International Journal of Advanced Biochemistry Research

ISSN Print: 2617-4693
ISSN Online: 2617-4707
IJABR 2024; 8(11): 786-793
www.biochemjournal.com
Received: 10-10-2024
Accepted: 14-11-2024

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Effect of different treatment modules for insect management of soybean

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DOI: https://doi.org/10.33545/26174693.2024.v8.i11j.2956

Abstract
The present investigation carried out in kharif season of year 2023 on field of Oilseed Research Unit, Dr. PDKV Akola. Research plot treated with seed treatment of Azoxystrobin 2.5% + Thiophanate Methyl 11.25% + Thiomethoxam 25% FS @ 10 ml/kg of seed before sowing. This experiment carried out in eight treatment modules and three replications. Amongst all treatment modules tested, the most promising treatment module found was M1 (Indoxacarb 15.80% followed by Chlorantraniliprole 9.30% + lambda cyhalothrin 4.60% ZC (combi prod) + Propiconazole 25% EC) for control of stem fly (1.51%), girdle beetle (1.21%) and semilooper (1.09 larvae/ml) in soybean.
These results translate into yield. And the best module obtained in terms of yield M3 (Chlorantraniliprole 18.5% SC followed by Thiamethoxam 12.60% + Lambda- cyhalothrin 9.50% ZC + Propiconazole 25% EC) recorded 23.71 q/ha yield, which statistically similar with treatment module M1 (Indoxacarb 15.80% EC followed by Chlorantraniliprole 9.30% + lambda cyhalothrin 4.60% ZC + Propiconazole 25% EC) recorded yield 22.22 q/ha yield. The highest ICBR was obtained in treatment module M3 (1:12.09), followed by treatment module were M4 (1:9.27) and M1 (1:9.09).

Keywords: Soybean, stem fly, girdle beetle, semilooper, newer insecticides

Introduction
Soybean (*Glycine max*, L. Merril) is one of the most important leguminous crops belonging to family Leguminosae syn. Fabaceae. The crop is in high demand all over the world because of its high oil (20%) and rich protein (40%) contents. Soybean has lush green, soft, succulent and nutritive dense foliage and is attacked by more than 273 types of insects from sowing till harvesting. Out of these, only two dozen insects are of economic importance causing serious losses.
Stem fly *Melanagromyza sojae* Zehntner has emerged as a major pest in the soybean growing areas of India over the last two decades (Gaur *et al*, 2015) [9]. The soybean crop is prone to heavy infestation by *M. sojae* at all the stages of growth and development, right from seedling to maturity. The maggot of *M. sojae* enters the stem through the leaf petiole, feeds on the stem pith by mining both upwards and downwards and makes a reddish-coloured tunnel in the affected plant (van den Berg et al, 2000) [23]. Infestations in the early crop growth stages cause high seedling mortality and thus reduce the crop stand.
The girdle beetle, *Obereopsis brevis* (Swedenbord) which belongs to family Cerambycidae is a serious growing menace to soybean crop. The initial damage is caused by the female, which makes two parallel girdles with its mandibles either on petiole, branch or main stem for egg laying. These girdles reduce the water supply in plants which in turn ensures successful hatching of eggs. It has been observed that girdle beetle cause higher reduction in yield in early and most vulnerable crop stages identified in between 30 to 55 days when girdler confined to petiole. (Chaudhary *et al*, 2014) [6]. Green semilooper (*Chrysodeixis acuta*) are the noxious pests, that damage the soybean crop extensively by skeletonizing the leaves and thus reducing the photosynthetic capacity of the plant. Many insecticides have been involved for the control of these notorious pest. (Purwar and Yadav, 2003, Harish, 2008) [18, 10]. Insecticide utilization in insect pest management is very important under farmer field conditions to manage the pest below economic injury level. In view of number of insecticides present in the market to control pests of soybean, it is necessary to identify the

best chemical to control the major insect pests of soybean at an affordable cost and also avoid pest resurgence. Hence, this study was conducted for evaluating the effectiveness of insecticides for the management of major insect pests of soybean crop.

Materials and Methods

The field experiment was undertaken in the field of Oilseed Research Unit, (Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola) in kharif season of 2023

A field trial with eight different insecticide modules along with untreated control was carried out in Randomized Block Design with three replications, during kharif 2023 for the management of major pests of soybean. The certified seed of variety PDKV Amba was sown in month of July on field plot size 4.5 m x 3 m with spacing 45 X 5 cm. Seed treatment given to experimental plot. Total two insecticidal application given first 35 days after sowing and second 30 days after first spray in module basis.

- The seed treatment will be given to all treatment with Azoxystrobin 2.5% + Thiophanate Methyl 11.25% + Thiomethoxam 25% FS @ 10 ml / Kg of seeds.

