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COMPARATIVE BIOEFFICACY OF NEWER INSECTICIDES AGAINST MAJOR DEFOLIATING INSECT PESTS OF SOYBEAN (*Glycine max* L. MERR.)

Nilavazhagan L.[1*], Anant G. Lad[1], R.S. Jadhav[2], Y.B. Matre[1], Ashutosh O. Maske[1] and Sri Ram K.[1]

[1]Department of Entomology, Vasantarao Naik Marathawada Krishi Vidyapeeth,Parbhani, Parbhani, Maharashtra, India
[2]AIRCP on Soybean Project, Vasantarao Naik Marathawada Krishi Vidyapeeth,Parbhani, Parbhani, Maharashtra, India
*Corresponding author E-mail: nilavazhagan2314@gmail.com
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ABSTRACT

A field experiment was conducted during *kharif* 2025 at the All India Coordinated Research Project on Soybean, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, to evaluate the bio-efficacy of newer insecticides against major defoliating insect pests of soybean (*Glycine max* (L.) Merr.). Eleven insecticidal treatments along with an untreated control were evaluated using soybean variety MAUS 612. Among the treatments, Broflanilide 300 g/L SC was most effective against the semilooper complex and *Spodoptera litura*, recording 80.76 and 83.67% reduction in pest population. Isocycloseram 9.2% w/w DC and Tetraniliprole 18.18% SC were the next most effective treatments against the semilooper complex and *S. litura*, respectively. All insecticidal treatments recorded lower pest population than the untreated control. The study demonstrated differential efficacy of the evaluated insecticides against the target defoliating pests and highlighted the importance of selecting suitable insecticidal molecules for effective management of soybean defoliators.

***Key words*:** Soybean, Bio-efficacy, Defoliators, Semilooper, *Spodoptera litura.*

Introduction

Soybean (*Glycine max* (L.) Merr.) is an important oilseed and protein-rich crop cultivated extensively for its nutritional, economic and industrial value. The crop is a major source of edible oil and high-quality plant protein and occupies a prominent position among important oilseed crops. However, soybean productivity is constrained by several biotic and abiotic factors, among which insect pests are of considerable economic importance. A diverse complex of insect pests attacks soybean at different stages of crop growth and causes damage to foliage, stems, flowers, pods and seeds, thereby adversely affecting plant growth and yield (Kogan and Turnipseed, 1987; Singh and Singh, 1992).

Among the insect pests infesting soybean, foliage-feeding lepidopteran larvae are particularly important because their feeding reduces the photosynthetically active leaf area of the crop. The semilooper complex and tobacco caterpillar, *Spodoptera litura* (Fabricius), are important defoliating pests of soybean. The larvae feed actively on foliage and, under favourable conditions, may cause extensive defoliation, resulting in substantial loss of functional leaf area and consequently affecting crop growth and productivity. The occurrence and economic importance of foliage-feeding caterpillars in soybean have been documented in earlier studies (Singh and Singh, 1990; Babu *et al.,* 2016; Natikar *et al.,* 2016).

Chemical insecticides play an important role in soybean insect-pest management, but repeated use of similar modes of action may lead to insecticide resistance. Broflanilide, a meta-diamide insecticide with a novel mode of action, has demonstrated activity against lepidopteran larvae (Nakao and Banba, 2016).

Hence, the present investigation evaluated the bio-efficacy of newer insecticides against major defoliating insect pests of soybean (*Glycine max* (L.) Merr.) under

field conditions.

Materials and Methods

A field experiment was conducted during the *kharif* season of 2025 at the experimental farm of the All India Coordinated Research Project on Soybean, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, to evaluate the bio-efficacy of newer insecticides against major defoliating insect pests of soybean, namely the semilooper complex comprising *Gesonia gemma*, *Achaea janata* and *Chrysodeixis acuta*, and the tobacco caterpillar, *Spodoptera litura* (Fabricius). The experimental field had black soil (Vertisol). The experiment was laid out in a randomized block design (RBD) comprising 12 treatments, including 11 insecticidal treatments and an untreated control, with three replications and a plot size of 1.8 × 3.0 m.

