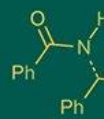


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Bio-efficacy of different insecticides against girdle beetle (*Obereopsis brevis* Swedenbord) in soybean crop

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Abstract

Soybean (*Glycine max* L. Merrill) is an economically important oilseed and protein-rich legume crop; however, its productivity is substantially constrained by insect pests, among which the girdle beetle, *Obereopsis brevis*, is one of the most destructive pests in soybean-growing regions of India. The present investigation was conducted during the *Kharif* seasons of 2024 and 2025 at the Research Farm, School of Agriculture Science, Bhopal, Madhya Pradesh, to evaluate the bio-efficacy and economic potential of different insecticides against soybean girdle beetle. Seven treatments comprising thiamethoxam 25% WG, imidacloprid 17.8% SL, fipronil 5% SC, lambda-cyhalothrin 5% EC, cartap hydrochloride 50% SP, chlorantraniliprole 18.5% SC, and an untreated control were evaluated under field conditions. The efficacy of the treatments was assessed based on girdle beetle infestation before spraying and at 1, 3, 7, and 10 days after each spray. Grain yield and incremental cost-benefit ratio (ICBR) were also determined to assess the economic feasibility of the treatments. The results revealed significant differences among the insecticides in suppressing *O. brevis* infestation during both years. Chlorantraniliprole 18.5% SC consistently exhibited the highest efficacy, recording the lowest pest population throughout the observation period. During 2024, chlorantraniliprole reduced the pest population by 61.47% at 7 days after the first spray and by 86.68% and 86.94% at 7 and 10 days after the second spray, respectively, over the untreated control. Fipronil 5% SC was the next most effective treatment, followed by cartap hydrochloride 50% SP. A similar trend was observed during 2025, with chlorantraniliprole recording the lowest pest population at 7 days after the first spray and maintaining superior suppression after the second spray. The untreated control consistently recorded the highest pest population and progressive pest resurgence. The superior performance of chlorantraniliprole was attributed to its rapid action and prolonged residual activity against the girdle beetle. Overall, chlorantraniliprole 18.5% SC emerged as the most promising treatment for effective management of *O. brevis* in soybean, followed by fipronil 5% SC and cartap hydrochloride 50% SP. The findings indicate that timely application of effective insecticides can substantially reduce girdle beetle infestation and contribute to improved soybean productivity and economic returns.

Keywords: Soybean, girdle beetle, *Obereopsis brevis*, insecticides, chlorantraniliprole

Introduction

Soybean (*Glycine max* L. Merrill), belonging to the family Fabaceae, is one of the world's most important grain legumes and a major source of edible oil and high-quality plant protein. Often referred to as the "golden bean" or "miracle crop," it plays a vital role in global food, nutritional, and economic security. In India, soybean has become a leading oilseed crop due to its high nutritional value, adaptability, and profitability. During the 2024-2025 crop year, soybean was cultivated on approximately 126.90 lakh hectares, reflecting increasing farmer preference supported by improved varieties, favorable market prices, and government initiatives promoting oilseed production. Madhya Pradesh, known as the "Soybean Bowl of India," contributed the largest share with 53.48 lakh hectares, followed by Maharashtra (51.36 lakh hectares) and Rajasthan (11.25 lakh hectares) (Anonymous 2025) ^[1]. Despite its economic importance, soybean production is severely constrained by numerous insect pests. Around 130 insect pest species have been reported on soybean in Madhya Pradesh alone (Singh and Verma, 1988) ^[8] among the major pests are stem fly (*Melanagromyza sojae*), girdle beetle (*Obereopsis brevis*), green semilooper (*Chrysodeixis acuta*), tobacco caterpillar (*Spodoptera litura*), Bihar hairy caterpillar (*Spilosoma obliqua*), whitefly (*Bemisia tabaci*), jassid (*Apheliona maculosa*), and blue beetle (*Cneorane* spp.). These pests collectively cause significant quantitative and qualitative yield losses, with their incidence varying across different agro-climatic regions.

