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

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ABSTRACT

The investigation on bio-efficacy of chemical insecticides against *S. litura* infesting soybean was conducted at Main Oilseeds Research Station farm, Junagadh Agricultural University, Junagadh during *Kharif*, 2023. Of the seven insecticides evaluated against *S. litura*, the treatment of chlorantraniliprole 10 + lambda-cyhalothrin 5 ZC @ 0.006% recorded the lowest (1.06) larvae/plant, which was statistically at par with novaluron 5.25 + emamectin benzoate 0.9 SC @ 0.009% (1.25 larvae/plant) and novaluron 5.25 + indoxacarb 4.5 SC @ 0.016% (1.38 larvae/plant) after 3 days of the first spray. A similar trend was seen after 7 and 10 days of the first spray as well as 3, 7, and 10 days after the second spray. The highest (2640 kg/ha) yield of soybean was produced in the treatment of chlorantraniliprole 10 + lambda-cyhalothrin 5 ZC 0.006% followed by novaluron 5.25 + emamectin benzoate 0.9 SC 0.009% (2346 kg/ha) and novaluron 5.25 + indoxacarb 4.5 SC 0.016% (2268 kg/ha). Looking to the ICBR, the treatment of chlorantraniliprole 10 + lambda-cyhalothrin 5 ZC 0.006% noted the highest (1:8.8) ICBR followed by thiamethoxam 12.6 + lambda-cyhalothrin 9.5 ZC 0.011% (1:8.3) and chlorpyriphos 50 + cypermethrin 5 EC 0.11% (1:7.1).

Keywords: Bio-efficacy, Chemical insecticides, Soybean, *Spodoptera litura*.

INTRODUCTION

Soybean is important oilseed crop it is also known as a miracle crop, golden bean, gold from the soil, pearl of the orient etc., belonging to family Leguminosae and originated in China. Soybean is a unique crop with high nutritional value, provides minerals and vitamins.

Soybean crop fetches many problems for low production from sowing to harvesting stage. Total 380 insect-pests species have been reported on soybean crop from many parts of the world, as many as 273 insect species have been recorded attacking soybean crop in India, of these, 14 species attack seed, seedling and roots, 126 defoliators, 10 stem, 72 suck the cell sap, 6 devour flowers and pods and 6 invade stored soybean.[1] Among this pests, leaf eating caterpillar, *S. litura* is major defoliator causing damage at various growth stages of soybean crop. [2] *S. litura* causes 26.06 to 52.01 per cent yield loss in soybean. [3] Considering the economic impact of this insect, this study was conducted to evaluate the effectiveness of chemical insecticides against *S. litura* in soybean crop.

MATERIALS AND METHODS

The experiment on efficacy of chemical insecticides against *S. litura* in soybean was conducted at Main Oilseeds Research Station, JAU, Junagadh during *Kharif*, 2023 in RBD design with three replications. The first spray of respective insecticides was done on initiation of *S. litura* and second spray was applied after 15 days of first spray. The larval population and per cent incidence of leaf damage by *S. litura* were recorded at five randomly selected plant before and 3, 7 and 10 days after spray applications. Seed yield was recorded at harvest. The per cent leaf damage was worked out through following formula.[4]

$$\text{Per cent leaf damage} = \frac{\text{Total number of damaged leaf}}{\text{Total number of leaf}} \times 100$$

The data was transformed appropriately into arc sine/square root values and then be subjected to the standard statistical method of analysis of variance (ANOVA) was employed for the analysis of data.[5]

RESULTS AND DISCUSSION

The larval population of *S. litura* and per cent leaf damage were found homogenous in all treatments before spray as treatment differences were non-significant (Table 1 and 3). The larval population before spraying ranged from 1.87 to 2.18 larvae/plant and leaf damage (%) ranged from 15.31 to 19.68 per cent per plant.

Larval population

The population of *S. litura* after three days after first spray indicated that all evaluated treatments significantly superior over control (Table 1). The lowest (1.06 larvae/plant) population of *S. litura* were recorded in chlorantraniliprole 10 + lambda-cyhalothrin 5 ZC 0.006% treatment which at par with novaluron 5.25 + emamectin benzoate 0.9 SC 0.009% (1.25 larvae/plant), novaluron 5.25 + indoxacarb 4.5 SC 0.016% (1.38 larvae/plant) and chlorpyriphos 50 + cypermethrin 5 EC 0.11% (1.46 larvae/plant). The treatment with thiamethoxam 12.6 + lambda-cyhalothrin 9.5 ZC 0.011%, beta-cyfluthrin 8.49 + imidacloprid 19.81 OD 0.028% and profenophos 40 + cypermethrin 4 0.088% were found comparatively less effective against the pest as they recorded the mean larval population of 1.49, 1.52 and 1.56 larvae/plant, respectively. More or less similar trend was observed after seven and ten days after first spray.