The insecticidal treatments comprised Broflanilide 300 g/L SC (52 ml/ha), Flubendiamide 20% WG (250 g/ha), lambda-cyhalothrin 4.9% CS (300 ml/ha), profenofos 50% EC (1,000 ml/ha), chlorantraniliprole 18.5% SC (150 ml/ha), Isocycloseram 9.2% w/w DC (600 ml/ha), Tetraniliprole 18.18% SC (250 ml/ha), emamectin benzoate 1.9% EC (425 ml/ha), spinetoram 11.7% SC (450 ml/ha), thiamethoxam 12.6% + lambda-cyhalothrin 9.5% ZC (125 ml/ha), and acetamiprid 25% + bifenthrin 25% WG (250 g/ha). Soybean variety MAUS 612 was sown on 18 July 2025 at a spacing of 45 × 5 cm, following the recommended agronomic practices.

The first insecticidal spray was applied on 4 September 2025, followed by a second spray on 20 September 2025. The respective insecticides were applied as foliar sprays at their prescribed experimental doses using a battery-operated knapsack sprayer fitted with a hollow-cone nozzle.

The larval populations of the semilooper complex and *S. litura* were recorded separately one day before each spray and at 3, 7, 10 and 14 days after spraying (DAS). Observations were recorded from five randomly selected one-metre row lengths (MRL) in each plot. For interpretation of pest incidence, the commonly reported economic threshold level (ETL) for green semiloopers is approximately 2 larvae/MRL, while that for *S. litura* is commonly reported as 4 larvae/MRL during the flowering stage. For *Chrysodeixis acuta*, stage-specific ETLs of 3 larvae/MRL at flower initiation and 2 larvae/MRL at pod filling have been reported (Singh and Singh, 1991). These thresholds were used as reference values for interpreting pest incidence.

The recorded larval population data were subjected to square-root transformation before statistical analysis. The transformed data were analysed using analysis of variance appropriate for a randomized block design, and treatment means were compared for statistical significance.

Results and Discussion

The results on the bio-efficacy of different insecticidal treatments against the major defoliating insect pests, *viz.*, semilooper complex and tobacco caterpillar, *Spodoptera litura* (Fabricius) of soybean are presented in Tables 1 and 2 and graphically illustrated in Fig. 1 and 2, respectively. The insecticidal treatments showed significant differences in their efficacy against the respective target insect pests. In general, the insecticidal treatments recorded lower pest populations than the untreated control, indicating differential efficacy of the evaluated insecticides under field conditions.

Semilooper Complex

The semilooper population recorded one day before the first spray ranged from 5.78 to 6.44 larvae/MRL, with no significant differences among the treatments, indicating uniform pest pressure before treatment imposition. The data are presented in Table 1 and graphically illustrated in Fig. 1 and 2. At 3 DAS

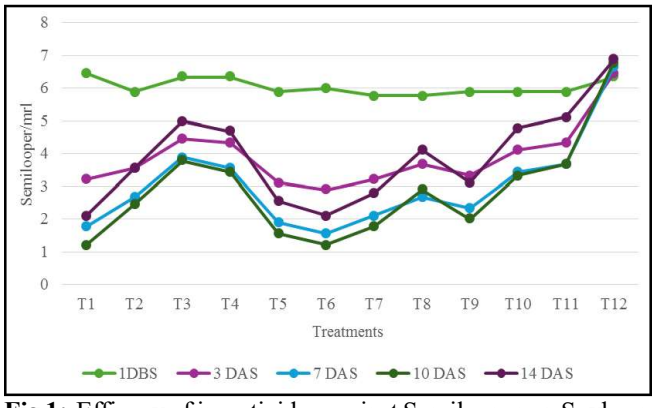


Fig 1: Efficacy of insecticides against Semilooper on Soybean during *Kharif* 2025 (first spray).