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Among them, the girdle beetle (*Obereopsis brevis*) has emerged as one of the most destructive pests of soybean. First reported in Madhya Pradesh in 1969 with about 13.5% plant infestation, its severity has increased considerably over the years, causing up to 80% plant damage in highly affected areas. Other pests also contribute substantially to crop losses; the green semilooper damages nearly 35% of flowers and 24% of pods, while the stem fly may cause up to 40% yield loss during winter and over 90% plant infestation under rainy-season conditions. Similarly, *Spodoptera litura* causes extensive defoliation during the kharif season, particularly from mid-August to October (Singh and Singh, 1987)^[7] & (Ramesh Babu, 2010)^[9]. The damaging stage of the girdle beetle is the larva, which bores into the stem and branches, disrupting the plant's vascular system and restricting the movement of water and nutrients. This internal feeding results in stunted growth, wilting, branch drying, lodging, and even complete plant death under severe infestation. Adult females girdle the petioles and sometimes the main stem by making characteristic ring-like cuts, which weaken the plant and facilitate larval entry. The pest is particularly destructive during the 30-55 days after sowing, when soybean plants are in their active vegetative growth stage. Infestation during this critical period has a direct and significant impact on crop growth and final yield. Owing to its increasing incidence, destructive feeding habit, and potential to cause severe economic losses, the girdle beetle has become a major biotic constraint in soybean cultivation. Therefore, the development and adoption of effective, timely, and sustainable management strategies are essential to minimize crop losses and ensure stable soybean productivity.

Materials and Methods

The present experiment was conducted at the Research Farm of the School of Agriculture Science, Bhopal, Madhya Pradesh, during the *Kharif* seasons of 2024 and 2025. The experimental site is situated at 23.26° N latitude and 77.41° E longitude, at an elevation of approximately 500 m above mean sea level. The location provided suitable agro-climatic conditions for conducting the experiment on soybean under field conditions. The experimental activities were carried out during two consecutive *Kharif* seasons to evaluate the crop response under prevailing environmental conditions and to generate reliable and comparative observations. The climate of Bhopal is generally characterized by warm and dry conditions, except during the south-west monsoon season. The region experiences four distinct seasons throughout the year. The average annual rainfall is approximately 1104 mm, with about 91.4% of the total

annual precipitation being received during the south-west monsoon period. The concentration of rainfall during the monsoon season significantly influences agricultural activities in the region, particularly the sowing and establishment of *Kharif* crops. The climatic conditions prevailing during the experimental period were therefore considered important for the growth and development of soybean and the occurrence and activity of associated insect pests. The soil of the experimental field is predominantly black cotton soil, which covers approximately three-fourths of the area. The region also comprises red and yellow mixed soils, which are mainly derived from sandstone and shale. The geological characteristics of the area are predominantly associated with Deccan basaltic formations. Alluvial soils are also present along the river courses and generally provide adequate drainage. The soil at the experimental site was characterized by a medium level of organic matter and a normal pH range, providing suitable conditions for soybean cultivation and experimental studies. Prior to sowing, the experimental field was thoroughly prepared to obtain a suitable seedbed for uniform crop establishment. The field was ploughed with the help of a tractor on 13 June 2024 and 18 June 2025. Following ploughing, crop stubbles and other unwanted plant residues were removed from the field. The experimental layout was subsequently prepared on 25 June 2024 and 29 June 2025, respectively. Drainage channels were also constructed at the time of sowing to facilitate the removal of excess water and prevent waterlogging, particularly during periods of heavy monsoon rainfall. Fertilizers were applied as a basal dose at the time of sowing to provide adequate nutrients for crop establishment and growth. The recommended fertilizer dose consisted of 30 kg nitrogen (N), 60 kg phosphorus (P₂O₅), and 40 kg potassium (K₂O) per hectare. Urea, diammonium phosphate (DAP), and muriate of potash (MOP) were used as sources of nitrogen, phosphorus, and potassium, respectively. Soybean seeds were sown at a seed rate of 75 kg ha⁻¹. The crop was established in rows spaced 45 cm apart. The rows were marked manually using ropes, and the seeds were dibbled by hand to ensure proper placement and uniform crop establishment. Sowing was carried out on 1 July 2024 and 3 July 2025 during the respective *Kharif* seasons. To maintain a uniform plant population of approximately 4.5 lakh plants ha⁻¹, necessary gap filling and thinning operations were performed. At 15 days after sowing, excess plants were removed, maintaining an approximate spacing of 5 cm between individual plants. These agronomic practices ensured uniform crop establishment and facilitated the effective conduct of observations and experimental assessments throughout the crop-growing period.

