The Pharma Innovation Journal 2023; SP-12(10): 1379-1384

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; SP-12(10): 1379-1384

www.thepharmajournal.com
Received: 25-08-2023
Accepted: 30-09-2023

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Efficacy of different combination insecticides against defoliators and sucking pests of soybean

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Abstract
The present study was conducted in Regional Sugarcane and Rice Research Station, Rudrur of Nizamabad District, Telangana State to evaluate the efficacy of different combination insecticides available in the market against defoliators and sucking pests of JS-335 Soybean variety. There were total eight treatments including untreated control. The randomized complete block design was followed with three replications of each treatment. Insecticides were sprayed 30 and 50 days after sowing when the pest had reached the economic threshold level and data was recorded after five and ten days after treatment for comparison with pre-treatment pest population data. Results revealed that spraying of combination insecticide, Chlorantraniliprole 8.8% + Thiomethoxam 17.5% SC @ 500ml ha^{-1} twice at 30 days and 50 days after sowing had reduced population of both defoliators (*Spodoptera litura & Chrysodeixis acuta*) and sucking pests like aphids and whiteflies in soybean crop to the tune of 84.25 percent and 76.56 percent over control, respectively. Plots treated with said insecticide has recorded maximum yield of 1617 kg ha^{-1} with benefit cost ratio of 1.79. The treatment was followed by Emamectin benzoate 3% + Thiomethoxam 12% WG @ 312.5 g ha^{-1} with yield and benefit cost ratio of 1424 and 1.72, respectively.

Keywords: Soybean, combination insecticides, defoliators, aphids, whitefly and yield

Introduction
Soybean is the unique crop playing an important role in augmenting the production of both oil and pulse. It is a two dimensional crop as it contains about 40-42 percent high quality protein and 20-22 percent oil. It also contains 20-30 percent carbohydrates. The protein quality of soybean is equivalent to that of meat, milk products and eggs. In India, area under soybean during 2022-23 was 120.90 lakh hectares as against 120.86 lakh hectares during 2021-22. Among the states, Madhya Pradesh stood first with 50.18 lakh ha followed by Maharashtra (49.10 lakh ha), Rajasthan (11.51 lakh ha), Karnataka (4.43 lakh ha), Gujarat (2.22 lakh ha) and Telangana (1.75 lakh ha). According to the first advance estimates 2022-23, Government of India, soybean crop is estimated at 128.92 lakh tonnes as compared to 129.95 lakh tonnes in 2021-22. In Telangana, by the end of September 2022 area under soybean was 1.73 lakh ha as against 1.50 lakh ha during 2021-22 [1]. In India one of the major constraints in increasing productivity is damage caused by insect pests. The crop is infested by more than 275 insect pests on different plant parts of soybean throughout its growth stage and about a dozen of them *viz.*, girdle beetle, tobacco caterpillar, green semilooper, *Helicoverpa armigera*, aphids, jassids and white fly have been reported causing serious damage to soybean from sowing to harvesting (Ramesh *et al.*, 2017) [2]. The tobacco caterpillar, *Spodoptera litura* (Fab) is a serious and regular pest in soybean (Ramesh *et al.*, 2018) [3]. It damages soybean from mid-August to October in kharif and from November to March in *rabi*. After damaging the leaves, they start feeding on younger parts, subsequently damaging 30 to 50 percent of the pods, similarly *Chrysodeixis acuta* cause 19% defoliation (Musser and Catchot, 2009) [4]. As Soybean attracts many insect pests which often pose a serious threat to its production by increasing cost of cultivation (Singh *et al.*, 1998) [5]. Numbers of insecticide have been recommended against insect pests of soybean. However, many of them either have lost their efficacy or banned recently due to development of resistance in the insect or their residual toxicity problems. There is always a need to know the activities of the pest in a cropping system and evaluate insecticides for effective and economical management of the pest. Thus the search for newer and most effective insecticides for the management of major insect pests is quite essential to avoid the yield losses. Hence, the present investigation is planned with an objective to evaluate the efficacy of combination insecticide molecule, which can effectively manage major defoliators and sucking pests of soybean.