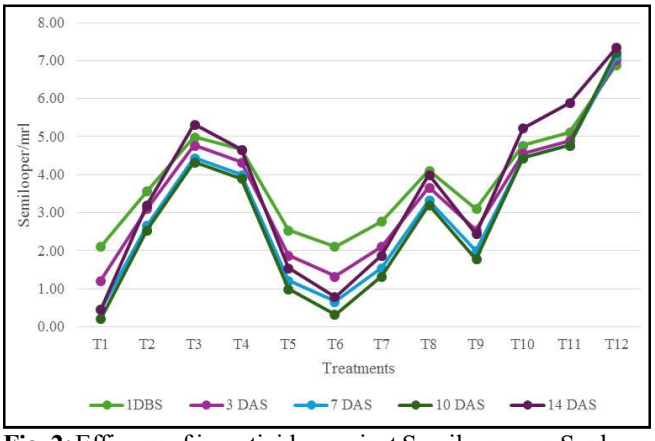


Fig. 2: Efficacy of insecticides against Semilooper on Soybean during *Kharif* 2025 (second spray).

Table 1: Bioefficacy of insecticides against semilooper, (*Gesonia gemma, Chrysodeixis acuta and Achaea janata*) after the first and second spray.

Treatment	Dose/ha	Semilooper (larvae/mrl)									MTS	ROC
		1st Spray					2nd Spray					
		1 DBS	3DAS	7DAS	10DAS	14DAS	3DAS	7DAS	10DAS	14DAS		
T_1	52 ml	6.44 (2.71)	3.22 (2.05)	1.78 (1.66)	1.22 (1.48)	2.11 (1.76)	1.22 (1.48)	0.44 (1.20)	0.22 (1.10)	0.44 (1.20)	1.33	80.76
T_2	250 g	5.89 (2.61)	3.56 (2.12)	2.67 (1.90)	2.44 (1.85)	3.56 (2.13)	3.11 (2.02)	2.67 (1.91)	2.56 (1.87)	3.22 (2.04)	2.97	57.11
T_3	300 ml	6.33 (2.70)	4.44 (2.33)	3.89 (2.21)	3.78 (2.18)	5.00 (2.44)	4.78 (2.40)	4.44 (2.32)	4.33 (2.30)	5.33 (2.51)	4.50	35.07
T_4	1000 ml	6.33 (2.70)	4.33 (2.30)	3.56 (2.13)	3.44 (2.10)	4.67 (2.37)	4.33 (2.30)	4.00 (2.23)	3.89 (2.20)	4.67 (2.36)	4.11	40.68
T_5	150 ml	5.89 (2.62)	3.11 (2.02)	1.89 (1.69)	1.56 (1.59)	2.56 (1.87)	1.89 (1.69)	1.22 (1.48)	1.00 (1.41)	1.56 (1.57)	1.85	73.35
T_6	600 ml	6.00 (2.64)	2.89 (1.95)	1.56 (1.59)	1.22 (1.48)	2.11 (1.76)	1.33 (1.52)	0.67 (1.28)	0.33 (1.15)	0.78 (1.32)	1.36	80.36
T_7	250 ml	5.78 (2.59)	3.22 (2.05)	2.11 (1.75)	1.78 (1.65)	2.78 (1.94)	2.11 (1.75)	1.56 (1.58)	1.33 (1.51)	1.89 (1.67)	2.10	69.74
T_8	425 ml	5.78 (2.59)	3.67 (2.15)	2.67 (1.91)	2.89 (1.96)	4.11 (2.25)	3.67 (2.15)	3.33 (2.07)	3.22 (2.04)	4.00 (2.23)	3.45	50.30
T_9	450 ml	5.89 (2.62)	3.33 (2.07)	2.33 (1.82)	2.00 (1.73)	3.11 (2.02)	2.56 (1.88)	2.00 (1.72)	1.78 (1.65)	2.44 (1.85)	2.44	64.73
T_{10}	125 ml	5.89 (2.62)	4.11 (2.25)	3.44 (2.10)	3.33 (2.07)	4.78 (2.39)	4.56 (2.35)	4.44 (2.32)	4.44 (2.32)	5.22 (2.49)	4.29	38.08
T_{11}	250 g	5.89 (2.62)	4.33 (2.30)	3.67 (2.15)	3.67 (2.15)	5.11 (2.47)	4.89 (2.42)	4.78 (2.40)	4.78 (2.40)	5.89 (2.62)	4.64	33.07
T_{12}	--	6.33 (2.69)	6.44 (2.70)	6.67 (2.73)	6.78 (2.77)	6.89 (2.79)	7.00 (2.81)	7.11 (2.82)	7.22 (2.84)	7.33 (2.87)	6.93	-
S.Em±		--	0.12	0.12	0.10	0.10	0.10	0.11	0.11	0.12	—	—
C.D. at 5%		NS	0.36	0.36	0.30	0.30	0.31	0.33	0.32	0.36	—	—
CV (%)		--	9.81	10.79	9.40	8.11	8.91	10.01	10.02	10.35	—	—