Table 1: Details of treatments

Sr. No.	Treatment	Dose (g or ml/litre of water)	Availability
T ₁	Thiamethoxam 25% WG	0.3	Areva, Dhanuka
T ₂	Imidacloprid 17.8% SL	2.5	Adama Cohigan
T ₃	Fipronil 5% SC	2.0	Fax SC, Dhanuka
T ₄	Lambda cyhalothrin 5% EC	0.5	Lambrada, Hifield
T ₅	Cartap Hydrochloride 50% SP	2.0	Caldan 50 SP, Dhanuka
T ₆	Chlorantraniliprole 18.5% SC	0.4	Cover, Dhanuka
T ₇	Control	-	-

Estimation of Bio-efficacy of insecticides against Soybean girdle beetle

The percent damage of stem girdler was estimated by counting the number of girdled plants damaged by the beetle and total number of plants in a meter row length. Three such meter row length spots were randomly selected per plot was recorded 24 hours before spray and after 1,3,7 and 10 days of each spray.

$$\text{Percent damage (\%)} = \frac{\text{Number of infested plant}}{\text{Total number of plant}} \times 100$$

Grain Yield and Economic Evaluation of Insecticide Treatments

Grain yield was recorded by harvesting each experimental plot separately, followed by weighing the grains obtained from each plot and expressing the yield in kilograms per plot. The grain yield was subsequently converted into quintals per hectare (q ha^{-1}) based on the respective plot area. To assess the economic feasibility of the tested insecticides for the management of stem girdler in soybean, the Incremental Cost-Benefit Ratio (ICBR) was calculated. The economic returns obtained from each insecticide treatment were compared with those of the untreated control. The cost of treatment included the expenditure incurred on insecticides and labour charges, while the economic returns were determined based on the additional yield and corresponding returns obtained over the control. The ICBR was used to identify the most economically viable and feasible insecticide treatment for effective management of stem girdler in soybean.

Results and Discussion

During kharif 2024, the bio-efficacy of different insecticides against girdle beetle (*Obereopsis brevis*) in soybean revealed clear differences in immediate and residual control following first and second sprays. Before the first spray, pest population was uniform across treatments, ranging from 10.74 (Fipronil 5% SC) to 11.81 (Lambda-cyhalothrin 5% EC), confirming equal initial infestation. At 1 day after first spray (DAS), the lowest population was recorded in Chlorantraniliprole 18.5% SC (7.54%) with 39.91% reduction over control, followed by Fipronil (8.35%; 33.52%) and Cartap hydrochloride (8.77%; 30.18%), while control increased to 12.56%. At 3 DAS, Chlorantraniliprole remained superior (7.26%; 49.60% reduction), followed by Fipronil (7.88%; 45.30%) and Cartap (8.14%; 43.49%), whereas control rose to 14.40%. Peak effectiveness during the first spray was observed at 7 DAS, where Chlorantraniliprole recorded the lowest population (6.12%) with 61.47% reduction, followed by Fipronil (7.09%; 55.39%) and Cartap (7.57%; 52.39%), compared to 15.93% in control. At 10 DAS, slight resurgence occurred, yet Chlorantraniliprole maintained superiority (7.46%; 57.80%), followed by Fipronil (8.78; 50.31%), while control reached 17.67. Before the second spray, pest resurgence was evident, with control population increasing to 23.68, while Chlorantraniliprole still maintained the lowest population (9.24; 60.98% lower than control). At 1 DAS of second spray, Chlorantraniliprole again recorded the minimum population (6.91) with 72.38% reduction, followed by Fipronil (9.10; 63.63%) and Cartap (10.40; 58.23%), whereas control increased to 25.02. At 3 DAS, further decline was noted with Chlorantraniliprole (5.53; 79.28%),