Table 1: Treatment modules sprayed for management of pest of soybean

Treatment modules	Application of insecticides	
	First spray Vegetative stage (25-35 DAS)	Second spray Podding stage (60-75 DAS)
M1	Indoxacarb 15.80% EC	Chlorantraniliprole 9.30% + lambda cyhalothrin 4.60% ZC (Combi Prod) + Propiconazole 25% EC
M2	Profenofos 50% EC	Betacyfluthrin 8.49% + Imidacloprid 19.81% WWOD (Combi Prod) + Hexaconazole 5% EC
M3	Chlorantraniliprole 18.5% SC	Thiamethoxam 12.60% + Lambda- cyhalothrin 9.50% ZC (Combi Prod) + Propiconazole 25% EC
M4	Profenofos 50% EC	Thiamethoxam 12.60% + Lambda- cyhalothrin 9.50% ZC (Combi Prod) + Hexaconazole 5% EC
M5	Emamectin benzoate 5% SG	Chlorantraniliprole 9.30% + lambda cyhalothrin 4.60% ZC (Combi Prod) + Propiconazole 25% EC
M6	Chlorpyriphos 50% + Cypermethrin 5% EC	Novaluron 05.25% + Indoxacarb 04.50% SC (Combi Prod) + Hexaconazole 5% EC
M7	Profenofos 50% EC	Thiamethoxam 12.60% + Lambda- cyhalothrin 9.50% ZC (Combi Prod) + Propiconazole 25% EC
M8	Untreated control	Untreated control

Method of recording observations

The observations were recorded on a randomly selected 1 MRL/plot at five places. Pre-treatment observations were recorded one day before spraying. After spraying the observations were recorded on a 3rd 7th and 14th day.

Observations recorded

Stem fly: Five spots were selected from each plot of one meter row length and seedling damage due to stem fly were counted and percentage infestation was calculated.

Girdle beetle: Five spots were selected from each plot of one meter row length and number of plants damaged due to Girdle beetle was calculated and percentage infestation was calculated. Recorded from each row at 1 day before and 3rd, 7th and 14th days after each spray.

Semilooper: From 5 spot selected from each plot each of one meter row length the number of larvae per meter row length was calculated. Recorded from each row at 1 day before and 3rd, 7th and 14th days after each spray.

Yield

The grain yield data in all the treatment modules recorded at the time of threshing. Economics of various treatments was also calculated.

Results and Discussion

Stem fly

Mean effect of various insecticidal module on infestation of soybean stem fly after first spray

It is evident from the mean data presented in (Table 2) that most effective treatment module found was M3 (Chlorantraniliprole 18.50% SC) recorded minimum infestation of stem fly 1.85%. The next effective treatment module was M1 (Indoxacarb 15.80% EC) recorded infestation of 2.36%. The next effective treatment module was M5 (Emamectin benzoate 5% SG) recorded infestation of 2.86% which was at par with M6 (Chlorpyriphos 50% + Cypermethrin 5% EC) recorded infestation of 3.13%. The next treatment module was M4 (Profenofos 50% EC) recorded 3.67% infestation of stem fly. The next effective treatment module was M2 (Profenofos 50% EC) recorded infestation of 4.78% and M7 (Profenofos 50% EC) recorded infestation of 5.64%. Maximum percent infestation of stem fly was recorded M8 i.e. untreated control 7.99%.

The present study revealed that among all the treatments T3 (Chlorantraniliprole 18.50% SC) found superior, which is in conformity with present findings Omprakash *et al.* (2018) [14], Bokan *et al*. (2022) [4], Annala *et al.* (2023) [1],

The insecticides, Indoxacarb 15.8% EC @ 333ml/ha and Emamectin benzoate 5% SG also showed promising result against stem fly compared to control which is in conformity with the findings of Tagger *et al.* (2011) [22], Gaur *et al.* (2012) [8], Natikar *et al.* (2016) [13], Kothalkar *et al.* (2015) [12].

Mean effect of various insecticidal module on infestation of soybean stem fly after second spray

It is evident from the mean data presented in Table 3 that the most effective treatment module was M1 (Indoxacarb 15.80% followed by Chlorantraniliprole 9.30% + lambda cyhalothrin 4.60% ZC + Propiconazole 25% EC) recorded infestation of 1.51% which statistically superior over all the treatments. The next effective treatment was M2 (Profenofos 50% EC followed by Beta-cyfluthrin 8.49% + Imidacloprid 19.81% OD + Hexaconazole 5% EC) recorded 2.20% stem fly**.** The next effective treatment module was M5 (Emamectin benzoate 5% SG followed by Chlorantraniliprole 9.30% + lambda cyhalothrin 4.60% ZC + Propiconazole 25% EC) recorded stem fly 2.65%. The next effective treatment module was M6 (Chlorpyriphos 50% + Cypermethrin 5% EC followed by Novaluron 05.25% + Indoxacarb 04.50% SC + Hexaconazole 5% EC)

recorded 3.18% stem fly. The next better treatment module found was M4 (Profenofos 50% EC followed by Thiamethoxam 12.60% + Lambda- cyhalothrin 9.50% ZC + Hexaconazole 5% EC) recorded 3.97%**.** The next effective treatment was M3 (Chlorantraniliprole 18.50% SC followed by Thiamethoxam 12.60% + Lambda- cyhalothrin 9.50% ZC + Propiconazole 25% EC) which recorded 5.05% and at par with M7 (Profenofos 50% EC followed by Thiamethoxam 12.60% + Lambda- cyhalothrin 9.50% ZC + Propiconazole 25% EC) which recorded 5.13%. The maximum infestation 12.93% was recorded in treatment module M8 i.e. untreated control.