MTS: Mean of two sprays; ROC: Reduction over control (%); T_1: Broflanilide 300 g/l SC; T_2: Flubendiamide 20% WG; T_3: Lambda-cyhalothrin 4.9% CS; T_4: Profenofos 50% EC; T_5: Chlorantraniliprole 18.50% SC; T_6: Isocycloseram 9.2% w/w DC; T_7: Tetraniliprole 18.18% SC; T_8: Emamectin benzoate 1.90% EC; T_9: Spinetoram 11.70% SC; T_{10}: Thiamethoxam 12.60% + Lambda-cyhalothrin 9.50%ZC; T_{11}: Acetamiprid 25% + Bifenthrin 25% WG; T_{12}: Control; *Figures in parentheses are square root transformed values, DBS = Days before spraying, DAS = Days after spraying, NS= Non-significant

Isocycloseram recorded the lowest population (2.89 larvae/MRL), followed by chlorantraniliprole (3.11), Broflanilide and Tetraniliprole (3.22 each), spinetoram (3.33), Flubendiamide (3.56), Emamectin benzoate (3.67), Thiamethoxam + lambda-cyhalothrin (4.11), Profenofos and Acetamiprid + bifenthrin (4.33 each), and Lambda-cyhalothrin (4.44 larvae/MRL). The highest population occurred in the untreated control (6.44 larvae/MRL).

At 7 days after the first spray Isocycloseram 9.2% w/w DC recorded the minimum population (1.56 larvae/MRL), which was statistically at par with Broflanilide 300 g/L SC (1.78 larvae/MRL), Chlorantraniliprole 18.50% SC (1.89 larvae/MRL), Tetraniliprole 18.18% SC (2.11 larvae/MRL), Spinetoram 11.70% SC (2.33 larvae/MRL), Flubendiamide 20% WG (2.67 larvae/MRL) and Emamectin benzoate 1.90% EC (2.67 larvae/MRL).

At 10 days after the first spray, the semilooper population varied from 1.22 to 6.78 larvae/MRL. The minimum population was recorded with Broflanilide 300 g/L SC and Isocycloseram 9.2% w/w DC (1.22 larvae/MRL each), which were statistically at par with Chlorantraniliprole 18.50% SC (1.56 larvae/MRL), Tetraniliprole 18.18% SC (1.78 larvae/MRL) and Spinetoram 11.70% SC (2.00 larvae/MRL).

At 14 days after the first spray, the semilooper minimum population was recorded with Broflanilide 300 g/L SC and Isocycloseram 9.2% w/w DC (2.11 larvae/MRL each), which were statistically at par with Chlorantraniliprole 18.50% SC (2.56 larvae/MRL), Tetraniliprole 18.18% SC (2.78 larvae/MRL) and Spinetoram 11.70% SC (3.11 larvae/MRL).