Materials and Methods

A field experiment was carried out during kharif, 2022 at Regional Sugarcane and Rice Research station, Rudrur, Nizamabad, Telangana. Sowing of popular soybean variety JS-335 with 45cm distance between two rows and 5cm between two plants with a plot size 25sq.m was taken up. The experiment was laid out in Randomized Block Design with 8 treatments in three replications including untreated control to compare the efficacy of insecticides against major defoliators and sucking pests of soybean *viz.*, Beta-cyfluthrin 8.49 + Imidacloprid 19.81% w/w @ 350 ml ha^{-1}, Thiomethoxam 12.6% + Lambda cyhalothrin 9.5% ZC @ 200 ml ha^{-1}, Emamectin benzoate 3% + Thiomethoxam 12% WG @ 312.5 g ha^{-1}, Acephate 50% + Imidacloprid 1.8% SP @ 1000 g ha^{-1}, Fipronil 4% + Acetamiprid 4% SC @ 1000 ml ha^{-1}, Chlorantraniliprole 8.8% + Thiomethoxam 17.5%SC @ 500 ml ha^{-1}, Profenophos 50%EC @ 1000 ml ha^{-1} and untreated control (water spray). The spraying was done in morning hours between 9.0 to 10.0 a.m., totally two sprayings by knapsack sprayers were given 30 and 50 days after sowing respectively. The pre-treatment count of insect was made one day before and post treatment population count was taken on 5 and 10 days after the spraying. The number of defoliator larvae/meter row length (mrl) was recorded at three places. Aphids and White fly population was recorded from 3 leaves (Top, middle and bottom) on randomly selected ten plants from each plot (Sharma, 1996) [6]. The data obtained one day before and 5 and 10days after spray were taken into consideration to calculate the reduction in the population which was done by applying a correction factor given by Henderson and Tilton (1955) [7]. The statistical analysis (analysis of variance) of the data was carried out by transforming the insect data into square root transformed values as per the procedure suggested by Gomez and Gomez (1984) [8]. Yield of soybean from each plot was recorded separately and computed on hectare basis.

Results and Discussion

Infestation of defoliators *viz., Spodoptera litura & Chrysodeixis acuta* were observed during soybean crop growth period, similarly incidence of sucking pests like aphids and whitefly population recorded on crop.

Comparative efficacy of different insecticides against defoliators after first spray.

Incidence of larval population was recorded in meter row length in all the plots treated with different insecticides, one day prior imposition and 5 & 10 days after imposition of treatments.

One day prior to the application of first spray with different insecticides

One day before imposition of treatments, number of larvae present per meter row length was recorded in all the plots. Larval population was almost similar in all the plots ranging from 2.85 to 3.25 per mrl (Table 1). There was no significant statistical difference between larval populations was recorded among the different plots.

Five days after imposition of the treatments after first spray

As per the data mentioned in the Table 1, it was observed that, five days after first spray all the treatments were significantly superior over untreated control. The larval population ranging from 0.52 to 1.25 larvae/mrl in plots treated with T6: Chlorantraniliprole 8.8% + Thiomethoxam 17.5%SC @ 500 ml ha^{-1} and T4: Acephate 50% + Imidacloprid 1.8% SP @ 1000 g ha^{-1}, respectively. Untreated control plot recorded 3.00 larvae /mrl.

Ten days after imposition of the treatments after first spray

The data presented in Table 1 indicated that, 10 days after first spray all the treatments were significantly superior over untreated control in terms of larval population. Maximum incidence of defoliators was recorded in control plot with 3.15larvae/mrl. Among the plots imposed with treatments, least population of 0.60 larvae/mrl was recorded in plots treated with Chlorantraniliprole 8.8% + Thiomethoxam 17.5%SC @ 500 ml ha^{-1}**.**

Mean number of larval population per mrl after first spray

Similar trend was observed in larval population/ mrl in all the plots treated with different insecticides. T6: Chlorantraniliprole 8.8% + Thiomethoxam 17.5%SC @ 500 ml ha^{-1} was found to be superior over other treatments by reducing larval population per mrl to 0.56 with 81.62 percent reduction of defoliators over control, followed by T3: Emamectin benzoate 3% + Thiomethoxam 12% WG @ 312.5 g ha^{-1} with mean larval population of 0.73 per mrl and percent reduction of 76.29 over control.

