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MANAGEMENT OF DEFOLIATOR PESTS AND GIRDLE BEETLE INFESTING SOYBEAN DURING SUMMER SEASON

Ravikumar¹, M. Shobharani^{2*}, Sidramappa³, A. Prabhuraj¹, N.M. Sunilkumar⁴ and Sunil Kulkarni³

¹Department of Agricultural Entomology, College of Agriculture, UAS, Raichur - 584 104, Karnataka, India.

²AICRP (Pigeon pea), Zonal Agricultural Research Station (UAS, Raichur) Kalaburagi - 585 101, Karnataka, India.

³Agricultural Research Station (University of Agricultural Sciences, Raichur), Bidar - 585 401, Karnataka, India.

⁴College of Agriculture (University of Agricultural Sciences, Raichur), Kalaburagi - 585 101, Karnataka, India.

*Corresponding author E-mail : srani.ent@gmail.com

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ABSTRACT

A field experiment was conducted during summer 2023 at agricultural research station, bidar to evaluate the bio efficacy of different insecticides i.e., chlorantraniliprole 18.5 % SC, novaluron 5.25% + indoxacarb 4.50% SC, spinetoram 11.70 % SC, flubendiamide 20% WG and emamectin benzoate 5% SG against defoliators viz., tobacco caterpillar (*Spodoptera litura*), semilooper (*Trichoplusia orichalcea* and *Chrysodeixis acuta*) and girdle beetle (*Obereopsis brevis*) during summer. Among the different insecticides, chlorantraniliprole 18.5% SC was found to be effective in suppressing the larval population of semiloopers and tobacco caterpillars and girdle beetle. The next best treatments were novaluron 5.25% + indoxacarb 4.50% SC, spinetoram 11.70% SC, flubendiamide 20 % WG and emamectin benzoate 5% SG. However, all the treatments proved their superiority over untreated control during both the sprays. From the study it is evident that insecticides treated plots recorded less insect pest load because of quick knock down effect, longer residual activity of insecticides under field condition.

Key words : Soybean, Defoliator pests, Insecticides.

Introduction

Soybean [*Glycine max* (L.) Merrill] is a unique crop with high nutritional value, providing 40% protein and 20% edible oil, besides minerals and vitamins. Soybean protein is rich in amino acids like lysine, methionine and cystine. Soybean ranks first among the oilseeds in the world as well as in India. Globally, soybean is grown over an area of 136.03 m ha and annual production of 369.72 m t with a productivity of 2720 kg ha⁻¹ (Anonymous, 2023). In India, it occupies an area of 13.00 m ha with a production of 12.04 m t and productivity of 930 kg ha⁻¹ (Anonymous, 2023a). In Karnataka, soybean is cultivated in an area of 0.381 m ha with a production of 0.437 m t and productivity of 1147 kg ha⁻¹ (Anonymous, 2022). In India, soybean productivity is lower than world average due to biotic as well as abiotic factors. Among the biotic factors, insect pests are of economically important. The leaf eating caterpillars, *Spodoptera litura* (Fabricius),

Thysanoplusia orichalcea (Fabricius) and *Spilarctia obliqua* (Walker) mainly feed on foliage, flower and pods resulting in severe yield loss (Singh and Singh, 1990). The larvae are also reported to feed on flowers and pods in case of severe infestation. Defoliation often reaches population levels that significantly limit the yield of soybean. The tobacco caterpillar, *S. litura* is a voracious feeder of soybean and its occurrence is being noticed in all the soybean growing areas of northern karnataka, during all the growing seasons. The young caterpillars initially feed gregariously on green tissue by scraping the leaves and older larvae after feeding the leaves move to tender pods, consequently damaging 30 to 50 per cent of pods resulting in poor growth of plants (Anonymous, 2007). The semilooper, *T. orichalcea* causes damage by biting round holes into leaves and infestation can result into 30 per cent underdeveloped pods and 50 per cent defoliation of leaf area. The bihar hairy caterpillar, *S.*

obliqua is a serious feeder, which feeds gregariously on soybean leaves. Under severe infestation, the entire crop will be defoliated. Foliage appears netted or webbed and eventually skeletonised and thus causing nearly 40 per cent defoliation of leaf area (Anonymous, 2007). In light of the foregoing and considering the seriousness of the pest infestation and damage to the soybean crop, the present study was undertaken to management of defoliator pests infesting soybean during summer.

