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Bio-efficacy of newer insecticides against *Spodoptera litura* in soybean

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Abstract
The experiments was conducted during kharif 2017 and 2018 at the farm of AICRP on soybean, VNMKV, Parbhani (Maharashtra) to evaluate the different newer chemical molecules against *Spodoptera litura* in soybean. The data revealed that chlorantraniliprole 18.5 SC@ 30 g a.i./ha was the most effective followed by spinetoram 11.7 SC @ 15 g a.i./ha. The next most effective emamectin benzoate 5 SG @ 11 g a.i./ha, flubendiamide 39.35 SC @ 48 g a.i./ha, indoxacarb 15.8 EC @ 30 g a.i./ha and lamda-cyhalothrin 4.9 CS @ 15 g a.i./ha which were at par with each other. chlorantraniliprole 18.5 SC and spinetoram 11.7 SC proved most safer treatments against natural enemies as compared to Emamectin benzoate 5 SG lamda cyhalothrin 4.9CS. The maximum yield was recorded in treatment chlorantranilipro le 18.5 SC followed by spinetoram 11.7 SC, emamectin benzoate 5 SG and flubendiamide 39.35 SC which were at par with each other.

Keywords: Bioefficacy, insecticides, *Spodoptera litura*, ladybird beetle, soybean, yield

1. Introduction
Soybean [*Glycine max* (L.) Merrill] is one of the most important leguminous crops originating from china [5]. India ranks fifth in area of soybean in the world with a productivity 1047 kg/ha during Kharif 2017 [1]. Soybean crop attracts about 380 species of insects [7]. In Maharashtra, especially in Marathwada 19 species of insects have been observed [8]. Among them tobacco caterpillar (*Spodoptera litura*), semiloopers (*Gesonia gema*, *Achaya janata*, *Chrysodeixis acuta*, *Thysanoplusia orichalcea*) american bollworm (*Helicoverpa armigera*) are important. The defoliators *Spodoptera litura* and *Helicoverpa armigera* feed on leaves, flowers, and pods and cause significant yield losses in soybean (Singh & Singh 1990).
Many insecticides are being used by the farmers on large scale for controlling defoliators. However, their overuse and misuse has led to resistance, resurgence of secondary pests, destruction of natural enemies, residual toxicity and other such hazards [2]. To overcome these problems, there is an immediate need to advocate use of less hazardous insecticides which should be environmentally safe with novel modes of action. The present study evaluates the field bio-efficacy of the newer insecticides for the management of *Spodoptera litura*.

2. Materials and Methods
The field experiments were conducted during kharif 2017 and 2018 at the farm of AICRP on soybean, VNMKV, Parbhani (Maharashtra). Six insecticides were evaluated *viz.* chlorantraniliprole 18.5 SC @30 g a.i /ha, emamectin benzoate 5 SG @11gm a.i/ha, lamda-cyhalothrin 4.9 CS @15 g a.i /ha, indoxacarb 15.8 EC @30 g a.i /ha, flubendiamide 39.35 SC @48 g a.i /ha, spinetoram 11.7 SC @15 g a.i /ha. The experiment was laid out in randomized block design with three replications and seven treatments including untreated control. The gross and net plot size of each treatment were 3.15 x 5.0 and 2.25 x 4.0 m respectively. JS-335 variety was used with spacing 45 x 5 cm. First foliar spray was given at 55 days after sowing. The second spray was given at 70 days after sowing. The 15 days interval taken between first and second spray. Observations were recorded on incidence of defoliator pests on one day before and three, seven, ten and fourteen DAT of each spraying from net plot. The data obtained on insect pests and their natural enemies were subjected to ANOVA analysis after square root transformation. The population data was converted into efficacy (% reduction) using the method employed by [4]. Per cent efficacy = {(Number on untreated control before

treatment x Number on treated plot after treatment)/ (Number on treated plot before treatment x Number on untreated check after treatment)} x 100. The efficacy and yield data obtained after transformation were subjected to statistical analysis as per [3] using OPSTAT software.

3. Results and Discussion

The observations on number of *S. litura* one day before spraying was non-significant showing uniform incidence during 2017 and 2018. Before first spray, they varied 2.72 to 3.21larvae/mrl (Table 1 Fig 1). The pooled data of two years revealed that chlorantraniliprole 18.5 SC (0.80 larvae/mrl) proved to be the most effective insecticide in suppression of *S. litura* population followed by spinetoram 11.7 SC (0.85 larvae/mrl). The next most effective treatments were emamectin benzoate 5 SG (0.92 larvae/mrl), flubendiamide 39.35 SC (1.02 larvae/mrl), indoxacarb 15.8 EC (1.19 larvae/mrl) and lamda-cyhalothrin 4.9 CS (1.34 larvae/mrl) were at par with each other. The control plot showed maximum larval population (3.17 larvae/mrl).