Comparative efficacy of different insecticides against Aphids after first spray.

Incidence of aphids was noticed 25 days after planting till pod formation stage with fluctuation in population during crop growth period. Number of aphids present on three leaves was randomly taken from 10 plants of all the plots treated with different insecticides, one day prior imposition and 5 & 10 days after imposition of treatments.

One day prior to the application of first spray with different insecticides

The data mentioned in the Table 1 indicated that the aphids population was ranging between 18.90 to 19.35 no. per 3 leaves. There was no significant variation in aphids population was observed among all the treatments including untreated control.

Five days after imposition of the treatments after first spray

Five days after first spray, all the treatments were significantly superior over untreated control. The aphids population ranging from 1.90 no./3 leaves in plots treated with T4: Acephate 50% + Imidacloprid 1.8% SP @ 1000 g ha^{-1} to 5.70 no./3 leaves in plots treated with T7: Profenophos 50%EC @ 1000 ml ha^{-1}. Untreated control plot recorded 19.80 no. aphids per 3 leaves.

Ten days after imposition of the treatments after first spray

As per the data mentioned in Table 1, it was observed that ten days after first spray the least aphids population of 3.55no. of aphids per 3 leaves was recorded in plots treated with T4: Acephate 50% + Imidacloprid 1.8% SP @ 1000 g ha^{-1} and among the plots imposed with treatments, maximum aphids population of 6.30no.per 3 leaves was recorded in plots treated with T7: Profenophos 50%EC @ 1000 ml ha^{-1}. Highest number of insects 20.15aphids per 3 leaves was recorded in untreated control plots.

Mean number of Aphids population per three leaves after first spray

All the treatments are significantly superior over the untreated control. Among them, T4: Acephate 50% + Imidacloprid 1.8% SP @ 1000 g ha^{-1} was found to be significantly superior over all other treatments with 86.79 percent reduction over control with mean count 2.72no. of aphids/3 leaves, followed by T6: Chlorantraniliprole 8.8% + Thiomethoxam 17.5%SC @ 500 ml ha^{-1} with 84.31percent reduction and aphid mean count of 3.20no. per 3 leaves.

Comparative efficacy of different insecticides against defoliators after second spray.

Considering incidence of defoliators, a second spray of the same treatments was given 55 days after planting of soybean to assess the performance of insecticides.

One day prior to the application of second spray with different insecticides

One day prior to imposition of treatments, number of larvae present per meter row length was recorded in all the plots. There was no statistical significant variation between larval population was recorded among the different plots. Larval population was ranging from 2.81 to 3.26 per mrl (Table 2).

Five days after imposition of the treatments after second spray

As per the data mentioned in Table 2, five days after second spray, all the treatments were significantly superior over untreated control. Minimum number of larval count *i,e* 0.50 no. per mrl was recorded in plots treated with T6: Chlorantraniliprole 8.8% + Thiomethoxam 17.5%SC @ 500 ml ha^{-1} followed by T3: Emamectin benzoate 3% + Thiomethoxam 12% WG @ 312.5 g ha^{-1} which recorded 0.84 larvae per mrl.

Ten days after imposition of the treatments after second spray

The data presented in Table 2 indicated that, 10 days after second spray all the treatments were significantly superior over untreated control. Among the plots treated with different insecticides, least population of 0.65 larvae/mrl was recorded in plots treated with Chlorantraniliprole 8.8% + Thiomethoxam 17.5%SC @ 500 ml ha^{-1}**.** Maximum incidence of defoliators was recorded in control plot with 4.43 larvae per mrl.

Mean number of larval population per mrl after second spray

Larval population was recorded 5 and 10 days after second spray, mean larval count was calculated to assess comparative efficacy of treatments. Among the treatments imposed, T6: Chlorantraniliprole 8.8% + Thiomethoxam 17.5%SC @ 500 ml ha^{-1} was found to be significantly superior over other treatments by reducing larval population per mrl to 0.58 with 86.80 percent reduction of defoliators over control, followed by T3: Emamectin benzoate 3% + Thiomethoxam 12% WG @ 312.5 g ha^{-1} with mean larval population of 0.83 larave per mrl and percent reduction of 81.01 over control.