Materials and Methods

A field experiment was conducted at Agricultural Research Station, Bidar during summer 2023 to evaluate the efficacy of different insecticides against green semiloopers (*Trichoplusia orichalcea* and *Chrysodeixis acuta*), tobacco caterpillar (*Spodoptera litura*) and girdle beetle (*Obereopsis brevis*) on soybean during summer, 2023. The trial was laid in randomized block design with six treatments replicated four times with a plot size of 4 × 3 m.

Soybean variety, DSb 21 was sown at 30×10 cm spacing and all the recommended package of practices was followed to raise the crop. First spray was given based on economic threshold level (ETL) of pests in all the experimental plots and subsequent one more spray was given at fifteen days interval or based on pest infestation. Wherever necessary a spray of flonicamid 50 WDG @ 0.3g/Lt was given to manage the sucking pests.

Observations on larval population of green semiloopers and tobacco caterpillar were recorded at one day before spray and 3, 7 and 10 days after each spray at five randomly selected one meter row length in each plot leaving the border rows. The data recorded was subjected to square root transformation before statistical analysis. Foliage and pod damage were recorded on ten randomly selected plants from each treatment, and converted into per cent damage and data was transformed to arcsine values and subjected for statistical analysis. The mean comparisons were made by Duncan's multiple range test (DMRT).

Observations on per cent plants damage by girdle beetle at one day before spray, 3, 7 and 10 days after each spray were recorded and cumulative per cent damage throughout the season was worked out and data was transformed to arc sine values and subjected for statistical analysis.

Observations on per cent plants damage by girdle beetle was done by marking the 1-meter area at 3 places in each plot and recording the total number of plants and girdled plants in each plot. All the infested plants were

labelled with date in the earmarked area and further number of plants showing typical 'cut-off' symptoms throughout the cropping period was recorded.

The seed yield was recorded plot wise after harvest and converted to hectare basis, later subjected to statistical analysis.

All the treatments were imposed in the form of foliar spray with hand knapsack sprayer using a spray fluid of 500 liters per hectare. The spray fluid was prepared by mixing measured quantity of water and insecticides. All necessary care was taken to prevent the drift of insecticides to reach the adjacent plots. Before and after spraying of insecticides, sprayer and measuring cylinder were thoroughly washed with clean water.

Results and Discussion

The investigation on evaluation of bio efficacy of different insecticides against defoliators viz., tobacco caterpillar (*Spodoptera litura*), semilooper (*Trichoplusia orichalcea* and *Chrysodeixis acuta*), girdle beetle (*Obereopsis brevis*) were presented in Tables 1, 2 and 3. All the treated plots with insecticide were significantly superior in their performance over that of control plots after application of insecticides.

Semilooper

During first spray day before imposition of treatment, larval population of semilooper ranged from 2.47 to 2.73 larvae per meter row length in various treatments and there was no significant difference among the treatments. Three days after imposing the treatment, the lowest larval population was recorded in the plots treated with chlorantraniliprole 18.5% SC (0.53 larvae/mrl), which was significantly superior over all other treatments. This treatment was followed by novaluron 5.25% + indoxacarb 4.50% SC with 0.86 larvae/ mrl and was on par with spinetoram 11.70% SC with larval population of 1.24 larvae/ mrl. The next best treatment was flubendiamide 20% WG with 1.05 larvae/ mrl and was followed by emamectin benzoate 5% SG with 1.44 larvae/ mrl. However, all the treatments were statistically superior over untreated control with 3.13 larvae per meter row length. Seven and Ten days after imposition of treatment same trend was followed with respect to the larval population. However, untreated control plot recorded highest larval population (Table 1).