After second spray pooled data revealed that chlorantraniliprole 18.5 SC (0.30 larvae/mrl) was most effective in reducing of *S. litura* population followed by spinetoram 11.7 SC (0.35 larvae/mrl). The next most effective treatments were flubendiamide 39.35 SC (0.41 larvae/mrl), emamectin benzoate 5 SG (0.42 larvae/mrl) and indoxacarb 15.8 EC (0.56 larvae/mrl) were at par with each other. It was followed by lamda-cyhalothrin 4.9 CS (1.18 larvae/mrl). The control plot showed maximum larval population (2.56 larvae/mrl) among all treatments.

The data on per cent reduction in larval population during two years revealed that chlorantraniliprole 18.5 SC (61.65%) was most effective in reducing larval population among all treatments. The next treatments were spinetoram 11.7 SC (58.11%), indoxacarb 15.8 EC (56.25%), flubendiamide 39.35 SC (56.07%) and emamectin benzoate 5 SG (52.27%) which were at par with each other. Except lamda-cyhalothrin 4.9 CS (41.53%).

The pooled data depicted in Fig.1 revealed that the reduction in *S. litura* population ranged from 54.37 to 67.70 per cent. chlorantraniliprole 18.5 SC (67.70%) recorded the highest reduction in *S. litura*. The next best treatments were spinetoram 11.7 SC (67.23%), emamectin benzoate 5 SG (63.34%) and flubendiamide 39.35 SC (61.30%). It was followed by indoxacarb 15.8 EC (60.42%). The least effective insecticide was lamda-cyhalothrin 4.9 CS (54.37%).

The results are parallel recorded that lowest population of *S. litura* was observed in rynaxypyr 20 SC followed by emamectin benzoate, flubendiamide 39.35 SC and indoxacarb [11]. The lowest population of *S. litura* was observed in chlorantraniliprole 18.5 SC followed by flubendiamide 39.35 SC, emamectin benzoate 5 SG and indoxacarb 14.5 SC [10]. The insecticide flubendiamide @ 100 ml/ha was most effective against defoliators pest after first spray having minimum population of 0.14 larva/mrl [6].

The observations on number of lady bird beetle one day before spraying was non-significant showing uniform distribution of population in all plots during 2017 and 2018. Before first spray, they varied 2.10 to 2.44 LBB/mrl. (Table 2). After first spray pooled data indicated that chlorantraniliprole 18.5 SC (1.96 LBB/mrl) and spinetoram 11.7 SC (1.94 LBB/mrl) were proved to be the most safer treatments against lady bird beetle. The lowest population was noticed in emamectin benzoate 5 SG (1.13 LBB/mrl) and lamda-cyhalothrin 4.9 CS (1.13 LBB/mrl) as compared to flubendiamide 39.35 SC (1.75 LBB/mrl) and indoxacarb 15.8 EC (1.77 LBB/mrl). The control plot showed maximum lady bird beetle population (2.41 LBB/mrl). All treatments were found non-significant.

After second spray pooled data revealed that the lowest population of lady bird beetle was found in lamda-cyhalothrin 4.9 CS (1.04 LBB/mrl) and emamectin benzoate 5 SG (1.06 LBB/mrl) among all the treatments. The control plot (2.15 LBB/mrl), chlorantraniliprole 18.5 SC (1.61 LBB/mrl) and spinetoram 11.7 SC (1.55 LBB/mrl) were most safer as compared to indoxacarb 15.8 EC (1.38 LBB/mrl) and flubendiamide 39.35 SC (1.37 LBB/mrl). These treatments were found non-significant.

The significantly highest population of LBB was observed in untreated control followed by rynaxypyr 20 SC, flubendiamide 39.35 SC emamectin benzoate 5 SG which were significantly effective over rest of treatments [11].

The pooled data of two year revealed that the maximum yield of soybean was recorded in treatment chlorantraniliprole 18.5 SC (27.03q/ha) followed by spinetoram 11.7 SC (26.59 q/ha), emamectin benzoate 5 SG (26.10 q/ha) and flubendiamide 39.35 SC (25.44 q/ha) at par with each other. The lowest yield was noticed in control plot (18.46 q/ha). Over the two years maximum seed yield was recorded in treatments with flubendiamide 480 SC 24.30 q/ha [9].

Table 1: Bio-efficacy of insecticides against *S. litura* on soybean (Pooled data of 2017 & 2018)