The pooled over second spray results (Table 2) indicated that *S. litura* population significantly reduced across all treatments as compared to the control. The treatment of chlorantraniliprole 10 + lambda-cyhalothrin 5 ZC 0.006% was found most effective which recorded the significantly lowest (0.78 larvae/plant) larval population which was at par with novaluron 5.25 + emamectin benzoate 0.9 SC 0.009% (1.06 larvae/plant) and novaluron 5.25 + indoxacarb 4.5 SC 0.016% (1.18 larvae/plant). The treatment of chlorpyriphos 50 + cypermethrin 5 EC 0.11% and thiamethoxam 12.6 + lambda-cyhalothrin 9.5 ZC 0.011% were moderately effective as they recorded 1.45 and 1.63 larvae/plant, respectively. The highest (1.85) larval population was recorded in the treatment of profenophos 40 + cypermethrin 4 EC 0.088% and it was at par with beta-cyfluthrin 8.49 + imidacloprid 19.81 OD 0.028% (1.75 larvae/plant).

Per cent leaf damage (%)

The per cent leaf damage after three days of first spray (Table 3) indicated that the chlorantraniliprole 10 + lambda-cyhalothrin 5 ZC 0.006% protected plots had minimum (9.26%) damaged soybean leaves and it was at par with novaluron 5.25 + emamectin benzoate 0.9 SC 0.009% (10.20%), novaluron 5.25 + indoxacarb 4.5 SC 0.016% (11.16%) and chlorpyriphos 50 + cypermethrin 5 EC 0.11% (12.38%). The plot treated of thiamethoxam 12.6 + lambda-cyhalothrin 9.5 ZC 0.011% showed 13.04 per cent leaf damage. Among the evaluated insecticides, the highest (13.68%) damage noted in the treatment of profenophos 40 + cypermethrin 4 EC 0.088% followed by beta-cyfluthrin 8.49 + imidacloprid 19.81 OD 0.028% (13.49%). However, these treatments were significantly superior to control (19.28%). Similar trend was observed after 7 and 10 days after first spray.

Pooled over periods data of second spray (Table 4) indicated that the plots treated with the chlorantraniliprole 10 + lambda-cyhalothrin 5 ZC 0.006% observed the lowest (10.07%) leaf damage and it was at par with novaluron 5.25 + emamectin benzoate 0.9 SC 0.009% (11.20%) and novaluron 5.25 + indoxacarb 4.5 SC 0.016% (13.43%). The treatments of chlorpyriphos 50 + cypermethrin 5 EC 0.11% (15.34%) and thiamethoxam 12.6 + lambda-cyhalothrin 9.5 ZC 0.011% (17.40%) were moderately effective. Beta-cyfluthrin 8.49 + imidacloprid 19.81 OD 0.028% and profenophos 40 + cypermethrin 4 EC 0.088% were found comparatively low effective and they recorded 18.86 and 20.16% leaf damage per plant, respectively.

The present findings were conformed with the earlier findings who found that chlorantraniliprole 9.3 + lambda-cyhalothrin 4.6 ZC @ 200 ml/ha provided better protection and registered significantly less larval population of *S. litura* in soybean [6]. Chlorantraniliprole 9.3 + lambda-cyhalothrin 4.6 ZC @ 0.006% found the most effective treatment against *S. litura* in soybean [7].

The results were also confirmed with the finding of [8] who found that novaluron + indoxacarb demonstrated more than 50 per cent mortality of *S. litura*. Similarly, [9] reported that the application of novaluron 5.25 + indoxacarb 4.5 SC @ 875 ml/ha reduced the incidence of *S. litura* in soybean.