During second spray, day before imposition of treatment there is no significance difference in semilooper larval population among the different treatments. After third days of spraying, lowest semilooper larval population was recorded in the plots treated with chlorantraniliprole

Table 1 : Bio-efficacy of promising insecticides against semiloopers on soybean during summer.

Tr. No.	Treatment details	Dosage (g a.i./ha)	Number of larvae/meter row length							
			First spray				Second spray			
			DBS	3 DAS	7 DAS	10 DAS	DBS	3 DAS	7 DAS	10 DAS
T ₁	Flubendiamide 20% WG	50.0	2.67(1.78) ^a	1.24(1.32) ^{cd}	0.96(1.21) ^{bc}	1.48(1.41) ^{bc}	2.40(1.70) ^a	0.97(1.21) ^{bc}	0.85(1.16) ^{bc}	0.49(0.99) ^{bc}
T ₂	Emamectin benzoate 5% SG	7.50	2.73(1.77) ^a	1.44(1.39) ^d	1.12(1.27) ^{bc}	1.70(1.48) ^c	2.73(1.77) ^a	1.12(1.27) ^c	0.97(1.21) ^c	0.59(1.04) ^c
T ₃	Novaluron 5.25%+Indoxacarb 4.50% SC	43.31+37.13	2.67(1.78) ^a	0.86(1.17) ^b	0.62(1.06) ^{ab}	1.07(1.25) ^{ab}	2.47(1.72) ^a	0.63(1.06) ^{ab}	0.54(1.02) ^{ab}	0.22(0.85) ^{ab}
T ₄	Chlorantraniliprole 18.5% SC	30.0	2.60(1.72) ^a	0.53(1.02) ^a	0.33(0.91) ^a	0.68(1.09) ^a	2.27(1.63) ^a	0.33(0.91) ^a	0.27(0.88) ^a	0.07(0.75) ^a
T ₅	Spinetoram 11.70% SC	54.0	2.47(1.70) ^a	1.05(1.24) ^{bc}	0.75(1.12) ^{bc}	1.24(1.32) ^{bc}	2.33(1.66) ^a	0.75(1.12) ^{bc}	0.65(1.07) ^{bc}	0.35(0.92) ^{bc}
T ₆	Untreated control	-	2.60(1.73) ^a	3.13(1.9) ^e	3.40(1.96) ^d	3.69(2.04) ^d	3.53(1.97) ^a	3.80(2.06) ^d	3.47(1.98) ^d	3.00(1.86) ^d
S.E.m±			0.05	0.04	0.06	0.06	0.04	0.05	0.06	0.05
CD at 5%			NS	0.13	0.18	0.19	NS	0.15	0.18	0.15

Figures in parentheses are $\sqrt{x + 0.5}$ transformed values.

DBS- Day before spray DAS- Days after spray NS- Non significant.

18.5% SC (0.33 larvae/ mrl), which was significantly superior over all other treatments. This treatment was followed by novaluron 5.25% + indoxacarb 4.50% SC with 0.63 larvae/ mrl and was on par with spinetoram 11.70% SC and flubendiamide 20% WG with 0.75, 0.97 larvae/ mrl respectively. The next best treatment was emamectin benzoate 5% SG with 1.12 larvae/ mrl. However, all the treatments were statistically superior over untreated control with 3.80 larvae/ mrl. Seventh and ten days after treatment same trend was followed with respect to the larval population (Table 1).

Tobacco caterpillar

As revealed in Table 2, one day before spraying there was no significant difference in *Spodoptera litura* larval population among the different treatment during summer. After third days of spraying, lowest Spodoptera larval population was recorded in the plots treated with chlorantraniliprole 18.5% SC (0.53 larvae/ mrl) which was significantly superior over all other treatments. This treatment was followed by novaluron 5.25% + indoxacarb 4.50% SC with 0.89 larvae/ mrl and was on par with spinetoram 11.70% SC with 1.06 larvae/ mrl. The next best treatment was flubendiamide 20% WG with larval population of 1.30 larvae/ mrl and was followed by emamectin benzoate 5% SG with 1.50 larvae/ mrl. However, all the treatments were statistically superior over untreated control with 3.13 larvae per meter row length. Seventh and ten days after treatment same trend was followed with respect to the larval population.

