bacillus thuringiensis* (14.03%). The next effective treatment, Azadirachtin 1000 ppm @ 0.003 per cent (16.22%) was at par with *Beauveria bassiana* which recorded 19.54 per cent pod damage. The treatment *Metarrhizium anisopliae* recorded 20.06 per cent pod damage. The treatment *Lecanicillium lecanii* recorded 26.51 per cent pod damage. All the above treatments were found to be superior over untreated control which recorded maximum (54.93%) pod damage.

The present findings are supported by the results of Karel and Schoonhoven (1986) [5]. They reported that two applications of *Bacillus thuringiensis* (Berliner) during the post flowering growth stage of bean plants controlled the larvae of pod borer, *M. testulalis* and *H. armigera* as effectively as two applications of lindane 20 EC @ 2 g a.i. per lit water and carbaryl 85 WP 2.25 g a.i. per lit water over the same period.

Manjula and Padmavathanma (1996) [6] also reported maximum reduction in the larval population of *M. vitrata* with the treatment of *B. thuringinensis* (1×107 spore per ml) +monocrotophos (0.025%).

Reddy *et al*. (2001) [9] studied the bio-efficacy of two synthetic pyrethroids viz., deltamethrin and fenvalerate, two biopesticides *viz., Bacillus thuringiensis* (Dipel) and *Beauveria bassiana* (Dispel) and their judicious combination, revealed that the combination of dipel with deltamethrin (0.004% or 0.002%) was most effective in reducing the damage due to pod borers.

Shinde (2014) [10] studied the efficacy of Entomopathogenic fungi against dolichos bean, the lowest aphid population was recorded in the treatments of *Verticillium lecanii* 7.5 g and *V. lecanii* 5 g with 33.70 and 35.28 aphids/3 leaves respectively, which were at par with each other and were superior over all other treatments followed by *V. lecanii* 3 g and *Metarhizium anisopliae* 7.5 g with 38.20 and 34.05 aphids/3 leaves count, respectively.

Nath *et al*. (2017) [8] studied the effect of bio-rational approaches such as intercropping and application of biopesticide on the larval population, pod damage, grain damage and grain weight loss by plume moth, *Exelastis atomosa* (Wlsm.) infesting pigeonpea, *C. cajan* (L.) Millsp. The two sprays of NSKE 5 per cent (first at flowering and pod formation stage and second after 20 days) were found superior in reducing larval population, pod damage, grain damage and grain weight loss. However, the plots devoid of any biopesticidal treatment had maximum larval population (0.68 larva per plant), pod damage (2.75%), grain damage (0.86%) and grain weight loss (0.60%) by *E. atomosa*.

Selvam (2018) [11] revealed that the treatment Azadirachtin (0.03%) was effective against pod borer which reduce flower (50.63%) and pod damage (65.80%).

Table 5: Cumulative bio-efficacy of insecticides against pod borer complex infesting dolichos bean

Sr. No.	Treatment	Conc. (%)	Mean per cent pod damage		Cumulative per cent infestation
			First spray	Second spray	
1	Beauveria bassiana	-	26.85 (31.15)*	12.23 (20.04)	19.54 (25.59)
2	Lecanicillium lecanii	-	29.92 (33.14)	23.10 (28.67)	26.51 (30.90)
3	Bacillus thuringiensis	-	23.47 (28.86)	4.60 (10.13)	14.0 (19.49)
4	Azadirachtin 1000ppm	0.003	24.33 (29.4)	8.12 (15.68)	16.22 (22.57)
5	Metarrhizium anisopliae	-	27.22 (31.3)	12.90 (20.54)	20.06 (25.96)
6	Chlorpyriphos	0.06	20.62 (26.6)	4.87 (10.90)	12.74 (18.78)

7	Untreated control	-	50.43 (45.24)	59.43 (50.45)	109.86 (47.84)
S.Em. ±			1.11	1.12	1.11
CD (p= 0.05)			3.44	3.46	3.45

*Figures in parentheses are arcsine transformed values

Conclusion

From the present study, it can be concluded that the treatment chlorpyriphos 20 EC @ 0.06 per cent was the best treatment for effective management of pod borer complex which was recorded minimum (12.74%) mean pod infestation and was at par with *Bacillus thuringiensis* (14.03%).

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