Following the second spray, Broflanilide recorded the

Table 2: Bioefficacy of insecticides against *Spodoptera litura* after the first and second spray

Treatment	Dose/ha	*Spodoptera* (larvae/mrl)									MTS	ROC
		1st Spray					2nd Spray					
		1 DBS	3DAS	7DAS	10DAS	14DAS	3DAS	7DAS	10DAS	14DAS		
T_1	52 ml	1.89 (1.69)	1.00 (1.41)	0.56 (1.24)	0.22 (1.10)	0.78 (1.33)	0.44 (1.20)	0.22 (1.10)	0.11 (1.05)	0.22 (1.05)	0.44	83.67
T_2	250 g	1.56 (1.59)	1.11 (1.44)	1.00 (1.41)	0.89 (1.37)	1.78 (1.64)	1.67 (1.63)	1.56 (1.54)	1.67 (1.60)	2.11 (1.60)	1.47	45.92
T_3	300 ml	1.44 (1.56)	1.11 (1.45)	1.11 (1.43)	1.00 (1.41)	2.11 (1.76)	2.00 (1.73)	1.89 (1.69)	2.11 (1.76)	2.67 (1.76)	1.75	35.71
T_4	1000 ml	1.56 (1.59)	1.00 (1.41)	1.00 (1.40)	0.89 (1.37)	1.89 (1.69)	1.78 (1.66)	1.67 (1.63)	1.89 (1.69)	2.33 (1.69)	1.56	42.86
T_5	150 ml	1.44 (1.56)	0.89 (1.37)	0.67 (1.28)	0.44 (1.18)	1.33 (1.52)	1.11 (1.44)	1.00 (1.41)	0.89 (1.36)	1.67 (1.36)	0.99	63.78
T_6	600 ml	1.56 (1.59)	0.78 (1.33)	0.44 (1.20)	0.22 (1.10)	0.89 (1.37)	0.67 (1.28)	0.44 (1.20)	0.33 (1.14)	0.56 (1.14)	0.54	80.10
T_7	250 ml	1.78 (1.66)	0.89 (1.37)	0.56 (1.24)	0.22 (1.10)	0.89 (1.37)	0.56 (1.24)	0.33 (1.14)	0.22 (1.10)	0.44 (1.10)	0.51	81.12
T_8	425 ml	1.44 (1.56)	0.89 (1.36)	0.67 (1.26)	0.44 (1.18)	1.33 (1.52)	1.11 (1.44)	1.00 (1.40)	1.11 (1.44)	1.56 (1.44)	1.01	62.76
T_9	450 ml	1.67 (1.63)	1.00 (1.41)	0.78 (1.33)	0.56 (1.24)	1.33 (1.52)	1.11 (1.45)	1.00 (1.41)	0.89 (1.37)	1.00 (1.37)	0.96	64.80
T_{10}	125 ml	1.67 (1.62)	1.44 (1.58)	1.44 (1.54)	1.33 (1.51)	2.56 (1.88)	2.56 (1.88)	2.44 (1.85)	2.78 (1.94)	3.44 (1.94)	2.25	16.84
T_{11}	250 g	1.78 (1.65)	1.56 (1.59)	1.56 (1.59)	1.44 (1.56)	2.56 (1.86)	2.44 (1.85)	2.44 (1.83)	2.78 (1.93)	3.33 (1.93)	2.24	17.86
T_{12}	--	1.78 (1.66)	2.00 (1.73)	2.22 (1.77)	2.44 (1.83)	2.67 (1.88)	2.78 (1.91)	2.89 (1.96)	3.22 (2.04)	3.11 (2.04)	2.72	-
S.Em±		—	0.07	0.11	0.09	0.11	0.09	0.10	0.10	0.10	—	—
C.D. at 5%		NS	0.23	0.32	0.26	0.33	0.28	0.32	0.29	0.29	—	—
CV (%)		—	9.34	13.77	11.79	12.18	10.76	12.40	11.41	11.42	—	—

MTS: Mean of two sprays; ROC: Reduction over control (%); T_1: Broflanilide 300 g/l SC; T_2: Flubendiamide 20% WG; T_3: Lambda-cyhalothrin 4.9% CS; T_4: Profenofos 50% EC; T_5: Chlorantraniliprole 18.50% SC; T_6: Isocycloseram 9.2% w/w DC; T_7: Tetraniliprole 18.18% SC; T_8: Emamectin benzoate 1.90% EC; T_9: Spinetoram 11.70% SC; T_{10}: Thiamethoxam 12.60% + Lambda-cyhalothrin 9.50%ZC; T_{11}: Acetamiprid 25% + Bifenthrin 25% WG; T_{12}: Control; *Figures in parentheses are square root transformed values, DBS = Days before spraying, DAS = Days after spraying, NS= Non-significant

