Int.J.Curr.Microbiol.App.Sci (2020) Special Issue-11: 3690-3698

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 Special Issue-11 pp. 3690-3698
Journal homepage: http://www.ijcmas.com

Original Research Article

Bio-Efficacy of Chemical and Microbial Insecticides against Major Foliage Feeders on Soybean

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Keywords

Bio-efficacy, chemical and microbial insecticides, major foliage feeders, soybean

A B S T R A C T

The present study was conducted during *Kharif*, 2019 at Breeder Seed Production Unit (BSP) JNKVV Jabalpur (M.P.). The experiment was laid out in Randomized Block Design (RBD) with eight treatments and three replications. Foliage feeders are the most damaging insect pest of soybean. On the basis of overall mean of two spraying all the insecticidal treatments evaluated were significantly effective in reducing the larval population of major foliage feeders as compared to untreated control. Among the various treatments emamectin benzoate 5% SG @ 200 gm/ha proved to be most effective in controlling the incidence of major foliage feeders *viz, S. litura* (0.72 larvae/mrl), *C. acuta* (0.31 larvae/mrl) and *S. obliqua* (0.72 larvae/mrl) with cost benefit ratio of (1:19.28) and registered highest grain yield (23.93 quintal/ha).

Introduction

Soybean [*Glycine max* (L) Merrill] referred as "Golden bean" and it has a vital place in Indian agriculture as a leading oil seed crop that significantly contribute to "yellow revolution" in India.

It contains 40-42% protein, 20-22% oil, 35% carbohydrates and 5-6% crude fiber. Nationally soybean occupies an area of 108.39 lakh ha and its production is 114.83 lakh MT.

Madhya Pradesh ranks first in total area (54.09 lakh ha) and production (59.170 lakh MT) in the country and is known as "Soya State" in India. Soybean crop having a luxuriant growth with succulent leaves attracts a number of insect pests for feeding, oviposition and shelter. Among them green semilooper *Chrysodeixis acuta* (Walker), tobacco caterpillar *Spodoptera litura* (Fabricius) and Bihar hairy caterpillar *Spilarctia obliqua* (Walker) are major foliage feeder insects which voraciously feed on foliage, flower and pods causing significant yield loss (Ahirwar *et al.,* 2013).

To avoid losses caused by these defoliator pests chemical and microbial insecticides were used under this investigation because microbial insecticides play an important role in insect pests management. They are biodegradable in nature and making the soybean cultivation more profitable.

Materials and Methods

A field experiment was conducted on soybean crop during *Kharif* 2019 using variety RVS 2001-4 at Breeder Seed Production Unit J.N.K.V.V. Jabalpur (M.P.). The experiment was laid out in a randomized block design (RBD) with eight treatments T_1(Chlorpyriphos 50% + Cypermethrin 5% EC @ 750ml/ha), T_2 (Chlorpyriphos 50% EC @ 600ml/ha), T_3 (Cypermethrin 10% EC @ 600ml/ha), T_4 (Spinetoram 11.7% SC @ 450ml/ha), T_5 (Emamectin benzoate 5% SG @ 200gm/ha), T_6 (Spinosad 45% SC @ 180ml/ha), T_7 (*Beauveria bassiana* 1×10^8 CFU @ 1000ml/ha), T_8 (Untreated control)and three replications conducted from July 2019 to October 2019.Two spray of insecticidal treatments were applied on soybean crop for management of major foliage feeders. 1st spray was done after pest emergence at ETL level and 2nd spray was done at 10 days after first spray. The plot size was kept 4×3 m^2 with a spacing of 40×10 cm between rows and plants respectively and recommended agronomical practices were followed.

Observation procedure

Observations of larval population were recorded at 24 hours before treatment and 3rd, 7th and 10th days after 1st and 2nd application of insecticides on one metre row length (1mrl) at 5 different places in each plot. The seed yield was recorded for each treatment and computed for hectare in q/ha.