Comparative efficacy of different insecticides against whitefly after second spray.

Incidence of whitefly was noticed in soybean throughout crop period from 20 days after planting. Number of whiteflies present on three leaves was randomly taken from 10 plants in all the plots treated with different insecticides, one day prior and 5 & 10 days after imposition of the treatments.

One day prior to the application of second spray with different insecticides

On perusal of data presented in the Table 2, it was observed that the whitefly population was ranging between 2.81 to 3.25 no. per 3 leaves. There was no significant variation in whitefly population was recorded between the plots.

Five days after imposition of the treatments after second spray

As per the data presented in Table 2, five days after second spray, all the treatments were significantly superior over untreated control. The whitefly population ranging from 0.55 no./3 leaves in plots treated with T4: Acephate 50% + Imidacloprid 1.8% SP @ 1000 g ha^{-1} to 1.52 no./3 leaves in plots treated with T7: Profenophos 50%EC @ 1000 ml ha^{-1}. Untreated control plot recorded maximum of 3.80 no. whiteflies per 3 leaves.

Ten days after imposition of the treatments after second spray

Ten days after second spray the least whitefly population of 1.11no. per 3 leaves was recorded in plots treated with T5: Fipronil 4% + Acetamiprid 4% SC @ 1000 ml ha^{-1} followed by T3: Emamectin benzoate 3% + Thiomethoxam 12% WG @ 312.5 g ha^{-1} which recorded whitefly population of 1.42 per mrl. Maximum infestation of whitefly 3.90 per 3 leaves was recorded in untreated control plots.

Mean number of whiteflies per three leaves after second spray

All the treatments are significantly superior over the untreated control. Among the treatments T5: Fipronil 4% + Acetamiprid 4% SC @ 1000 ml ha^{-1} was found to be superior over all other treatments with 74.58 percent reduction of whiteflies over control with mean population of 0.98 no. of whiteflies/3 leaves, followed by T4: Acephate 50% + Imidacloprid 1.8% SP @ 1000 g ha^{-1}with 73.15 percent reduction and whitefly mean count of 1.04 no. per 3 leaves.

Pooled efficacy of various treatments against defoliators after two consecutive sprays on soybean revealed that T6: Chlorantraniliprole 8.8% + Thiomethoxam 17.5%SC @ 500 ml ha^{-1} was superior in suppressing defoliators population to the tune of 84.25 percent over untreated control (Table 3). Whereas, data presented in table 4 indicated that the treatment T4: Acephate 50% + Imidacloprid 1.8% SP @ 1000 g ha^{-1} was found to be superior among all the treatments in reducing sucking pests such as aphids and whiteflies populations to the tune of 79.97 percent over control. Research on efficacy of combination insecticides against soybean insect pests is lacking however, one of the components of the treatment *i.e* Chlorantraniliprole was found to be effective against tobacco caterpillar in soybean (Sonkamble *et al*., 2018) [9], defoliators in sunflower (Muzamil *et al*., 2017) [10] and larval population in black gram (Patidar and Kumar, 2018) [11]. Similarly, Dinesh *et al.*, 2018 [12] expressed that the insecticide Thiomethoxam 25WG had effectively reduced whitefly population in soybean.

Effect of different treatments on yield and cost economics

Yield data recorded at harvest was converted from kg plot $^{-1}$ to kg ha^{-1}. Among all the treatments T6: Chlorantraniliprole 8.8% + Thiomethoxam 17.5%SC @ 500 ml ha^{-1} was found to be superior with yield of 1617 kg ha^{-1} With benefit cost ratio of 1.79, followed by T3: Emamectin benzoate 3% +

Thiomethoxam 12% WG @ 312.5 g ha^{-1}, which recorded yield of 1506 kg ha^{-1} with benefit cost ratio of 1.72. Untreated control plot recorded yield of 1062 kg ha^{-1} and benefit cost ratio of 1.27.