Table 2: Effect of different treatment modules on percent infestation of soybean stem fly after first spray

M. No.	Treatment modules	Percent stem fly infestation				
		1 DBS	3 DAS	7 DAS	14 DAS	Mean
M1	Indoxacarb 15.80% EC	5.30 (2.30)	2.05 (1.38)	2.23 (1.71)	2.79 (1.65)	2.36 (1.53)
M2	Profenofos 50% EC	5.03 (2.25)	4.30 (2.06)	4.79 (2.18)	5.24 (2.26)	4.78 (2.18)
M3	Chlorantraniliprole 18.50% SC	5.12 (2.27)	1.60 (1.25)	1.62 (1.25)	2.32 (1.50)	1.85 (1.35)
M4	Profenofos 50% EC	5.77 (2.40)	3.23 (1.73)	3.89 (1.96)	3.88 (1.96)	3.67 (1.91)
M5	Emamectin benzoate 5%SG	5.64 (2.38)	2.38 (1.52)	2.88 (1.70)	3.33 (1.81)	2.86 (1.69)
M6	Chlorpyriphos 50% + Cypermethrin 5% EC	5.53 (2.35)	2.84 (1.67)	3.09 (1.73)	3.47 (1.86)	3.13 (1.77)
M7	Profenofos 50% EC	5.45 (2.33)	5.22 (2.29)	5.42 (2.33)	6.27 (2.50)	5.64 (2.37)
M8	Untreated control	5.47 (2.34)	6.80 (2.61)	7.67 (2.78)	9.51 (3.09)	7.99 (2.82)
	'F' Test	N.S.	Sig	Sig	Sig	Sig
	SE (m)±	-	0.12	0.13	0.16	0.04
	CD at 5%	-	0.36	0.41	0.48	0.11
	CV%	-	11.40	11.65	13.59	3.15

Figures in parentheses are square root transformation. DAS - day after spray, DBS - day before spray.

The present study revealed that among all the treatment modules Chlorantraniliprole 9.30% + Lambda Cyhalothrin 4.60% ZC @ 250ml/ha was found superior, which is in conformity with present findings Kambrekar (2020) [11], Dhore *et al.* (2024) [7].

The findings of Punithavalli and Sharma (2020) [17] revealed, Beta cyfluthrin 8.49% + Imidacloprid 19.81% 300 OD @ 350 ml/ha were highly effective against internal feeder girdle beetle, *Obereopsis brevis* and stem fly *Melanagromyza sojae* (Zehnt) in soybean under field conditions which do support the present investigation.

Table 3: Effect of different treatments modules on percent infestation of soybean stem after second spray

M. No.	Treatment modules	Percent stem fly infestation				
		1 DBS	3 DAS	7 DAS	14 DAS	Mean
M1	Indoxacarb 15.80% EC Fb Chlorantraniliprole 9.30% + lambda cyhalothrin 4.60% ZC (Combi prod) + Propiconazole 25% EC	6.50 (2.54)	1.20 (1.17)	1.26 (1.12)	2.07 (1.44)	1.51 (1.22)
M2	Profenofos 50% EC Fb Betacyfluthrin 8.49% + Imidacloprid 19.81% WWOD (Combi prod) + Hexaconazole 5% EC	6.03 (2.43)	1.51 (1.28)	2.18 (1.44)	2.92 (1.68)	2.20 (1.47)
M3	Chlorantraniliprole 18.50% SC Fb Thiamethoxam 12.60% + Lambda- cyhalothrin 9.50% ZC (Combi prod) + Propiconazole 25% EC	6.53 (2.56)	4.30 (2.07)	4.76 (2.13)	6.09 (2.47)	5.05 (2.24)
M4	Profenofos 50% EC Fb Thiamethoxam 12.60% + Lambda- cyhalothrin 9.50% ZC (Combi prod) + Hexaconazole 5% EC	6.38 (2.53)	3.09 (1.76)	3.68 (1.92)	5.14 (2.26)	3.97 (1.98)
M5	Emamectin Benzoate 5% EC Fb Chlorantraniliprole 9.30% lambda cyhalothrin 4.60% ZC (Combi prod) + Propiconazole 25% EC	6.19 (2.49)	2.01 (1.42)	2.59 (1.59)	3.35 (1.82)	2.65 (1.62)
M6	Chlorpyriphos 50% + Cypermethrin 5% EC Fb Novaluron 05.25% + Indoxacarb 04.50% SC (Combi prod) + Hexaconazole 5% EC	6.27 (2.50)	2.44 (1.53)	2.92 (1.69)	4.17 (2.04)	3.18 (1.77)
M7	Profenofos 50% EC Fb Thiamethoxam 12.60% + Lambda- cyhalothrin 9.50% ZC(Combi prod) + Propiconazole 25% EC	6.51 (2.55)	4.37 (2.09)	4.83 (2.20)	6.18 (2.49)	5.13 (2.26)
M8	Untreated control	6.09 (2.47)	10.30 (3.21)	12.90 (3.60)	15.60 (3.95)	12.93 (3.58)
	'F' Test	N.S.	Sig	Sig	Sig	Sig
	SE (m)±	-	0.10	0.15	0.16	0.04
	CD at 5%	-	0.32	0.45	0.49	0.12
	CV%	-	9.97	12.97	13.38	3.45