lowest semilooper population at 3 DAS (1.22 larvae/MRL), and was statistically at par with Isocycloseram (1.33), Chlorantraniliprole (1.89) and Tetraniliprole (2.11 larvae/MRL). At 7 DAS, the lowest population was recorded with Broflanilide (0.44 larvae/MRL), which was statistically at par with Isocycloseram (0.67) and Chlorantraniliprole (1.22 larvae/MRL). At 10 DAS, Broflanilide (0.22 larvae/MRL) remained statistically at par with Isocycloseram (0.33), and Chlorantraniliprole 18.50% SC (1.00 larvae/MRL). At 14 DAS, Broflanilide (0.44 larvae/MRL) recorded the lowest population and was statistically at par only with Isocycloseram (0.78 larvae/MRL).

Based on the mean population over two sprays, Broflanilide recorded the lowest semilooper population (1.33 larvae/MRL), followed by Isocycloseram (1.36) and Chlorantraniliprole (1.85 larvae/MRL), compared with 6.93 larvae/MRL in the untreated control. The corresponding reduction over the untreated control was 80.76%, 80.36% and 73.35% with Broflanilide, Isocycloseram and Chlorantraniliprole, respectively.

Similar findings were reported by Nakao and Banba (2016), who reported that Broflanilide exhibits high larvicidal activity against *Spodoptera litura* through its novel GABA receptor-targeting mode of action, supporting its strong activity against lepidopteran larvae.

Tobacco caterpillar

The pre-treatment population of *S. litura* did not differ significantly among the treatments, indicating uniform pest incidence before the application of insecticides, as presented in Table 3 and graphically illustrated in Fig. 3 and 4 At 3 DAS after the first spray, Isocycloseram recorded the lowest population (0.78 larvae/MRL), which was statistically at par with Chlorantraniliprole, Tetraniliprole and emamectin benzoate (0.89 larvae/MRL

Table 3: Incremental Cost-Benefit Ratio (ICBR) of Various Insecticidal Treatments against major insect pests of soybean.

T. No.	Entry	Dose/ha	SY	IYOC	AIIY	CISC	Net Return	ICBR	Rank
1	Broflanilide 300 G/L SC	52 ml	2570	1013	57839	8900	48938.65	6.50	4
2	Flubendiamide 20% WG	250 g	2203	646	36884	5404	31479.73	6.82	2
3	Lambda-Cyhalothrin 4.90% CS	300 ml	1730	173	9876	2420	7456.50	4.10	8
4	Profenofos 50% EC	1000 ml	1819	262	14943	3300	11642.69	4.53	7
5	Chlorantraniliprole 18.50% SC	150 ml	2311	754	48038	6700	36338.32	6.42	5
6	Isocycloseram 9.2% w/w DC	600 ml	2246	689	39314	12700	26613.79	3.10	10
7	Tetraniliprole 18.18% SC	250 ml	2315	758	43258	6900	36358.25	6.27	6
8	Emamectin benzoate 1.90% EC	425 ml	1710	153	8756	3738	5017.56	2.34	11
9	Spinetoram 11.70% SC	450 ml	2091	534	30474	8400	22073.98	3.63	9
10	Thiamethoxam 12.60% + Lambda-cyhalothrin 9.50% ZC	125 ml	1985	428	24452	2900	21551.65	8.42	1
11	Acetamiprid 25% + Bifenthrin 25% WG	250 g	1991	434	24769	3750	21018.61	6.61	3
12	Control	-	1557	-	-	-	-	-	-

*Labour charges for two sprays (Rs./ha = Rs 1,200)*Avg Market price = Rs. 57.09/kg; SY: Seed yield (kg/ha); IYOC: Increase in yield over control (kg); AIIY: Additional income due to increase in yield (Rs.); CISC: Cost of insecticides including spraying charges (Rs.)

each), Broflanilide, Profenofos and Spinetoram (1.00 larvae/MRL each), and Flubendiamide and Lambda-cyhalothrin (1.11 larvae/MRL each).