During second spray, day before imposing the treatment there is no significance difference in the treatment. three days after imposition of treatment plot treated with chlorantraniliprole 18.5% SC (0.53 larvae/ mrl) which was significantly superior over all other treatments. This treatment was followed by novaluron 5.25 % + indoxacarb 4.50 % SC with 0.89 larvae/ mrl and was on par with spinetoram 11.70% SC with 1.06 larvae/ mrl. The next best treatment was flubendiamide 20 % WG with larval population of 1.30 larvae/ mrl and was followed by emamectin benzoate 5% SG with 1.50 larvae/ mrl. However, all the treatments were statistically superior over untreated control with 3.13 larvae per meter row length. Seven and Ten days after treatment same trend was followed with respect to the larval population. However, untreated control plot recorded highest larval population (Table 2).

Girdle beetle incidence

Day before spray girdle beetle infestation ranged from 8.25 to 9.33 per cent and there is no significant difference among the treatments (Table 3).

Table 2 : Bio-efficacy of promising insecticides against *Spodoptera litura* on soybean during summer.

Tr. No.	Treatment details	Dosage (g a.i./ha)	Number of larvae/meter row length									
			First spray					Second spray				
			DBS	3 DAS	7 DAS	10 DAS	DBS	3 DAS	7 DAS	10 DAS	DBS	10 DAS
T ₁	Flubendiamide 20 % WG	50.0	2.60(1.76) ^a	1.30(1.34) ^{cd}	0.96(1.21) ^{bc}	1.48(1.41) ^{bc}	2.60(1.76) ^a	0.96(1.21) ^{bc}	0.59(1.04) ^{cd}	0.49(0.99) ^{bc}		
T ₂	Emamectin benzoate 5% SG	7.50	2.80(1.79) ^a	1.50(1.41) ^d	1.13(1.28) ^c	1.69(1.48) ^c	2.67(1.75) ^a	1.12(1.27) ^c	0.73(1.11) ^d	0.62(1.06) ^c		
T ₃	Novaluron 5.25%+Indoxacarb 4.50% SC	43.31+37.13	2.73(1.79) ^a	0.89(1.18) ^b	0.62(1.06) ^{ab}	1.06(1.25) ^{ab}	2.60(1.76) ^a	0.62(1.06) ^{ab}	0.29(0.89) ^{ab}	0.22(0.85) ^{ab}		
T ₄	Chlorantraniliprole 18.5% SC	30.0	2.80(1.77) ^a	0.53(1.02) ^a	0.33(0.91) ^a	0.68(1.09) ^a	2.53(1.70) ^a	0.33(0.91) ^a	0.07(0.75) ^a	0.00(0.71) ^a		
T ₅	Spinetoram 11.70% SC	54.0	2.67(1.76) ^a	1.06(1.25) ^{bc}	0.78(1.13) ^{bc}	1.25(1.32) ^{bc}	2.57(1.73) ^a	0.75(1.12) ^{bc}	0.43(0.96) ^{bc}	0.34(0.92) ^{bc}		
T ₆	Untreated control	-	2.73(1.77) ^a	3.13(1.90) ^e	3.40(1.96) ^d	3.60(2.01) ^d	3.87(2.05) ^a	3.80(2.06) ^d	3.33(1.95) ^e	3.00(1.86) ^d		
S.E.m±			0.05	0.05	0.06	0.07	0.06	0.06	0.04	0.06		
CD at 5%			NS	0.15	0.18	0.21	NS	0.18	0.14	0.18		

Figures in parentheses are $\sqrt{x + 0.5}$ transformed values.

NS- Non significant.