Figures in parentheses are square root transformation. DAS - day after spray, DBS - day before spray. Fb- followed by 1st spray

Girdle beetle

Mean effect of various insecticidal module on of soybean girdle beetle after first spray

It is evident from the mean data presented in Table 4 that treatment module proved effective was M3 (Chlorantraniliprole 18.50% SC) minimum infestation of girdle beetle 1.10%. The next effective treatment module was M1 (Indoxacarb 15.80% EC) recorded 1.57%., however, this treatment module was at par with M5 (Emamectin benzoate 5% SG) recorded 1.83%. The next effective treatment was M6 (Chlorpyriphos 50% + Cypermethrin 5% EC) recorded 2.16%. The next effective treatment found was M4 (Profenofos 50% EC) recorded 2.68%. The next better treatment was M2 (Profenofos 50% EC) recorded 3.12% and at par with M7 (Profenofos 50% EC) recorded 3.18%. Maximum infestation of stem fly was recorded in M8 i.e. untreated control 4.96%.

The present investigation reported that the treatment Chlorantraniliprole 18.5% SC@ 150ml/ha was found effective in reduction of girdle beetle population on soybean which were similar to the findings of Bokan *et al.* (2022) [4]. The insecticides, Indoxacarb 15.8% EC @ 333ml/ha and Emamectin benzoate 5% SG also show superior result against stem fly compared to control which confirms the findings of Tagger *et al.* (2011) [22], Gaur and Chaudhary (2012) [8], Natikar *et al.* (2016) [13], Kothalkar *et al.* (2015) [12].

Table 4: Effect of different treatment modules on percent infestation of soybean girdle beetle after first spray

M. No.	Treatment modules	Percent infestation of girdle beetle				
		1 DBS	3 DAS	7 DAS	14 DAS	Mean
M1	Indoxacarb 15.80% EC	2.42 (1.53)	0.93 (1.13)	1.35 (1.24)	2.37 (1.51)	1.57 (1.23)
M2	Profenofos 50% EC	2.32 (1.50)	2.34 (1.52)	3.02 (1.74)	4.19 (2.01)	3.12 (1.75)
M3	Chlorantraniliprole 18.5% SC	2.48 (1.58)	0.72 (1.11)	0.91 (1.20)	1.60 (1.27)	1.10 (1.04)
M4	Profenofos 50% EC	2.29 (1.52)	2.13 (1.46)	2.29 (1.49)	3.86 (1.97)	2.68 (1.62)
M5	Emamectin benzoate 5%SG	2.32 (1.53)	1.20 (1.17)	1.59 (1.26)	2.69 (1.62)	1.83 (1.33)
M6	Chlorpyriphos 50% + Cypermethrin 5% EC	2.36 (1.51)	1.33 (1.23)	1.68 (1.30)	3.47 (1.85)	2.16 (1.44)
M7	Profenofos 50% EC	2.35 (1.54)	2.46 (1.56)	3.15 (1.76)	4.24 (2.05)	3.18 (1.77)
M8	Untreated control	2.75 (1.66)	3.67 (1.92)	5.03 (2.25)	6.17 (2.49)	4.96 (2.21)
	'F' Test	N.S.	Sig	Sig	Sig	Sig
	SE (m)±	-	0.08	0.08	0.12	0.04
	CD at 5%	-	0.23	0.25	0.36	0.12
	CV%	-	9.51	9.17	11.11	4.45

Figures in parentheses are square root transformation. DAS - day after spray, DBS - day before spray.

Mean effect of various insecticidal module on infestation of soybean girdle beetle after second spray

It is evident from the mean data showed (Table 5) that the treatment module M1 proved effective (Indoxacarb 15.80% followed by Chlorantraniliprole 9.30% + lambda cyhalothrin 4.60% ZC + Propiconazole 25% EC) recorded infestation of 1.21%. The next effective treatment module found was M2 (Profenofos 50% EC followed by Beta-cyfluthrin 8.49% + Imidacloprid 19.81% OD + Hexaconazole 5% EC) recorded 1.59%**.** The next effective treatment module was M5 (Emamectin benzoate 5% SG followed by Chlorantraniliprole 9.30% + lambda cyhalothrin 4.60% ZC + Propiconazole 25% EC) recorded 2.04%. The next effective treatment module was M6 (Chlorpyriphos 50% + Cypermethrin 5% EC followed by Novaluron 05.25% + Indoxacarb 04.50% SC + Hexaconazole 5% EC) recorded 2.47%**.** The next effective treatment module was M4 (Profenofos 50% EC followed by Thiamethoxam 12.60% + Lambda- cyhalothrin 9.50% ZC + Hexaconazole 5% EC) recorded 2.93%**.** The next effective treatment module was M3 (Chlorantraniliprole 18.50% SC followed by Thiamethoxam 12.60% + Lambda- cyhalothrin 9.50% ZC + Propiconazole 25% EC) which recorded 4.00%. The next better treatment module was M7 (Profenofos 50% EC followed by Thiamethoxam 12.60% + Lambda- cyhalothrin 9.50% ZC + Propiconazole 25% EC) which recorded 5.40%. The maximum infestation 9.10% was recorded in treatment module M8 i.e. untreated control.