At 7 days after the first spray, the lowest population of *Spodoptera litura* was recorded with Isocycloseram 9.2% w/w DC (0.44 larvae/MRL), which was statistically at par with Broflanilide 300 g/L SC and Tetraniliprole 18.18% SC (0.56 larvae/MRL each), Chlorantraniliprole 18.50% SC and Emamectin benzoate 1.90% EC (0.67 larvae/MRL each), Spinetoram 11.70% SC (0.78 larvae/MRL), Flubendiamide 20% WG and Profenofos 50% EC (1.00 larvae/MRL each) and Lambda-cyhalothrin 4.9% CS (1.11 larvae/MRL).

At 10 days after the first spray, the lowest population was recorded with Broflanilide 300 g/L SC, Isocycloseram 9.2% w/w DC and Tetraniliprole 18.18% SC (0.22 larvae/MRL each), which were statistically at par with Chlorantraniliprole 18.50% SC and Emamectin benzoate 1.90% EC (0.44 larvae/MRL each) and Spinetoram 11.70% SC (0.56 larvae/MRL).

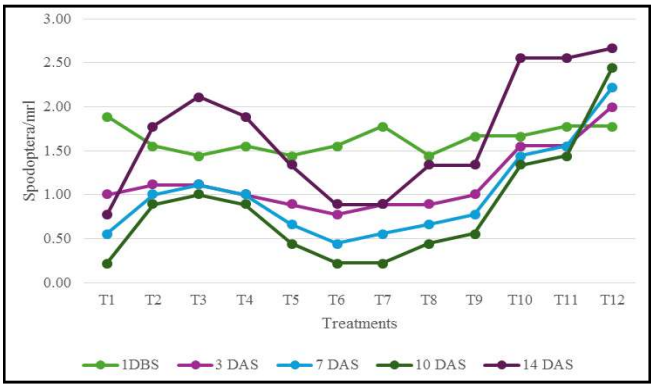


Fig. 3: Efficacy of insecticides against *S. litura* on Soybean during *Kharif* 2025 (first spray).

At 14 days after the first spray, the lowest population was recorded with Broflanilide 300 g/L SC (0.78 larvae/MRL), which was statistically at par with Isocycloseram 9.2% w/w DC and Tetraniliprole 18.18% SC (0.89 larvae/MRL each), Chlorantraniliprole 18.50% SC, Emamectin benzoate 1.90% EC and Spinetoram 11.70% SC (1.33 larvae/MRL each), and Flubendiamide 20% WG (1.78 larvae/MRL).

Following the second spray, Broflanilide recorded the lowest population at 3 DAS (0.44 larvae/MRL) and was statistically at par with Tetraniliprole 18.18% SC (0.56 larvae/MRL) and Isocycloseram 9.2% w/w DC (0.67 larvae/MRL). At 7 days after the lowest population was recorded with Broflanilide 300 g/L SC (0.22 larvae/MRL), which was statistically at par with Tetraniliprole 18.18% SC (0.33 larvae/MRL), Isocycloseram 9.2% w/w DC (0.44 larvae/MRL), Chlorantraniliprole 18.50% SC, Emamectin benzoate 1.90% EC and Spinetoram 11.70% SC (1.00 larvae/MRL each). At 10 DAS, Broflanilide recorded the lowest population (0.11 larvae/MRL) and which was statistically at par with Tetraniliprole 18.18%

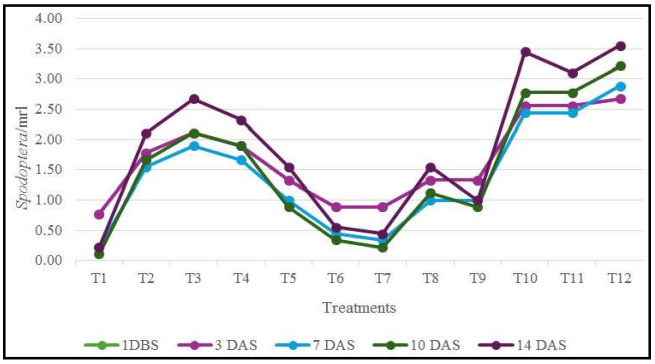


Fig. 4: Efficacy of insecticides against *S. litura* on Soybean during *Kharif* 2025 (second spray).