Fipronil (9.10; 65.90%), and Cartap (9.78; 63.34%), while control rose to 26.68. Maximum suppression during the second spray occurred at 7 DAS, where Chlorantraniliprole recorded only 3.82 population with 86.68% reduction, followed by Fipronil (5.41; 81.13%) and Cartap (6.12; 78.68%), in contrast to 28.67 in control. Even at 10 DAS, Chlorantraniliprole sustained highest efficacy (4.48; 86.94%), followed by Fipronil (6.41; 81.33%), while control peaked at 34.33.

During kharif 2025, the bio-efficacy evaluation of different insecticides against girdle beetle (*Obereopsis brevis*) in soybean demonstrated clear differences in immediate knockdown effect and residual persistence after both sprays. Before the first spray, pest population was uniform, ranging from 11.97 to 12.33, with control at 12.09, indicating homogeneous infestation. At 1 DAS, Chlorantraniliprole 18.5% SC showed the fastest action with the lowest population (9.48), followed by Fipronil 5% SC (9.75) and Cartap hydrochloride (10.12), while control increased to 13.22. At 3 DAS, Chlorantraniliprole further reduced the population to 7.68, followed by Fipronil (8.32) and Cartap (8.89), whereas control rose to 14.40. Peak effectiveness was recorded at 7 DAS, where Chlorantraniliprole showed minimum population (5.79), followed by Fipronil (7.38) and Cartap (7.90), compared to 17.23 in control. At 10 DAS, slight resurgence occurred, but Chlorantraniliprole (7.45) and Fipronil (8.89) remained superior, while control reached 20.11. Before the second spray, infestation was considerably higher in control (22.36) compared to treated plots, with Chlorantraniliprole again recording the lowest population (8.96). At 1 DAS of second spray, Chlorantraniliprole maintained superiority (7.70), followed by Fipronil (8.23) and Cartap (9.07), whereas control rose to 25.47. Continued suppression was observed at 3 DAS, with Chlorantraniliprole (6.57) and Fipronil (7.52) performing best, while control increased to 26.91. Maximum suppression was achieved at 7 DAS, where Chlorantraniliprole recorded only 3.93, followed by Fipronil (5.07) and Cartap (6.57), in contrast to 28.65 in control. Even at 10 DAS, Chlorantraniliprole (4.59) and Fipronil (6.00) sustained lowest pest levels, while control peaked at 33.34. The present investigation demonstrating the superior effectiveness, persistence, and residual toxicity of selected insecticides against the girdle beetle is in strong conformity with earlier research on soybean stem girdler management. The prolonged suppression of *Obereopsis brevis* observed in the most efficacious treatments substantiates the findings of Bhamare *et al.* (2020) ^[2], who reported that newer generation insecticidal molecules maintained significantly lower infestation levels for extended periods compared with conventional compounds and ensured protection even during later crop stages. A similar trend in comparative performance among chemical groups also corroborates the observations of Bokan *et al.* (2021) ^[3], wherein certain insecticides exhibited rapid knock-down action followed by sustained residual control, while gradual pest resurgence occurred as residues declined — a phenomenon likewise evident in the present study. Furthermore, the marked reduction in infestation shortly after spraying supports the conclusions of Raju *et al.* (2013) ^[4], who emphasized that timely application during the active larval phase considerably enhances management efficiency against soybean stem borers and defoliators. In addition, the consistently lower pest incidence in treated plots relative to

the untreated control agrees with the results of Patil and Phad (2014) [5], who demonstrated that promising insecticides effectively minimized damage from stem fly and girdle beetle and thereby reduced potential yield losses.

Collectively, these concordant findings reinforce that judicious and timely application of effective insecticides constitutes a crucial component of reliable girdle beetle management in soybean.