The current investigation found that Chlorantraniliprole 10% + Lambda cyhalothrin 5% ZC @ 150ml/ha was superior to all other treatments, which is consistent with recent findings by Kambrekar (2020) [11], Dhore *et al.* (2024) [7]

According to Punithavalli and Sharma (2020) [17] research, Beta cyfluthrin 8.49% + Imidacloprid 19.81% 300 OD @ 350 ml/ha were incredibly efficient against the internal feeder girdle beetle *Obereopsis brevis*, and stem fly *Melanagromyza sojae* (Zehnt) in soybean under field conditions, which supports the current investigation.

Table 5: Effect of different treatment modules on percent infestation of soybean girdle beetle after second spray

M. No.	Treatment modules	Percent infestation of girdle beetle				
		1 DBS	3 DAS	7 DAS	14 DAS	Mean
M1	Indoxacarb 15.80% EC Fb Chlorantraniliprole 9.30% + lambda cyhalothrin 4.60% ZC (Combi prod) + Propiconazole 25% EC	2.46 (1.57)	0.75 (1.12)	1.16 (1.08)	1.72 (1.29)	1.21 (1.09)
M2	Profenofos 50% EC Fb Betacyfluthrin 8.49% + Imidacloprid 19.81% WWOD (Combi prod) + Hexaconazole 5% EC	2.40 (1.52)	1.14 (1.13)	1.56 (1.24)	2.08 (1.42)	1.59 (1.25)
M3	Chlorantraniliprole 18.50% SC Fb Thiamethoxam 12.60% + Lambda- cyhalothrin 9.50% ZC (Combi prod) + Propiconazole 25% EC	2.52 (1.59)	3.02 (1.69)	3.75 (1.92)	5.23 (2.26)	4.00 (1.99)
M4	Profenofos 50% EC Fb Thiamethoxam 12.60% + Lambda- cyhalothrin 9.50% ZC (Combi prod) + Hexaconazole 5% EC	2.21 (1.49)	2.49 (1.58)	3.05 (1.75)	3.24 (1.74)	2.93 (1.71)
M5	Emamectin Benzoate 5% EC Fb Chlorantraniliprole 9.30% lambda cyhalothrin 4.60% ZC (Combi prod) + Propiconazole 25% EC	2.23 (1.50)	1.56 (1.25)	2.01 (1.42)	2.54 (1.58)	2.04 (1.42)
M6	Chlorpyriphos 50% + Cypermethrin 5% EC Fb Novaluron 05.25% + Indoxacarb 04.50% SC (Combi prod) + Hexaconazole 5% EC	2.30 (1.49)	1.77 (1.37)	2.62 (1.60)	3.03 (1.73)	2.47 (1.56)
M7	Profenofos 50% EC Fb Thiamethoxam 12.60% + Lambda- cyhalothrin 9.50% ZC(Combi prod) + Propiconazole 25% EC	2.50 (1.59)	4.57 (2.14)	5.23 (2.29)	6.40 (2.53)	5.40 (2.32)
M8	Untreated control	2.47 (1.57)	7.35 (2.72)	9.59 (3.10)	10.36 (3.22)	9.10 (3.01)
	'F' Test	N.S.	Sig	Sig	Sig	Sig
	SE (m)±	-	0.10	0.11	0.15	0.04
	CD at 5%	-	0.32	0.33	0.46	0.11
	CV%	-	11.19	10.54	13.40	3.57

Figures in parentheses are square root transformation. DAS - day after spray, DBS - day before spray. Fb- followed by 1st spray

Semilooper

Mean effect of various insecticidal module on soybean semilooper population after first spray

It is evident from the mean data presented in Table 6 that treatment module M1 (Indoxacarb 15.80% EC) which recorded 1.43 larvae/mrl found superior and at par with M3 (Chlorantraniliprole 18.50% SC) and recorded population of 1.56 larvae/mrl. The next effective treatment module was M5 (Emamectin benzoate 5% SG) recorded 2.01 larvae/mrl and at par with M2 (Profenofos 50% EC) and M6 (Chlorpyriphos 50% + Cypermethrin 5% EC) recorded infestation of 2.33 larvae/mrl 2.40 larvae /mrl respectively. The next better treatment module was M4 (Profenofos 50% EC) recorded 2.60 larvae/mrl and at par with M7 (Profenofos 50% EC) recorded 2.83 larvae/mrl. The maximum population of semilooper was recorded in treatment module M8 i.e. untreated control 4.38 larvae/mrl.