YIELD AND ECONOMICS

The seed yield on hectare base, the treatment of chlorantraniliprole 10 + lambda-cyhalothrin 5 ZC 0.006% recorded significantly the highest seed yield (2640 kg/ha) and it was at par with novaluron 5.25 + emamectin benzoate 0.9 SC 0.009% (2346 kg/ha) and novaluron 5.25 + indoxacarb 4.5 SC 0.016% (2268 kg/ha) (Table 5). The highest (37,260 Rs.) net realization was recorded in the treatment of chlorantraniliprole 10 + lambda-cyhalothrin 5 ZC 0.006% followed by novaluron 5.25 + emamectin benzoate 0.9 SC 0.009% (24,030 Rs./ha) and novaluron 5.25 + indoxacarb 4.5 SC 0.016% (20,520 Rs./ha) (Table 5).

CONCLUSION

Among evaluated ready-mixed insecticides against *S. litura* infesting soybean chlorantraniliprole 10 + lambda-cyhalothrin 5 ZC 0.006%, novaluron 5.25 + emamectin benzoate 0.9 SC 0.009% and novaluron 5.25 + indoxacarb 4.5 SC 0.016% were noticed higher effective in protecting the soybean from this pest. The highest (2640 kg/ha) seed yield was recorded in the plot treated with chlorantraniliprole 10 + lambda-cyhalothrin 5 ZC 0.006% and it was at par with novaluron 5.25 + emamectin benzoate 0.9 SC 0.009% (2346 kg/ha) and novaluron 5.25 + indoxacarb 4.5 SC 0.016% (2268 kg/ha). The lowest ICBR was recorded in the treatment of beta-cyfluthrin 8.49 + imidacloprid 19.81 OD 0.028% (1:4.0) followed by novaluron 5.25 + indoxacarb 4.5 SC 0.016% (1:4.1) and profenophos 40 + cypermethrin 4 EC 0.088% (1:4.3).

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Conflict of interest

The authors declared no conflict of interest.

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Table 1: Efficacy of ready-mixed insecticides against *S. litura* in soybean (First spray)

S. No.	Treatment	Concentration (%)	Mean number of larvae per plant				
			Before spray	Days after spraying (DAS)			Pooled over period
				3	7	10	
1.	Thiamethoxam 12.6 + Lambda-cyhalothrin 9.5 ZC	0.009	1.45 (2.09)	1.22 (1.49)	1.09 (1.19)	1.20 (1.46)	1.17 (1.38)
2.	Profenophos 40 + Cypermethrin 4 EC	0.088	1.47 (2.18)	1.25 (1.56)	1.20 (1.44)	1.30 (1.69)	1.25 (1.56)
3.	Novaluron 5.25 + Emamectin benzoate 0.9 SC	0.009	1.35 (1.87)	1.11 (1.25)	0.84 (0.71)	0.96 (0.93)	0.97 (0.96)
4.	Beta-cyfluthrin 8.49 + Imidacloprid 19.81 OD	0.028	1.43 (2.08)	1.23 (1.52)	1.17 (1.38)	1.24 (1.55)	1.21 (1.48)
5.	Chlorpyriphos 50 + Cypermethrin 5 EC	0.11	1.46 (2.14)	1.20 (1.46)	1.01 (1.02)	1.16 (1.36)	1.12 (1.28)
6.	Chlorantraniliprole 10 + Lambda-cyhalothrin 5 ZC	0.006	1.40 (1.98)	1.02 (1.06)	0.76 (0.58)	0.84 (0.71)	0.87 (0.78)
7.	Novaluron 5.25 + Indoxacarb 4.5 SC	0.016	1.40 (1.97)	1.17 (1.38)	0.94 (0.89)	1.04 (1.08)	1.05 (1.12)
8.	Control	-	1.45 (2.15)	1.45 (2.11)	1.45 (2.12)	1.55 (2.41)	1.48 (2.21)
	S. Em. ±	**T**	**0.09**	**0.06**	**0.06**	**0.07**	**0.04**
		P	**-**	**-**	**-**	**-**	**0.02**
		T × P	**-**	**-**	**-**	**-**	**0.07**
	C.D. at 5%	**T**	**NS**	**0.187**	**0.183**	**0.210**	**0.11**
		P	**-**	**-**	**-**	**-**	**0.07**
		T × P	**-**	**-**	**-**	**-**	**NS**
	C.V. (%)	**-**	**11.24**	**9.04**	**10.09**	**10.53**	**9.89**

Figures in parenthesis are original values, while outsides are square root transformed values.
NS: Non-significant

Table 2: Efficacy of ready-mixed insecticides against *S. litura* in soybean (Second spray)