Results and Discussion

Overall mean of two spraying (1st and 2nd spray) for *Spodoptera litura*

On the basis of overall mean of two spraying (Table 1) all the insecticidal treatments significantly reduced the larval population of tobacco caterpillar as compared to untreated control (5.30 larvae/mrl). Among the various treatments emamectin benzoate 5% SG @ 200 gm/ha was found to be most effective as it recorded lowest mean larval population (0.72 larvae/mrl) followed by chlorpyrifos 50% + cypermethrin 5% EC @ 750 ml/ha (0.99 larvae/mrl), spinosad 45% SC @ 180 ml/ha (1.28 larvae/mrl), cypermethrin 10% EC @ 600 ml/ha (1.70 larvae/mrl), chlorpyrifos 50% EC @ 600 ml/ha (2.02 larvae/mrl) and *Beauveria bassiana* 1×10^8 CFU @ 1000 ml/ha (2.37 larvae/mrl) in reducing the incidence of tobacco caterpillar. However, spinetoram 11.7% SC @ 450 ml/ha (2.72 larvae/mrl) was significantly least effective.

Similar findings have been reported by Harish *et al.*,(2009) who reported that emamectin benzoate 5% SG recorded the lowest larval population of tobacco caterpillar in soybean crop and was significantly superior over chlorpyriphos 20% EC and spinosad 45% SC.The results of present investigation are supported by the findings of Gupta *et al.*, (2004) who reported that emamectin benzoate (Proclaim) was more toxic than fenvalerate, indoxacarb, cypermethrin and endosulfan to *Spodoptera litura* (Fab.). Khan *et al.*, (2011) established that after 3 days of insecticide treatment, 100% mortality of *Spodoptera litura* was observed in emamectin benzoate @ 100 and 110 ml/acre followed by chlorpyriphos, leufenuron and methomyl. Bengochea *et al.*, (2014) noted that ingesting a diet contaminated with 0.5 mg/L *a.i.* of emamectin benzoate caused 100% mortality in L_2 and L_4 larvae of *Spodoptera exigua* 24 and 72 hours after ingestion respectively. Ramzan *et al.*, (2019) reported that emamaectin benzoate proved to be effective one with significantly higher level of mortality of *Spodoptera litura* followed by profenofos and leufenuron after 48 and 72 hours respectively. Karuppaiah *et al.,* (2017) concede that emamectin benzoate 5% SG @ dose of 1-3 ppm (LC_{50}) was most effective formulation for *Spodoptera litura*.

Overall mean of two spraying (1st and 2nd spray) for *Chrysodeixis acuta*

On the basis of overall mean of two spraying(Table 2) indicated that all the insecticidal treatments were significantly effective in reducing the larval population of green semilooper as compared to control (4.34 larvae/mrl). Among the various treatments emamectin benzoate 5% SG @ 200 gm/ha proved to be most effective in controlling the incidence of green semilooper (0.31 larvae/mrl) and was significantly superior over rest of the treatments. Whereas efficacy of rest of the treatments were in the order of chlorpyrifos 50% + cypermethrin 5% EC @ 750 ml/ha (0.50 larvae/mrl), spinosad 45% SC @ 180 ml/ha (0.69 larvae/mrl), cypermethrin 10% EC @ 600 ml/ha (0.90 larvae/mrl), chlorpyrifos 50% EC @ 600 ml/ha (1.10 larvae/mrl), *Beauveria bassiana* 1×10^8 CFU @ 1000 ml/ha (1.31 larvae/mrl) and spinetoram 11.7% SC @ 450 ml/ha (1.52 larvae/mrl). The results of present studies are in accordance with Kothalkar *et al.,* (2015) who reported that emamectin benzoate 5% SG @ 0.002% (0.13 larvae/mrl) was found to be significantly most effective in minimizing the larval population of semilooper in soybean crop. Muzammil *et al.,* (2017) reported that emamectin benzoate 5% SG @ 0.2 gm/L and rynaxpyr 18.5% SC @ 0.15 ml/L were found most effective in managing green semilooper, *T. orichalcea.*

Overall mean of two spraying (1st and 2nd spray) for *Spilarctia obliqua*

On the basis of overall mean of two spraying (Table 3) indicated that all the insecticidal treatments were significantly effective in reducing the larval population of bihar hairy caterpillar as compared to untreated control (4.98 larvae/mrl).