The present study revealed that among all the treatments module M1 (Indoxacarb 15.80% EC) was found superior which is in conformity with present findings Balaji *et al.* (2012) [2], Gaur and Chaudhary (2012) [8].

The insecticide Chlorantraniliprole 18.50% SC also show superior result against semilooper compared to control which confirms the findings of Patil and Phad (2014) [16], Raut *et al.* (2014) [19].

Table 6: Effect of different treatment modules on soybean semilooper population after first spray

M. No.	Treatment modules	Semilooper (larva/mrl)				
		1 DBS	3 DAS	7 DAS	14 DAS	Mean
M1	Indoxacarb 15.80% EC	2.05 (1.43)	1.15 (1.08)	1.31 (1.22)	1.82 (1.34)	1.43 (1.19)
M2	Profenofos 50% EC	2.27 (1.51)	2.33 (1.53)	2.33 (1.53)	2.33 (1.51)	2.33 (1.53)
M3	Chlorantraniliprole 18.50% SC	2.12 (1.46)	1.33 (1.15)	1.42 (1.46)	1.93 (1.39)	1.56 (1.25)
M4	Profenofos 50% EC	2.07 (1.44)	2.40 (1.54)	2.47 (1.57)	2.93 (1.72)	2.60 (1.61)
M5	Emamectin benzoate 5%SG	2.53 (1.58)	1.47 (1.21)	2.10 (1.45)	2.47 (1.57)	2.01 (1.42)
M6	Chlorpyriphos 50% + Cypermethrin 5% EC	2.40 (1.54)	1.93 (1.39)	2.13 (1.45)	3.14 (1.77)	2.40 (1.55)
M7	Profenofos 50% EC	2.13 (1.46)	2.47 (1.56)	2.48 (1.57)	3.54 (1.85)	2.83 (1.68)
M8	Untreated control	2.00 (1.41)	3.80 (2.08)	4.60 (2.14)	4.73 (2.17)	4.38 (2.09)
	'F' Test	N.S.	Sig	Sig	Sig	Sig
	SE (m)±	-	0.08	0.11	0.11	0.04
	CD at 5%	-	0.26	0.33	0.33	0.14
	CV%	-	10.20	12.76	11.22	5.05

Figures in parentheses are square root transformation. DAS - day after spray, DBS - day before spray.

Mean effect of various insecticidal module on soybean semilooper population after second spray

It is evident from the mean data presented in Table 7 that the treatment module found effective was M1 (Indoxacarb 15.80% followed by Chlorantraniliprole 9.30% + lambda cyhalothrin 4.60% ZC + Propiconazole 25% EC) recorded 1.09 larvae/mrl and found statistically similar and at par with M3 (Chlorantraniliprole 18.50% SC followed by Thiamethoxam 12.60% + Lambda- cyhalothrin 9.50% ZC + Propiconazole 25% EC) recorded 1.33 larvae/mrl. The next effective treatment module was M2 (Profenofos 50% EC followed by Beta-cyfluthrin 8.49% + Imidacloprid 19.81% OD + Hexaconazole 5% EC) recorded 1.54 larvae/mrl. The next effective treatment module was M5 (Emamectin benzoate 5% SG followed by Chlorantraniliprole 9.30% + lambda cyhalothrin 4.60% ZC + Propiconazole 25% EC) recorded 2.06 larvae/mrl. The next effective treatment was M6 (Chlorpyriphos 50% + Cypermethrin 5% EC followed by Novaluron 05.25% + Indoxacarb 04.50% SC + Hexaconazole 5% EC) recorded 2.50 larvae/mrl. The next better treatment module was M7 (Profenofos 50% EC followed by Thiamethoxam 12.60% + Lambda- cyhalothrin 9.50% ZC + Propiconazole 25% EC) which recorded 2.77 larvae/mrl. and at par with M4 (Profenofos 50% EC followed by Thiamethoxam 12.60% + Lambda- cyhalothrin 9.50% ZC + Hexaconazole 5% EC), which recorded 2.91 larvae/mrl respectively. The maximum population of semilooper was recorded in treatment module M8 i.e. untreated control (4.34 larvae / mrl).

The similar results obtained by the researcher's like Annala *et al.* (2023) [1] evaluated six insecticides for management of stem fly, found Chlorantraniliprole 18.50% SC as most effective insecticide followed by Profenofos 50 EC, Betacyfluthrin 8.49% + Imidacloprid 19.81% WWOD. As well as the present finding as in conformity with finding Shabana *et al.* (2018) [20]. Watti and Deotale (2015) [24] was found statistically significant result. The minimum cumulative average number of semilooper larvae (0.12/mrl) was recorded in Indoxacarb 15.8 EC.