S. No.	Treatment	Concentration (%)	Mean number of larvae per plant				
			Before spray	Days after spraying (DAS)			Pooled over period
				3	7	10	
1.	Thiamethoxam 12.6 + Lambda-cyhalothrin 9.5 ZC	0.009	1.36 (1.86)	1.31 (1.74)	1.27 (1.63)	1.23 (1.52)	1.27 (1.63)
2.	Profenophos 40 + Cypermethrin 4 EC	0.088	1.41 (1.99)	1.38 (1.92)	1.35 (1.86)	1.33 (1.78)	1.36 (1.85)
3.	Novaluron 5.25 + Emamectin benzoate 0.9 SC	0.009	1.08 (1.20)	1.06 (1.13)	1.04 (1.08)	0.99 (0.98)	1.03 (1.06)
4.	Beta-cyfluthrin 8.49 + Imidacloprid 19.81 OD	0.028	1.38 (1.92)	1.37 (1.88)	1.31 (1.74)	1.27 (1.64)	1.32 (1.75)
5.	Chlorpyriphos 50 + Cypermethrin 5 EC	0.11	1.32 (1.74)	1.26 (1.59)	1.18 (1.40)	1.15 (1.35)	1.20 (1.45)
6.	Chlorantraniliprole 10 + Lambda-cyhalothrin 5 ZC	0.006	0.94 (0.90)	0.91 (0.83)	0.87 (0.78)	0.84 (0.71)	0.87 (0.78)
7.	Novaluron 5.25 + Indoxacarb 4.5 SC	0.016	1.15 (1.33)	1.12 (1.26)	1.08 (1.17)	1.05 (1.11)	1.08 (1.18)
8.	Control	-	1.67 (2.79)	1.70 (2.91)	1.72 (2.98)	1.74 (3.06)	1.72 (2.98)
	S. Em. ±	**T**	**0.07**	**0.08**	**0.08**	**0.07**	**0.04**
		P	**-**	**-**	**-**	**-**	**0.03**
		T × P	**-**	**-**	**-**	**-**	**0.07**
	C.D. at 5%	**T**	**0.221**	**0.226**	**0.229**	**0.208**	**0.12**
		P	**-**	**-**	**-**	**-**	**0.08**
		T × P	**-**	**-**	**-**	**-**	**NS**
	C.V. (%)	**-**	**10.00**	**10.42**	**10.89**	**10.08**	**10.47**

Figures in parenthesis are original values, while outsides are square root transformed values.
NS: Non-significant

Table 3: Efficacy of ready-mixed insecticides against *S. litura* and in soybean (First spray)

S. No.	Treatment	Concentration (%)	Per cent leaf damage (%)				
			Before spray	Days after spraying (DAS)			Pooled over period
				3	7	10	
1.	Thiamethoxam 12.6 + Lambda-cyhalothrin 9.5 ZC	0.009	24.97 (17.82)	21.17 (13.04)	20.99 (12.84)	22.54 (14.69)	21.57 (13.52)
2.	Profenophos 40 + Cypermethrin 4 EC	0.088	25.74 (18.86)	21.71 (13.68)	21.88 (13.89)	23.60 (16.03)	22.39 (14.53)
3.	Novaluron 5.25 + Emamectin benzoate 0.9 SC	0.009	22.90 (15.14)	18.63 (10.20)	16.14 (7.73)	17.64 (9.18)	17.47 (9.04)
4.	Beta-cyfluthrin 8.49 + Imidacloprid 19.81 OD	0.028	24.83 (17.64)	21.55 (13.49)	21.48 (13.41)	23.02 (15.29)	22.02 (14.06)
5.	Chlorpyriphos 50 + Cypermethrin 5 EC	0.11	25.42 (18.43)	20.60 (12.38)	18.90 (10.49)	21.09 (12.95)	20.20 (11.94)
6.	Chlorantraniliprole 10 + Lambda-cyhalothrin 5 ZC	0.006	23.98 (16.52)	17.72 (9.26)	14.80 (6.53)	15.79 (7.40)	16.10 (7.73)
7.	Novaluron 5.25 + Indoxacarb 4.5 SC	0.016	25.90 (19.08)	19.52 (11.16)	17.05 (8.59)	19.42 (11.06)	18.66 (10.27)
8.	Control	-	26.23 (19.53)	26.04 (19.28)	26.70 (19.45)	28.24 (22.39)	26.82 (20.37)
	S. Em. ±	**T**	**1.58**	**1.11**	**1.08**	**1.30**	**0.67**
		P	**-**	**-**	**-**	**-**	**0.41**
		T × P	**-**	**-**	**-**	**-**	**1.17**
	C.D. at 5%	**T**	**NS**	**3.299**	**3.207**	**3.870**	**1.93**
		P	**-**	**-**	**-**	**-**	**1.18**
		T × P	**-**	**-**	**-**	**-**	**NS**
	C.V. (%)	**-**	**10.92**	**9.22**	**9.50**	**10.53**	**9.80**