Among the various treatments emamectin benzoate 5% SG @ 200 gm/ha proved to be most effective in controlling the incidence of bihar hairy caterpillar (0.72 larvae/mrl) and was significantly superior over rest of the treatments.

Whereas efficacy of rest of the treatments were in the order of chlorpyrifos 50% + cypermethrin 5% EC @ 750 ml/ha (0.94 larvae/mrl), spinosad 45% SC @ 180 ml/ha (1.22 larvae/mrl), cypermethrin 10% EC @ 600 ml/ha (1.49 larvae/mrl), chlorpyrifos 50% EC @ 600 ml/ha (1.71 larvae/mrl), *Beauveria bassiana* 1×10^8 CFU @ 1000 ml/ha (2.03 larvae/mrl) and spinetoram 11.7% SC @ 450 ml/ha (2.36 larvae/mrl).

Similar findings have been reported by Nair *et al.,* (2007) who found that emamectin benzoate 5% SG showed lowest LC_{50} value (0.00005) and was most toxic among all the chemicals to the larvae of *Spilarctia obliqua.*

Rahman *et al.,* (2020) reported that emamectin benzoate proved to be significantly superior over rest of the treatments as it showed maximum per cent reduction (86.13%) of infestation by *Spilosoma obliqua.* Selvaraj *et al.,* (2015) expressed that emamectin benzoate was superior to lambdacyhalothrin in respect of per cent reduction of infestation by *Spilarctia obliqua* and yield.

Table.1 Overall mean of two spraying (1st and 2nd spray) for *Spodoptera litura*

Treatment code	Treatment	Dose (gm or ml/ha)	Mean larval population /mrl				
			Pre treatment	Days after spraying **			Overall mean
				3	7	10	
T_1	Chlorpyrifos 50% + Cypermethrin 5% EC	750	3.33 (1.95)	1.13 (1.28)	1.03 (1.24)	0.80 (1.14)	0.99 (1.22)
T_2	Chlorpyrifos 50% EC	600	4.00 (2.11)	2.20 (1.64)	2.00 (1.58)	1.87 (1.54)	2.02 (1.59)
T_3	Cypermethrin 10% EC	600	3.80 (2.07)	1.87 (1.54)	1.67 (1.47)	1.57 (1.44)	1.70 (1.48)
T_4	Spinetoram 11.7% SC	450	4.40 (2.21)	2.90 (1.84)	2.70 (1.79)	2.57 (1.75)	2.72 (1.79)
T_5	Emamectin benzoate 5% SG	200	4.47 (2.23)	0.90 (1.18) **L**	0.77 (1.13) **L**	0.50 (1.00) **L**	0.72 (1.10) **L**
T_6	Spinosad 45% SC	180	3.60 (2.02)	1.40 (1.38)	1.27 (1.33)	1.17 (1.29)	1.28 (1.33)
T_7	*Beauveria bassiana* 1×10^8 CFU	1000	4.20 (2.17)	2.57 (1.75)	2.33 (1.68)	2.20 (1.64)	2.37 (1.69)
T_8	Untreated control	-	4.00 (2.12)	5.30 (2.41)**H**	5.07 (2.36) **H**	5.53 (2.46) **H**	5.30 (2.41)**H**
S.E.m ±			**-**	**0.02**	**0.02**	**0.01**	**0.02**
CD at 5%			**NS**	**0.06**	**0.07**	**0.03**	**0.07**

**= Mean of two spraying, Figures in parentheses are $\sqrt{x+0.5}$ square root transformed values, NS = Non-significant, L- Lowest, H- Highest

Table.2 Overall mean of two spraying (1^{st} and 2^{nd} spray) for *Chrysodeixis acuta*