Table 7: Effect of different treatment modules on soybean semilooper population after second spray

M. No.	Treatment modules	Semilooper (larva/mrl)				
		1 DBS	3 DAS	7 DAS	14 DAS	Mean
M1	Indoxacarb 15.80% EC Fb Chlorantraniliprole 9.30% + lambda cyhalothrin 4.60% ZC (Combi prod) + Propiconazole 25% EC	2.54 (1.60)	0.80 (1.07)	1.00 (1.09)	1.47 (1.22)	1.09 (1.04)
M2	Profenofos 50% EC Fb Betacyfluthrin 8.49% + Imidacloprid 19.81% WWOD (Combi prod) + Hexaconazole 5% EC	2.23 (1.46)	1.10 (1.13)	1.39 (1.18)	2.13 (1.46)	1.54 (1.23)
M3	Chlorantraniliprole 18.50% SC Fb Thiamethoxam 12.60% + Lambda-cyhalothrin 9.50% ZC (Combi prod) + Propiconazole 25% EC	2.90 (1.71)	0.87 (1.10)	1.27 (1.13)	1.87 (1.37)	1.33 (1.14)
M4	Profenofos 50% EC Fb Thiamethoxam 12.60% + Lambda- cyhalothrin 9.50% ZC (Combi prod) + Hexaconazole 5% EC	2.98 (1.73)	1.93 (1.39)	2.87 (1.70)	3.93 (1.99)	2.91 (1.69)
M5	Emamectin Benzoate 5% EC Fb Chlorantraniliprole 9.30% lambda cyhalothrin 4.60% ZC (Combi prod) + Propiconazole 25% EC	2.93 (1.72)	1.40 (1.18)	2.00 (1.42)	2.80 (1.68)	2.06 (1.42)
M6	Chlorpyriphos 50% + Cypermethrin 5% EC Fb Novaluron 05.25% + Indoxacarb 04.50% SC (Combi prod) + Hexaconazole 5% EC	2.58 (1.61)	1.73 (1.32)	2.29 (1.52)	3.47 (1.87)	2.50 (1.52)
M7	Profenofos 50% EC Fb Thiamethoxam 12.60% + Lambda- cyhalothrin9.50% ZC (Combi prod) + Propiconazole 25% EC	2.76 (1.64)	1.81 (1.35)	2.74 (1.62)	3.76 (1.90)	2.77 (1.65)
M8	Untreated control	2.75 (1.64)	3.40 (1.82)	4.54 (2.13)	5.07 (2.26)	4.34 (2.08)
	'F' Test	N.S.	Sig	Sig	Sig	Sig
	SE (m)±	-	0.09	0.08	0.10	0.03
	CD at 5%	-	0.27	0.25	0.29	0.10
	CV%	-	11.84	9.63	9.66	3.95

Figures in parentheses are square root transformation. DAS - day after spray, DBS - day before spray. Fb- followed by 1st spray.

Effects of different treatments modules on yield of soybean

The treatment module M3 (Chlorantraniliprole 18.5% SC followed by Thiamethoxam 12.60% + Lambda- cyhalothrin 9.50% ZC + Propiconazole 25% EC) recorded maximum yields of 23.71 q/ha with an increase of 13.78 q/ha yields over control. And found at par with treatment module M1 (Indoxacarb 15.80% EC followed by Chlorantraniliprole 9.30% + lambda cyhalothrin 4.60% ZC + Propiconazole 25% EC) recorded yield of 22.22 q/ha with increase of 12.29 q/ha yields over control and treatment module was M5 (Emamectin benzoate 5%SG followed by Chlorantraniliprole 9.30% lambda cyhalothrin 4.60% ZC + Propiconazole 25% EC) recorded yields of 18.37 q/ha. All this treatment modules M3, M1 and M5 are statistically similar.

These results corroborate with the finding of Bhamare *et al.* (2021) [3], who obtained highest yield of soyabean (34.87q/ha) in the treatment Chlorantraniliprole 0.04 percent documented highest incremental cost benefit ratio. Similarly, Shobarani *et al.* (2019) [21] received maximum seed yield recorded in indoxacarb 14.5%Sc (14.87q/ha). Patel *et al.* (2019) [15] Obtained highest B:C ratio (1:10.7) was recorded with Thiamethoxam + Lambda Cyhalothrin. Similarly with the earlier finding of Kambrekar *et al.* (2020) [11] who reported that maximum yield of soybean obtained in Chlorantraniliprole 9.3% + Lambda Cyhalothrin 4.6% ZC 17.57 q/ha and 18.65 q/ha@ 150ml/ha. The next finding Chand and Gaur (2015) [5] who reported the maximum yield of soybean obtained in Beta cyfluthrin 8.49% + Imidacloprid 19.81% 300 OD @ 350 ml/ha.

The best treatment modules in terms of ICBR found was M3 (1:12.09), followed by treatment module were M4 (1:9.27) and M1 (1:9.09).