Figures in parenthesis are retransformed values, while outsides are arc sine transformed values.
NS: Non-significant

Table 4: Efficacy of ready-mixed insecticides against *S. litura* and in soybean (Second spray)

S. No.	Treatment	Concentration (%)	Per cent leaf damage (%)				
			Before spray	Days after spraying (DAS)			Pooled over period
				3	7	10	
1.	Thiamethoxam 12.6 + Lambda-cyhalothrin 9.5 ZC	0.009	25.85 (19.01)	25.44 (18.46)	24.38 (17.04)	24.13 (16.72)	24.65 (17.40)
2.	Profenophos 40 + Cypermethrin 4 EC	0.088	27.56 (21.41)	27.05 (20.68)	26.66 (20.13)	26.35 (19.71)	26.68 (20.16)
3.	Novaluron 5.25 + Emamectin benzoate 0.9 SC	0.009	21.12 (12.98)	20.18 (11.91)	19.60 (11.25)	19.03 (10.63)	19.55 (11.20)
4.	Beta-cyfluthrin 8.49 + Imidacloprid 19.81 OD	0.028	27.09 (20.74)	26.38 (19.74)	25.63 (18.72)	25.24 (18.19)	25.74 (18.86)
5.	Chlorpyriphos 50 + Cypermethrin 5 EC	0.11	25.14 (18.04)	23.88 (16.38)	23.80 (16.29)	23.40 (15.77)	23.06 (15.34)
6.	Chlorantraniliprole 10 + Lambda-cyhalothrin 5 ZC	0.006	20.46 (12.21)	19.32 (10.94)	18.19 (9.74)	17.97 (9.52)	18.49 (10.07)
7.	Novaluron 5.25 + Indoxacarb 4.5 SC	0.016	22.80 (15.02)	22.33 (14.44)	21.24 (13.12)	20.86 (12.67)	21.49 (13.43)
8.	Control	-	32.72 (29.21)	34.14 (31.49)	34.57 (32.20)	35.07 (33.02)	30.25 (25.38)
	S. Em. ±	**T**	**1.49**	**1.47**	**1.48**	**1.39**	**0.83**
		P	**-**	**-**	**-**	**-**	**0.51**
		T × P	**-**	**-**	**-**	**-**	**1.44**
	C.D. at 5%	**T**	**4.433**	**4.359**	**4.388**	**4.117**	**2.38**
		P	**-**	**-**	**-**	**-**	**1.29**
		T × P	**-**	**-**	**-**	**-**	**NS**
	C.V. (%)	**-**	**10.20**	**10.23**	**10.55**	**10.00**	**10.26**

Figures in parenthesis are retransformed values, while outsides are arc sine transformed values.
NS: Non-significant

Table 5: Economics of ready-mixed insecticides against *S. litura* on soybean

Treatment	Quantity of insecticide required for two spray (l or kg/ha)	Cost of insecticides for 2 spray (Rs/ha)	Total cost of treatment (Rs/ha)	Yield (kg/ha)	Gross realization (Rs/ha)	Net realization (Rs/ha)	ICBR
T1	0.40	680	1680	2121	95445	13905	1:8.3
T2	2.00	1300	2300	2033	91485	9945	1:4.3
T3	1.50	3000	4000	2346	105570	24030	1:6.0
T4	1.00	2200	3200	2093	94185	12645	1:4.0
T5	2.00	1200	2200	2158	97110	15570	1:7.1
T6	0.40	3240	4240	2640	118800	37260	1:8.8
T7	1.60	4000	5000	2268	102060	20520	1:4.1
T8	-			1812	81540		

Labour charges @ Rs. 500/spray/ha
Market value of soybean @ Rs. 45/kg

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