Table 1: I Spray - Bioefficacy of different insecticides against defoliators and aphids during *kharif*, 2022

S. No	Treatments	Defoliators (No./mrl)					Aphids (No./3leaves)				
		Pre-count (No.)	5DAT (No.)	10DAT (No.)	Mean	Percent reduction over control	Pre-count (No.)	5DAT (No.)	10DAT (No.)	Mean	Percent reduction over control
1	T1: Beta-cyfluthrin 8.49 + Imidacloprid 19.81% w/w @ 350 ml ha^{-1}	2.87	0.90(0.95)	0.78(0.88)	0.87(0.93)de	71.67	19.20	4.20(2.05)	4.30(2.07)	4.25(2.06)c	79.30
2	T2: Thiomethoxam 12.6% + Lambda cyhalothrin 9.5% ZC @ 200 ml ha^{-1}	3.05	1.02(1.01)	0.90(0.95)	0.96(0.98)cd	68.53	19.33	3.80(1.95)	3.60(1.90)	3.70(1.92)d	81.86
3	T3: Emamectin benzoate 3% + Thiomethoxam 12% WG @ 312.5 g ha^{-1}	3.12	0.78(0.88)	0.68(0.82)	0.73(0.85)ef	76.29	18.90	3.10(1.76)	3.65(1.91)	3.37(1.84)de	83.49
4	T4: Acephate 50% + Imidacloprid 1.8% SP @ 1000 g ha^{-1}	3.14	1.25(1.12)	1.10(1.05)	1.18(1.09)b	61.87	19.11	1.90(1.38)	3.55(1.88)	2.72(1.65)f	86.79
5	T5: Fipronil 4% + Acetamiprid 4% SC @ 1000 ml ha^{-1}	2.85	1.21(1.10)	1.11(1.05)	1.16(1.08)bc	61.98	19.23	2.60(1.61)	4.78(2.19)	3.69(1.92)d	81.90
6	T6: Chlorantraniliprole 8.8% + Thiomethoxam 17.5%SC @ 500 ml ha^{-1}	3.25	0.52(0.72)	0.60(0.77)	0.56(0.75)f	81.68	18.95	2.60(1.61)	3.80(1.95)	3.20(1.79)e	84.31
7	T7: Profenophos 50%EC @ 1000 ml ha^{-1}	2.89	1.20(1.10)	1.25(1.12)	1.23(1.11)b	60.12	19.35	5.70(2.39)	6.30(2.51)	6.00(2.45)b	70.63
8	T8: Untreated control	2.95	3.00(1.73)	3.15(1.77)	3.08(1.75)a	0.00	19.10	19.80(4.45)	20.15(4.49)	19.97(4.47)a	0.00
	S.Em(+)	-	0.11	0.07	0.07		-	0.38	0.25	0.28	
	CD (5%)	NS	0.33	0.22	0.21		NS	1.16	0.76	0.85	
	CV	-	15.44	10.59	10.08		-	12.16	6.91	8.24	

Values in the parenthesis are square root transformed values

Table 2: II Spray - Bioefficacy of different insecticides against defoliators and whitefly during *kharif*, 2022