Girdle beetle infestation during the study period was very less hence; the cumulative incidence was worked out by taking all the observations at 3, 7, 10 and 15 days after spraying. The significantly lowest cumulative incidence of 2.11% was recorded in chlorantraniliprole 18.5% SC treatment and was superior over all other treatments. The next best treatment was novaluron 5.25% + indoxacarb 4.50% SC with 3.67% cumulative incidence and was on par with spinetoram 11.70% SC with 4.63% cumulative incidence of girdle beetle. The next best treatments were flubendiamide 20% WG and emamectin benzoate 5% SG with 5.11% and 6.33% cumulative incidence of girdle beetle damage respectively. However, untreated control recorded highest per cent cumulative incidence of 11.33%.

Percent foliage damage

The lowest per cent foliage damage of 7.86 per cent was recorded in chlorantraniliprole 18.5% SC treatment and was superior over all other treatments. The next best treatment was novaluron 5.25% + indoxacarb 4.50% SC with 9.96 per cent foliage damage and was on par with spinetoram 11.70% SC, flubendiamide 20% WG and emamectin benzoate 5% SG with 11.56, 12.11 and 12.45 per cent foliage damage respectively. However, untreated control recorded highest per cent foliage damage of 26.29 per cent (Table 3).

Percent pod damage

Data pertaining to per cent pod damage was given in the (Table 3). During the present study, significantly lowest per cent pod damage of 3.26% was recorded in the chlorantraniliprole 18.5% SC treatment and was followed by novaluron 5.25% + indoxacarb 4.50% SC with 4.65% pod damage. The next best treatments were spinetoram 11.70% SC (6.11% pod damage) flubendiamide 20% WG (7.00% pod damage) and emamectin benzoate 5% SG (7.86% pod damage). However, untreated control recorded highest per cent pod damage of 24.36 per cent.

Yield

The impact of different treatments on grain yield of soybean revealed that, all the treatments were significantly superior over untreated check in suppressing the pest population throughout the cropping period and by increasing soybean grain yield.

During the present study, the highest grain yield was obtained in the treatment chlorantraniliprole 18.5 % SC (14.9 q/ha). The next best treatment was novaluron 5.25% + indoxacarb 4.50% SC (13.5 q/ha). This treatment was on par with spinetoram 11.70% SC and flubendiamide 20% WG with (11.75 and 11.21 q/ha), respectively. Further, the plots treated with emamectin benzoate 5%

Table 3 : Bio-efficacy of promising insecticides against girdle beetle incidence, foliage and pod damage due to defoliators during summer.

Tr. No.	Treatment details	Dosage (g a.i./ha)	1DBS	Mean girdle beetle incidence (%)	Foliage damage (%)	Pod damage (%)	Yield (q/ha)
T ₁	Flubendiamide 20% WG	50.0	8.25(16.40) ^a	5.11(12.84) ^{cd}	12.11(20.35) ^b	7.00(15.33) ^{bc}	11.21 ^{bc}
T ₂	Emamectin benzoate 5% SG	7.50	9.11(17.24) ^a	6.33(13.62) ^d	12.45(20.65) ^b	7.86(16.27) ^c	10.90 ^c
T ₃	Novaluron 5.25%+ Indoxacarb 4.50 % SC	43.31+ 37.13	9.30(17.70) ^a	3.67(11.03) ^b	9.96(18.37) ^{ab}	4.65(12.43) ^{ab}	13.50 ^{ab}
T ₄	Chlorantraniliprole 18.5% SC	30.0	8.68(16.56) ^a	2.11(8.35) ^a	7.86(16.27) ^a	3.26(10.40) ^a	14.90 ^a
T ₅	Spinetoram 11.70 % SC	54.0	9.33(17.73) ^a	4.63(11.95) ^{bc}	11.56(19.84) ^b	6.11(14.29) ^{bc}	11.75 ^{bc}
T ₆	Untreated control	-	9.25(17.31) ^a	11.33(19.55) ^e	26.29(30.70) ^c	24.36(29.42) ^d	5.11 ^d
S.Em ±			0.10	0.33	1.02	0.94	0.31
CD at 5 %			NS	0.99	3.07	2.82	0.94

Figures in the parentheses are arcsine transformed values; DBS: Days before spray.