Present investigation of the research work is collaborated with the earlier finding Bhamare *et al.* (2021) [3], who obtained highest yield of soyabean in the treatment Chlorantraniliprole 0.04 percent documented highest incremental cost benefit ratio. Patel *et al.* (2019) [15] who reported that highest ICBR rank obtained in Thiamethoxam 12.6% + Lambda Cyhalothrin 9.5% ZC@ 125ml/ha (1:10). Dhore *et al.* (2024) [7] highest incremental cost benefit ratio was obtained in treatment of Thiamethoxam 12.6% + Lambda Cyhalothrin 9.5% ZC @ 125 ml/ha (1:16.36) followed by Beta cyfluthrin 8.49% + Imidacloprid 19.81% 300 OD @ 350 ml/ha (1:11.12).

Table 8: Effect of different treatment modules on soybean yield.

Tr. No.	Treatment modules		Yield kg/plot	Av. Yield (q/ha)
	Vegetative stage (25-35 DAS)	Podding stage (60-75 DAS)		
M1	Indoxacarb 15.80% EC	Chlorantraniliprole 9.30% + lambda cyhalothrin 4.60% ZC + Propiconazole 25% EC	2.08 (1.45)	22.22 (4.72)
M2	Profenofos 50% EC	Betacyfluthrin 8.49% + Imidacloprid 19.81% WWOD + Hexaconazole 5% EC	1.60 (1.27)	17.09 (4.14)
M3	Chlorantraniliprole 18.5% SC	Thiamethoxam 12.60% + Lambda- cyhalothrin 9.50% ZC + Propiconazole 25% EC	2.22 (1.46)	23.71 (4.87)
M4	Profenofos 50% EC	Thiamethoxam 12.60% + Lambda- cyhalothrin 9.50% ZC + Hexaconazole 5% EC	1.54 (1.25)	16.45 (4.06)
M5	Emamectin benzoate 5%SG	Chlorantraniliprole 9.30% lambda cyhalothrin 4.60% ZC + Propiconazole 25% EC	1.72 (1.31)	18.37 (4.27)
M6	Chlorpyriphos 50% + Cypermethrin 5% EC	Novaluron 05.25% + Indoxacarb 04.50% SC + Hexaconazole 5% EC	1.47 (1.22)	15.70 (3.97)
M7	Profenofos 50% EC	Thiamethoxam 12.60% + Lambda cyhalothrin 9.50% ZC + Propiconazole 25% EC	1.39 (1.18)	14.85 (3.80)
M8	Untreated Control	Control	0.93 (0.97)	9.93 (3.09)
	'F' Test		Sig	Sig
	SE (m) ±		0.08	0.22
	CD at 5%		0.23	0.66
	CV%		10.47	9.17

Incremental cost benefits ratio of various treatment modules in soybean

Labor charges Rs.322/day 2) Spray pump charges Rs. 50/day. 3) Two labour/spray. 4) Indoxacarb 15.80% EC Rs.1220/L. 5) Profenofos 50% EC Rs.960/L. 6) Chlorantraniliprole 18.5% SC Rs.14800/L. 7) Emamectin benzoate 5%SG Rs.3800/L. 8) Chlorpyriphos 50% + Cypermethrin 5% EC Rs. 1350 /L. 9) Chlorantraniliprole 9.30% + lambda cyhalothrin 4.60% ZC Rs. 11400/L. 10) Betacyfluthrin 8.49% + Imidacloprid 19.81% WWOD Rs.4500/L 11) Thiamethoxam 12.60% + Lambda-cyhalothrin 9.50% ZC Rs.2350/L. 12) Novaluron 05.25% + Indoxacarb 04.50% SC Rs. 3440/L. 13) Propiconazole 25% EC Rs. 1900/L. 14) Hexaconazole 5% EC Rs.550/L. 15) Sale price of soybean seed @4600 Rs/q.

Conclusions

- The results for management of stem fly, girdle beetle and semilooper module M1 indicated promising results. Cumulative effect of all translates into yield. As highest yield obtained in treatment module M3 (Chlorantraniliprole 18.50% SC followed by Thiamethoxam 12.60% + Lambda- cyhalothrin 9.50% ZC + Propiconazole 25% EC) which is statistically similar with treatment module M1 (Indoxacarb 15.80% EC followed by Chlorantraniliprole 9.30% + lambda cyhalothrin 4.60% ZC + Propiconazole 25% EC) and M5 (Emamectin benzoate 5%SG followed by Chlorantraniliprole 9.30% lambda cyhalothrin 4.60% ZC + Propiconazole 25% EC)
- In terms of ICBR, treatment module M3 (Chlorantraniliprole 18.50% SC followed by Thiamethoxam 12.60% + Lambda- cyhalothrin 9.50% ZC + Propiconazole 25% EC) obtained highest ICBR (1:12.09) followed by treatment module M4 (Profenofos 50% EC followed by Thiamethoxam 12.60% + Lambda- cyhalothrin 9.50% ZC + Hexaconazole 5% EC) with ICBR of 1:9.27, M1 (Indoxacarb 15.80% EC followed by Chlorantraniliprole 9.30% + lambda cyhalothrin 4.60% ZC + Propiconazole 25% EC) with ICBR 1:9.09

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