SC (0.22 larvae/MRL) and Isocycloseram 9.2% w/w DC (0.33 larvae/MRL). At 14 DAS, Broflanilide (0.22 larvae/MRL), which was statistically at par with Tetraniliprole 18.18% SC (0.44 larvae/MRL) and Isocycloseram 9.2% w/w DC (0.56 larvae/MRL).

Based on the mean population over two sprays, Broflanilide recorded the lowest population (0.44 larvae/MRL), followed by Tetraniliprole (0.51) and Isocycloseram (0.54 larvae/MRL), compared with 2.72 larvae/MRL in the untreated control. The highest reduction over the untreated control was recorded with Broflanilide (83.67%), followed by Tetraniliprole (81.12%) and Isocycloseram (80.10%).

Similar findings were reported by Nakao and Banba (2016), who observed that Broflanilide exhibited high larvicidal activity against *Spodoptera litura* through its novel GABA receptor-targeting mode of action. Liu *et al.*, (2023) also reported that Broflanilide showed the highest toxicity among 11 insecticides evaluated against *Spodoptera litura*, including Tetraniliprole, Spinetoram, Chlorantraniliprole and Flubendiamide, further supporting the strong efficacy of Broflanilide against *S. litura*.

Effect of insecticidal treatments on seed yield of soybean

Seed yield of soybean varied considerably among the insecticidal treatments. Broflanilide 300 g/L SC recorded the highest seed yield (2,570 kg/ha), followed by Tetraniliprole 18.18% SC (2,315 kg/ha), Chlorantraniliprole 18.50% SC (2,311 kg/ha) and Isocycloseram 9.2% w/w DC (2,246 kg/ha), whereas the untreated control recorded the lowest seed yield (1,557 kg/ha). The higher seed yield obtained under effective insecticidal treatments may be associated with better suppression of major insect pests, thereby reducing pest damage and supporting better crop performance.

Incremental Cost-Benefit Ratio (ICBR)

The incremental cost-benefit ratio (ICBR) varied among the insecticidal treatments depending on the additional seed yield obtained over the untreated control and the cost of insecticidal application presented in Table 4. Thiamethoxam 12.60% + Lambda-cyhalothrin 9.50% ZC recorded the highest ICBR (1:8.42), followed by Flubendiamide 20% WG (1:6.82) and Acetamiprid 25% + Bifenthrin 25% WG (1:6.61). Broflanilide 300 g/L SC and Chlorantraniliprole 18.50% SC recorded ICBRs of 1:6.50 and 1:6.42, respectively. The remaining treatments recorded ICBRs ranging from 1:2.34 to 1:6.27. Thus, Thiamethoxam 12.60% + Lambda-cyhalothrin 9.50% ZC was the most economically efficient treatment under the prevailing experimental conditions.

Conclusion

The present study demonstrated differential efficacy of newer insecticides against major defoliating insect pests of soybean. Broflanilide 300 g/L SC was the most effective treatment against the semilooper complex, recording 80.76% reduction, while it also provided the highest suppression of *S. litura* (83.67% reduction). Broflanilide also recorded the highest seed yield (2,570 kg/ha) compared with 1,557 kg/ha in the untreated control.

From an economic perspective, Thiamethoxam 12.60% + Lambda-cyhalothrin 9.50% ZC recorded the highest ICBR (1:8.42), followed by Flubendiamide 20% WG (1:6.82) and Acetamiprid 25% + Bifenthrin 25% WG (1:6.61). Overall, Broflanilide 300 g/L SC can be considered a promising option for managing soybean defoliators, owing to its high efficacy against both the semilooper complex and *S. litura*. However, Thiamethoxam 12.60% + lambda-cyhalothrin 9.50% recorded the highest ICBR and was the most economically efficient treatment under the prevailing experimental conditions.

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