Sr. No.	Treatments	Dose (g a.i/ha)	Number of larvae /mrl			Per cent reduction		
			1 DBS	After first spray	After second spray	After first spray	After second spray	Pooled
T1	Chlorantraniliprole 18.5 SC	30	2.72 (1.90)*	0.80 (1.32)	0.30 (1.13)	73.74 (59.16)#	61.65 (51.71)	67.70 (55.43)
T2	Emamectin benzoate 5 SG	11	3.21 (2.03)	0.92 (1.37)	0.42 (1.18)	74.41 (59.65)	52.27 (46.29)	63.34 (52.97)
T3	Lamda-cyhalothrin 4.9 CS	15	3.05 (1.98)	1.34 (1.51)	0.74 (1.30)	60.78 (51.22)	47.97 (43.82)	54.37 (47.52)
T4	Indoxacarb 15.8 EC	30	3.00 (1.96)	1.19 (1.46)	0.56 (1.24)	64.59 (53.46)	56.25 (48.57)	60.42 (51.02)
T5	Flubendiamide 39.35 SC	48	2.72 (1.90)	1.02 (1.40)	0.41 (1.18)	66.52 (54.63)	56.07 (48.44)	61.30 (51.54)
T6	Spinetoram 11.7 SC	15	3.21 (2.03)	0.85 (1.34)	0.35 (1.16)	76.36 (60.89)	58.11 (49.63)	67.23 (55.26)
T7	Control	-	2.83 (1.94)	3.17 (2.02)	2.56 (1.85)	-	-	-
	SE±		0.08	0.06	0.05	1.04	1.75	1.38
	C.D at 5%		NS	0.19	0.14	3.10	5.36	4.23
	C.V %		7.82	8.71	6.29	6.98	7.12	7.05

* Figures in parentheses are square root transformed values. MRL: meter row length

Figures in parentheses are angular transformed values

Table 2: Bio-efficacy of insecticides against lady bird beetle on soybean (Pooled data of 2017 & 2018)

Sr. No.	Treatments	Dose (g a.i/ha)	LBB /mrl		
			1 DBS	After first spray	After second spray
T1	Chlorantraniliprole 18.5 SC	30	2.10 (1.74)*	1.96 (1.71)	1.61 (1.62)
T2	Emamectin benzoate 5 SG	11	2.27 (1.79)	1.13 (1.45)	1.06 (1.42)
T3	Lamda-cyhalothrin 4.9 CS	15	2.27 (1.79)	1.13 (1.45)	1.04 (1.41)
T4	Indoxacarb 15.8 EC	30	2.44 (1.84)	1.77 (1.66)	1.38 (1.54)
T5	Flubendiamide 39.35 SC	48	2.27 (1.79)	1.75 (1.65)	1.37 (1.54)
T6	Spinetoram 11.7 SC	15	2.22 (1.77)	1.94 (1.69)	1.55 (1.58)
T7	Control	-	2.21 (1.77)	2.41 (1.83)	2.15 (1.75)
	SE±		0.14	0.08	0.06
	C.D at 5%		NS	NS	NS
	C.V %		13.66	10.40	10.56

* Figures in parentheses are square root transformed values. mrl: meter row length

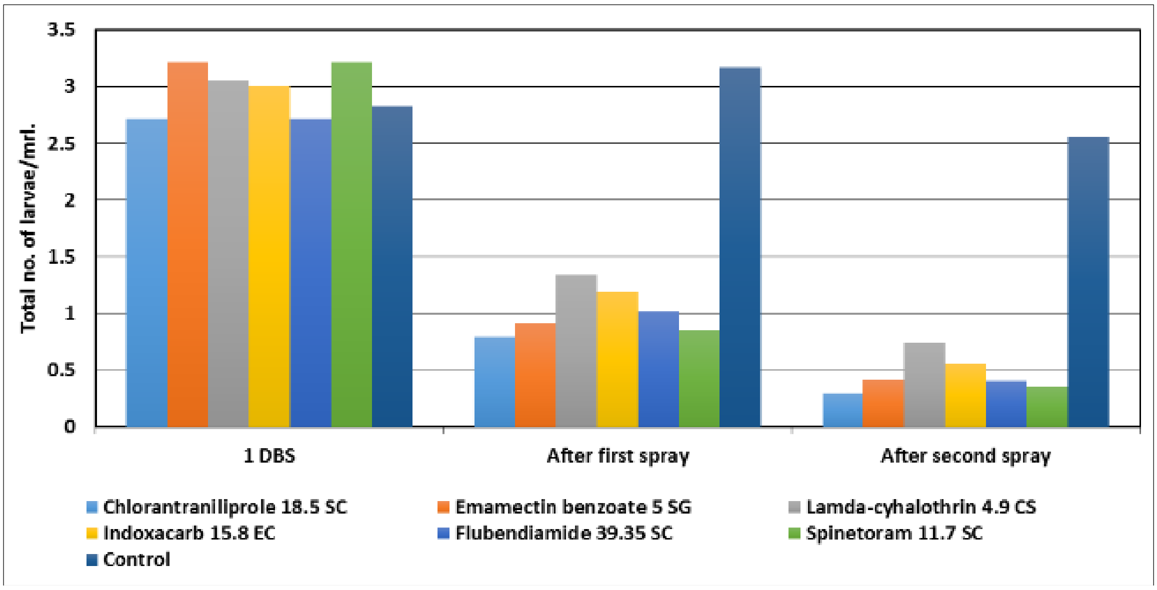

Fig 1: Efficacy of insecticides against *S. litura* on soybean (Pooled)

4. Conclusion

Concluded that among the insecticides chlorantraniliprole 18.5 SC and spinetoram 11.7 SC most effective insecticides against management of Tobacco leaf eating caterpillar, *Spodoptera litura* in soybean as well as these insecticides safer to lady bird beetle.

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