Table 2: Bio efficacy of different insecticides against girdle beetle (*Obereopsis brevis*) in soybean during *kharif*, 2025

Treatments	First Spray									Second Spray									
	1 DBS	1 DAS	Percent reduction over control	3 DAS	Percent reduction over control	7 DAS	Percent reduction over control	10 DAS	Percent reduction over control	1 DBS	Percent reduction over control	1 DAS	Percent reduction over control	3 DAS	Percent reduction over control	7 DAS	Percent reduction over control	10 DAS	Percent reduction over control
Thiamethoxam 25% WG	11.72	10.35	17.60	9.75	32.31	8.78	44.78	13.56	23.29	16.55	30.10	14.95	40.22	10.42	56.00	9.95	67.55	11.95	65.19
Imidacloprid 17.8% SL	11.69	9.95	20.76	9.34	35.16	8.63	45.72	12.64	28.46	15.51	34.52	13.72	45.14	9.883	59.07	9.54	68.90	11.21	67.37
Lambda cyhalothrin 5% EC	11.81	9.54	24.02	9.243	35.83	8.03	49.50	11.36	35.72	13.91	41.26	11.61	53.59	8.113	61.84	7.94	74.10	9.28	72.99
Fipronil 5% SC	10.74	8.35	33.52	7.88	45.30	7.09	55.39	8.78	50.31	10.03	57.64	9.1	63.63	7.52	68.28	5.41	82.36	6.41	81.33
Cartap Hydrochloride 50% SP	11.08	8.77	30.18	8.14	43.49	7.57	52.39	9.94	43.73	12.78	46.03	10.4	58.23	7.65	65.90	6.11	80.07	7.45	78.31
Chlorantraniliprole 18.5% SC	11.42	7.54	39.91	7.26	49.60	6.12	61.47	7.46	57.80	9.24	60.98	6.91	72.38	6.56	80.72	3.82	87.55	4.48	86.94
Control	10.86	12.56	0.00	14.40	0.00	15.93	0.0	17.67	0	23.68	0.00	25.02	0.00	26.91	0.00	28.68	0.00	34.35	0.00
C. D.	N/A	1.44		2.09		2.85		2.71		1.98		2.59		2.54		2.19		2.16	
SE (m)	0.31	0.46		0.67		0.91		0.87		0.63		0.83		0.81		0.70		0.69	

DBS-Day before spray, DAS-Day after spray

Table 3: Bio efficacy of different insecticides against girdle beetle (*Obereopsis brevis*) in soybean during *kharif*, 2025

Treatments	First Spray									Second Spray									
	1 DBS	1 DAS	Percent reduction over control	3 DAS	Percent reduction over control	7 DAS	Percent reduction over control	10 DAS	Percent reduction over control	1 DBS	Percent reduction over control	1 DAS	Percent reduction over control	3 DAS	Percent reduction over control	7 DAS	Percent reduction over control	10 DAS	Percent reduction over control
Thiamethoxam 25% WG	12.33	11.01	16.73	10.57	26.55	9.98	42.07	13.05	35.10	14.73	34.12	12.73	50.02	10.427	61.25	9.297	67.55	10.22	69.35
Imidacloprid 17.8% SL	12.16	10.41	21.29	10.19	29.22	9.55	44.56	11.99	40.39	12.69	43.25	10.863	57.35	9.883	63.27	8.443	70.53	9.23	72.32
Lambda cyhalothrin 5% EC	11.97	10.22	22.73	9.91	31.18	9.06	47.41	11.11	44.78	12.243	45.25	9.877	61.22	8.113	69.85	7.873	72.52	8.63	74.12
Fipronil 5% SC	12.19	9.75	26.30	8.32	42.17	7.38	57.15	8.89	55.78	9.563	57.23	8.23	67.69	7.52	72.05	5.067	82.31	5.997	82.01
Cartap Hydrochloride 50% SP	12.14	10.12	23.51	8.89	38.22	7.90	54.14	9.96	50.46	10.3	53.94	9.07	64.39	7.65	71.57	6.57	77.07	7.653	77.05
Chlorantraniliprole 18.5% SC	12.00	9.48	28.32	7.68	46.67	5.79	66.40	7.45	62.94	8.957	59.94	7.69	69.78	6.56	75.60	3.927	86.29	4.593	86.22
Control	12.09	13.22	0.00	14.40	0.00	17.23	0.00	20.11	0.00	22.36	0.00	25.46	0.00	26.91	0.00	28.65	0.00	33.34	0.00
C. D.	N/A	2.23		2.54		2.26		2.89		1.94		1.96		2.36		2.47		2.61	
SE (m)	0.44	0.71		0.81		0.72		0.92		0.62		0.63		0.75		0.79		0.84	