Treatment code	Treatment	Dose (gm or ml/ha)	Mean larval population/mrl				
			Pre treatment	Days after spraying **			Overall mean
				3	7	10	
T_1	Chlorpyrifos 50% + Cypermethrin 5% EC	750	3.60 (2.02)	0.63 (1.06)	0.50 (1.00)	0.37 (0.93)	0.50 (1.00)
T_2	Chlorpyrifos 50% EC	600	2.93 (1.85)	1.20 (1.30)	1.10 (1.26)	1.00 (1.22)	1.10 (1.26)
T_3	Cypermethrin 10% EC	600	3.53 (2.01)	1.00 (1.22)	0.90 (1.18)	0.80 (1.14)	0.90 (1.18)
T_4	Spinetoram 11.7% SC	450	3.87 (2.09)	1.60 (1.45)	1.53 (1.43)	1.43 (1.39)	1.52 (1.42)
T_5	Emamectin benzoate 5% SG	200	3.40 (1.97)	0.43 (0.97) **L**	0.30 (0.89) **L**	0.20 (0.84) **L**	0.31 (0.90) **L**
T_6	Spinosad 45% SC	180	2.87 (1.83)	0.80 (1.14)	0.70 (1.09)	0.57 (1.03)	0.69 (1.09)
T_7	*Beauveria bassiana* 1×10^8 CFU	1000	3.33 (1.96)	1.40 (1.38)	1.33 (1.35)	1.20 (1.30)	1.31 (1.35)
T_8	Untreated control	-	3.87 (2.09)	4.37 (2.21) **H**	4.37 (2.21) **H**	4.30 (2.19) **H**	4.34 (2.20) **H**
S.E.m ±			-	**0.01**	**0.02**	**0.02**	**0.01**
CD at 5%			**NS**	**0.04**	**0.05**	**0.05**	**0.03**

**= Mean of two spraying, Figures in parentheses are $\sqrt{x+0.5}$ square root transformed values, NS = Non-significant, L- Lowest, H- Highest

Table.3 Overall mean of two spraying (1st and 2nd spray) for *Spilarctia oblique*

Treatment code	Treatment	Dose (gm or ml/ha)	Mean larval population / mrl				
			Pre treatment	Days after spraying **			Overall mean
				3	7	10	
T_1	Chlorpyrifos 50% + Cypermethrin 5% EC	750	3.33 (1.95)	1.07 (1.25)	0.97 (1.21)	0.80 (1.14)	0.94 (1.20)
T_2	Chlorpyrifos 50% EC	600	3.93 (2.11)	1.87 (1.54)	1.70 (1.48)	1.57 (1.44)	1.71 (1.49)
T_3	Cypermethrin 10% EC	600	3.80 (2.07)	1.60 (1.45)	1.47 (1.40)	1.40 (1.38)	1.49 (1.41)
T_4	Spinetoram 11.7% SC	450	4.00 (2.11)	2.53 (1.74)	2.33 (1.68)	2.20 (1.64)	2.36 (1.69)
T_5	Emamectin benzoate 5% SG	200	3.60 (2.02)	0.83 (1.15) **L**	0.73 (1.11) **L**	0.60 (1.05) **L**	0.72 (1.10) **L**
T_6	Spinosad 45% SC	180	3.67 (2.04)	1.33 (1.35)	1.23 (1.32)	1.10 (1.26)	1.22 (1.31)
T_7	*Beauveria bassiana* 1×10^8 CFU	1000	4.13 (2.15)	2.20 (1.64)	2.03 (1.59)	1.87 (1.54)	2.03 (1.59)
T_8	Untreated control	-	3.93 (2.11)	4.83 (2.31) **H**	5.03 (2.35) **H**	5.07 (2.36) **H**	4.98 (2.34) **H**
S.E.m ±			-	**0.01**	**0.02**	**0.01**	**0.02**
CD at 5%			**NS**	**0.04**	**0.05**	**0.03**	**0.05**