SG recorded 10.9 q/ha of soybean grain yield. However, the lowest grain yield of 5.11 q/ha was recorded from untreated plot.

The present findings are in conformity with Bokan *et al.* (2021b), who reported that chlorantraniliprole 18.5 SC @ 30 g a.i./ha was the most effective in suppressing the larval population of soybean semilooper and recorded maximum yield. Similarly, Bhamare *et al.* (2020) reported that, chlorantraniliprole (0.004%) found most effective treatment in reducing the population of *S. litura* (0.81 larvae/ mrl) and recorded maximum grain yield (34.87 q/ha) of soybean. Chaudhari *et al.* (2020) reported that chlorantraniliprole 18.5 SC @ 150 ml /ha, flubendiamide 39.35 SC @ 100 ml/ha, spinosad 45 SC @ 250 ml/ha and emamectin benzoate 5 SG @ 200 g/ha were found effective for the control of tobacco leaf eating caterpillar and green semilooper with recording the highest grain yield of 26.73 q/ha, 26.01 q/ha, 22.77 q/ha and 25.89 q/ha, respectively. Meena *et al.* (2014), who reported that chlorantraniliprole (30 g a.i./ha) reduced the per cent pod damage (15.91%) and protecting the soybean crop from the infesting lepidopteran pests. Similarly, chlorantraniliprole 18.5% SC was found effective in managing the pod borers in soybean (Kambrekar *et al.*, 2017). Bokan *et al.* (2021a) reported that, chlorantraniliprole 0.4 GR @ 40g a.i./ ha effective against soybean girdle beetle *Obereopsis brevis* and recorded highest yield of soybean. Similarly, Bhamare *et al.* (2020) reported that, chlorantraniliprole 0.004% was found effective insecticide in minimizing infestation due to *O. brevis* on soybean (6.10% and 3.77% per mrl) after first

and second sprays and recorded highest grain yield and incremental cost benefit ratio.

Bokan *et al.* (2021b) reported that, chlorantraniliprole 18.5 SC recorded maximum yield 27.03 q/ha and recorded, lowest population of semilooper. Similarly, Bhamare *et al.* (2020) recorded the maximum yield in the treatment chlorantraniliprole 0.004 per cent (34.87 q/ha) and recorded lowest population of *Spodoptera litura* in soybean. In another study, Chaudhari *et al.* (2020) recorded significantly highest grain yield (11.67 q/ha) in the plots treated with chlorantraniliprole 18.5% SC and lowest population of leaf eating caterpillars in soybean.

Conclusion

Among the different insecticides used to manage the lepidopteron pests and girdle beetle infesting soybean during summer season, chlorantraniliprole 18.5% SC was found to be effective in suppressing the larval population of semiloopers and tobacco caterpillars and girdle beetle damage on soybean crop and recorded the highest grain yield of (14.9 q/ha) soybean, followed by novaluron 5.25% + indoxacarb 4.50% SC with grain yield of 13.5 q/ha. The next best treatments found effective in managing pests were spinetoram 11.70% SC (11.75 q/ha), flubendiamide 20% WG (11.21 q/ha) and emamectin benzoate 5% SG (10.9 q/ha). However, the lowest grain yield of 5.11 q/ha was recorded from untreated plot.

The highest Benefit: Cost ratio (1.99) was recorded in chlorantraniliprole 18.5% SC followed by novaluron 5.25% + indoxacarb 4.50% SC (1.81), emamectin benzoate 5% SG (1.52), spinetoram 11.70% SC (1.48)

respectively and minimum Benefit: Cost ratio was recorded in flubendiamide 20% WG (1.40).

Chlorantraniliprole 18.5% SC @ 30 g a.i/ha, novaluron 5.25% + indoxacarb 4.50% SC @ 43.31+37.13 g a.i/ha and spinetoram 11.70% SC @ 54 g a.i/ha can be effectively used to suppress the lepidopteron pests and girdle beetle infestation on soybean crop during summer season.

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