S. No	Treatments	Defoliators (No./mrl)					Whitefly (No./3leaves)				
		Pre-count (No.)	5DAT (No.)	10DAT (No.)	Mean	Percent reduction over control	Pre-count (No.)	5DAT (No.)	10DAT (No.)	Mean	Percent reduction over control
1	T1: Beta-cyfluthrin 8.49 + Imidacloprid 19.81% w/w @ 350 ml ha^{-1}	2.81	0.92(0.96)	1.10(1.05)	1.01(1.00)c	76.74	2.81	1.25(1.12)	1.60(1.26)	1.43(1.19)bc	62.96
2	T2: Thiomethoxam 12.6% + Lambda cyhalothrin 9.5% ZC @ 200 ml ha^{-1}	3.10	1.25(1.12)	1.32(1.15)	1.29(1.14)b	70.42	2.95	1.32(1.15)	1.45(1.20)	1.39(1.18)bc	64.03
3	T3: Emamectin benzoate 3% + Thiomethoxam 12% WG @ 312.5 g ha^{-1}	2.78	0.84(0.92)	0.81(0.90)	0.83(0.91)d	81.01	3.10	1.12(1.06)	1.42(1.19)	1.27(1.13)cd	66.99
4	T4: Acephate 50% + Imidacloprid 1.8% SP @ 1000 g ha^{-1}	3.21	1.22(1.10)	1.31(1.14)	1.27(1.13)b	70.88	3.23	0.55(0.74)	1.52(1.23)	1.04(1.02)de	73.15
5	T5: Fipronil 4% + Acetamiprid 4% SC @ 1000 ml ha^{-1}	3.26	1.21(1.10)	1.38(1.17)	1.30(1.14)b	70.20	2.90	0.85(0.92)	1.11(1.05)	0.98(0.99)e	74.58
6	T6: Chlorantraniliprole 8.8% + Thiomethoxam 17.5%SC @ 500 ml ha^{-1}	3.20	0.50(0.71)	0.65(0.81)	0.58(0.76)e	86.80	3.25	0.82(0.91)	1.58(1.26)	1.20(1.10)cde	68.81
7	T7: Profenophos 50%EC @ 1000 ml ha^{-1}	2.81	1.35(1.16)	1.38(1.17)	1.39(1.18)b	68.09	3.10	1.52(1.23)	1.81(1.35)	1.67(1.29)b	56.73
8	T8: Untreated control	2.95	4.27(2.07)	4.43(2.10)	4.35(2.09)a	0.00	2.88	3.80(1.95)	3.90(1.97)	3.85(1.96)a	0.00
	S.Em (+)		0.09	0.1	0.05			0.09	0.1	0.08	
	CD (5%)	NS	0.27	0.31	0.15		NS	0.27	0.3	0.24	
	CV		10.48	11.38	5.63			10.88	9.64	8.60	

Values in the parenthesis are square root transformed values

Table 3: Bioefficacy of different insecticides against defoliators *kharif*, 2022

S. o	Treatments	Percent reduction over control I Spray	Percent reduction over control II Spray	Mean
1	T1: Beta-cyfluthrin 8.49 + Imidacloprid 19.81% w/w @ 350 ml ha^{-1}	71.67	76.74	74.25
2	T2: Thiomethoxam 12.6% + Lambda cyhalothrin 9.5% ZC @ 200 ml ha^{-1}	68.53	70.42	69.56
3	T3: Emamectin benzoate 3% + Thiomethoxam 12% WG @ 312.5 g ha^{-1}	76.29	81.01	78.64
4	T4: Acephate 50% + Imidacloprid 1.8% SP @ 1000 g ha^{-1}	61.87	70.88	66.35
5	T5: Fipronil 4% + Acetamiprid 4% SC @ 1000 ml ha^{-1}	61.98	70.20	66.14
6	T6: Chlorantraniliprole 8.8% + Thiomethoxam 17.5%SC @ 500 ml ha^{-1}	81.68	86.80	84.25
7	T7: Profenophos 50%EC @ 1000 ml ha^{-1}	60.12	68.09	64.38
8	T8: Untreated control	0.00	0.00	0.00

Table 4: Bioefficacy of different insecticides against sucking pests *kharif*, 2022

S. No	Treatments	Percent reduction over control I Spray	Percent reduction over control II Spray	Mean
1	T1: Beta-cyfluthrin 8.49 + Imidacloprid 19.81% w/w @ 350 ml ha^{-1}	79.30	62.96	71.13
2	T2: Thiomethoxam 12.6% + Lambda cyhalothrin 9.5% ZC @ 200 ml ha^{-1}	81.86	64.03	72.95
3	T3: Emamectin benzoate 3% + Thiomethoxam 12% WG @ 312.5 g ha^{-1}	83.49	66.99	75.24
4	T4: Acephate 50% + Imidacloprid 1.8% SP @ 1000 g ha^{-1}	86.79	73.15	79.97
5	T5: Fipronil 4% + Acetamiprid 4% SC @ 1000 ml ha^{-1}	81.90	74.58	78.24
6	T6: Chlorantraniliprole 8.8% + Thiomethoxam 17.5%SC @ 500 ml ha^{-1}	84.31	68.81	76.56
7	T7: Profenophos 50%EC @ 1000 ml ha^{-1}	70.63	56.73	63.68
8	T8: Untreated control	0.00	0.00	0.00