**= Mean of two spraying, Figures in parentheses are $\sqrt{x+0.5}$ square root transformed values, NS = Non-significant, L- Lowest, H- Highest

Table.4 Assessment of cost benefit ratio on grain yield of soybean during *kharif* 2019

Treatment Code	Treatment Details	Dose (gm or ml/ha)	Grain yield (q/ha)	Increase in yield over control	Cost of treatments	Value increased yield over control @ Rs. 3399/- per quintal	Net Profit (Rs/ha.)	Cost benefit ratio
T_1	Chlorpyrifos 50% + Cypermethrin 5% EC	750	22.73	12.86	2706	43711.14	41005.14	1:15.15
T_2	Chlorpyrifos 50% EC	600	17.53	7.66	2316	26036.34	23720.34	1:10.24
T_3	Cypermethrin 10% EC	600	19.67	9.8	1952	33310.20	31358.20	1:16.06
T_4	Spinetoram 11.7% SC	450	14.47	4.6	11976	15635.40	3659.40	1:0.30 **L**
T_5	Emamectin benzoate 5% SG	200	23.93	14.06	2356	47789.94	45433.94	1:19.28**H**
T_6	Spinosad 45% SC	180	21.47	11.6	8829.6	39428.40	30598.80	1:3.46
T_7	*Beauveria bassiana* 1×10^8 CFU	1000	15.73	5.86	2456	19918.14	17462.14	1:7.11
T_8	Untreated control	-	9.87					

Effect of different treatment on grain yield of soybean

The grain yield of net plot area of each plot was recorded and converted into quintal/ha. The treatments had significant effect on the grain yield of soybean. The lowest yield was recorded in the control plot (9.87 quintal/ha), while maximum yield was obtained in the treatment, emamectin benzoate 5% SG @ 200 gm/ha (23.93 quintal/ha) followed by chlorpyrifos 50% + cypermethrin 5% EC @ 750 ml/ha (22.73 quintal/ha), spinosad 45% SC @ 180 ml/ha (21.47 quintal/ha), cypermethrin 10% EC @ 600 ml/ha (19.67 quintal/ha), chlorpyrifos 50% EC @ 600 ml/ha (17.53 quintal/ha), *Beauveria bassiana* 1×10^8 CFU @ 1000 ml/ha (15.73 quintal/ha) and spinetoram 11.7% SC @ 450 ml/ha (14.47 quintal/ha) respectively. Similar findings have been reported by Harish *et al.,* (2009) who found significant difference in grain yield among the treatments. Wherein highest grain yield was recorded in emamectin benzoate (2276.67 kg/ha) treated plots. Kothalkar *et al.,* (2015) found highest soybean grain yield in emamectin benzoate 5% SG + trizophos 40 EC (29.17 q/ha) followed by emamectin benzoate 5% SG (28.95 q/ha). Rahman *et al.,* (2020) reported that emamectin benzoate contributed significantly more yield production followed by lambdacyhalothrin, cypermethrin and imidacloprid. Selvaraj *et al.,* (2015) reported emamectin benzoate was superior to other treatments in respect of yield.

Assessment of cost benefit ratio

Among the different treatments, highest cost benefit ratio per hectare (Table 4) was registered in emamectin benzoate 5% SG @ 200 gm/ha (1:19.28) followed by cypermethrin 10% EC @ 600 ml/ha (1:16.06), chlorpyrifos 50% + cypermethrin 5% EC @ 750 ml/ha (1:15.15), chlorpyrifos 50% EC @ 600 ml/ha (1:10.24), *Beauveria bassiana* 1×10^8 CFU @ 1000 ml/ha (1:7.11), spinosad 45% SC @ 180 ml/ha (1:3.46) and spinetoram 11.7% SC @ 450 ml/ha (1:0.30).

The present results collaborate with that of Kothalkar *et al.,* (2015) who found maximum net profit on control in emamectin benzoate 5% SG (42385 Rs/ha) they also found highest benefit cost ratio in emamectin benzoate 5% SG.

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