DBS-Day before spray, DAS-Day after spray

Table 4: Incremental cost benefit ratio of different insecticides against girdle beetle (*Obereopsis brevis*) in soybean during *kharif*, 2024.

Treatments	Yield (q/ha.)	Increase yield over control (q/ha.)	Minimum support price (Rs./q)	Total Return (Rs./ha.)	Cost of insecticide application (Rs./ha.)	Net Return (Rs./ha.)	Return over control (Rs./ha.)	ICBR
Thiamethoxam 25% WG	14.00	2.00	4892	68488	1600	66888	8184	5.12
Imidacloprid 17.8% SL	16.28	4.28	4892	79641.76	4300	75341.76	16637.76	3.87
Lambda cyhalothrin 5% EC	18.89	6.89	4892	92409.88	3200	89209.88	30505.88	9.53
Fipronil 5% SC	23.00	11.00	4892	112516	1600	110916	52212	32.63
Cartap Hydrochloride 50% SP	21.48	9.48	4892	105063.9	5100	99963.85	41259.85	8.09
Chlorantraniliprole 18.5% SC	25.62	13.62	4892	125333	3800	121533	62829.04	16.53
Control	12.00	0.00	4892	58704		58704	0	

Table 5: Incremental cost benefit ratio of different insecticides against girdle beetle (*Obereopsis brevis*) in soybean during *kharif*, 2025.

Treatments	Yield (q/ha.)	Increase yield over control (q/ha.)	Minimum support price (Rs./q)	Total Return (Rs./ha.)	Cost of insecticide application (Rs./ha.)	Net Return (Rs./ha.)	Return over control (Rs./ha.)	ICBR
Thiamethoxam 25% WG	14.33	1.66	5328	76368	1600	74768	7280	4.55
Imidacloprid 17.8% SL	16.97	4.30	5328	90398.4	4300	86098.4	18610.4	4.33
Lambda cyhalothrin 5% EC	19.56	6.89	5328	104197.9	3200	100997.9	33509.92	10.47
Fipronil 5% SC	24.27	11.60	5328	129292.8	1600	127692.8	60204.8	37.63
Cartap Hydrochloride 50% SP	22.81	10.14	5328	121549.4	5100	116449.4	48961.44	9.60
Chlorantraniliprole 18.5% SC	26.29	13.62	5328	140090.9	3800	136290.9	68802.88	18.11
Control	12.67	0.00	5328	67488		67488	0	

Conclusion

The findings of the present investigation conducted during *kharif* 2024 and 2025 clearly demonstrate that Chlorantraniliprole 18.5% SC was the most effective insecticide against soybean girdle beetle (*Obereopsis brevis*), consistently recording the lowest pest population and highest percentage reduction over the untreated control after both spray applications. Fipronil 5% SC emerged as the second most effective treatment, followed by Cartap hydrochloride 50% SP, while the remaining insecticides exhibited comparatively lower efficacy. The superior and persistent residual activity of Chlorantraniliprole ensured prolonged suppression of the pest, particularly up to 10 days after the second spray, thereby minimizing pest resurgence. These results, together with their close agreement with previous reports, indicate that timely application of Chlorantraniliprole 18.5% SC can be recommended as an effective and reliable component of an integrated management strategy for girdle beetle in soybean, with Fipronil 5% SC serving as a suitable alternative under field conditions.

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