Table 5: Yield observed in soybean plots treated with different combination insecticides

S. No	Treatments	Yield (kg ha^{-1}) *kharif*, 2022	Additional yield over control (kg ha^{-1})	Gross returns/ha	Total expenditure/ha	Net returns	B:C
1	T1: Beta-cyfluthrin 8.49 + Imidacloprid 19.81% w/w @ 350 ml ha^{-1}	1424	362	85,440	54,800	30,640	1.56
2	T2: Thiomethoxam 12.6% + Lambda cyhalothrin 9.5% ZC @ 200 ml ha^{-1}	1261	199	75,660	52,800	22,860	1.43
3	T3: Emamectin benzoate 3% + Thiomethoxam 12% WG @ 312.5 g ha^{-1}	1506	444	90,360	52,500	37,860	1.72
4	T4: Acephate 50% + Imidacloprid 1.8% SP @ 1000 g ha^{-1}	1336	274	80,160	52,400	27,760	1.53
5	T5: Fipronil 4% + Acetamiprid 4% SC @ 1000 ml ha^{-1}	1345	283	80,700	51,500	29,200	1.57
6	T6: Chlorantraniliprole 8.8% + Thiomethoxam 17.5%SC @ 500 ml ha^{-1}	1617	555	97,020	54,250	42,770	1.79
7	T7: Profenophos 50%EC @ 1000 ml ha^{-1}	1221	159	73,260	52,000	21,260	1.41
8	T8: Untreated control	1062	-	63,720	50,000	13,720	1.27

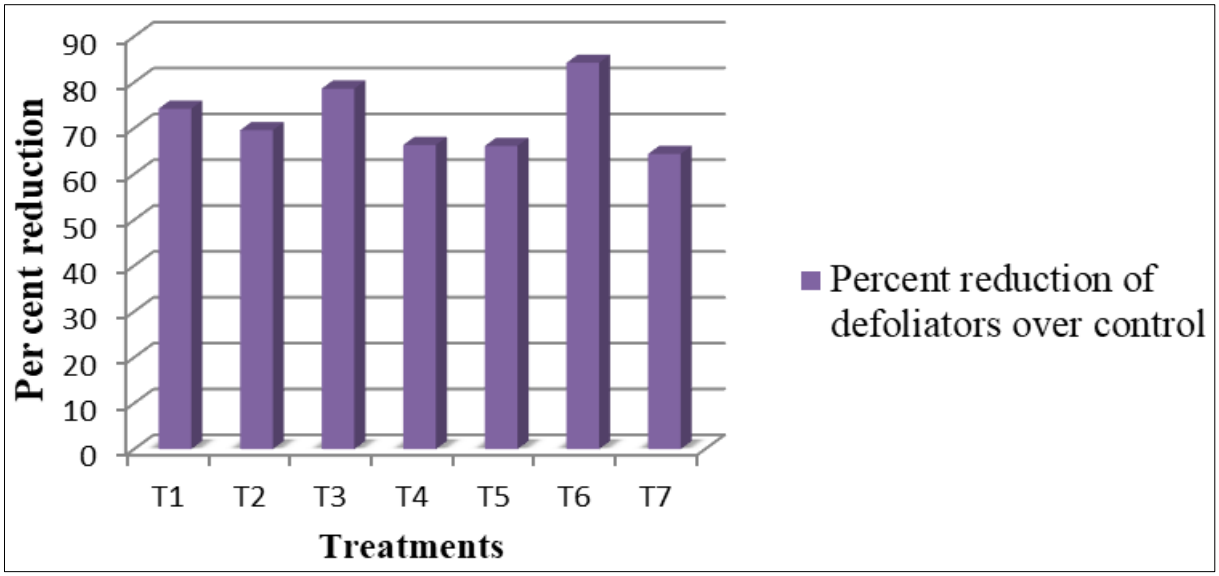

Fig 1: Mean efficacy of different combination insecticides against soybean defoliators

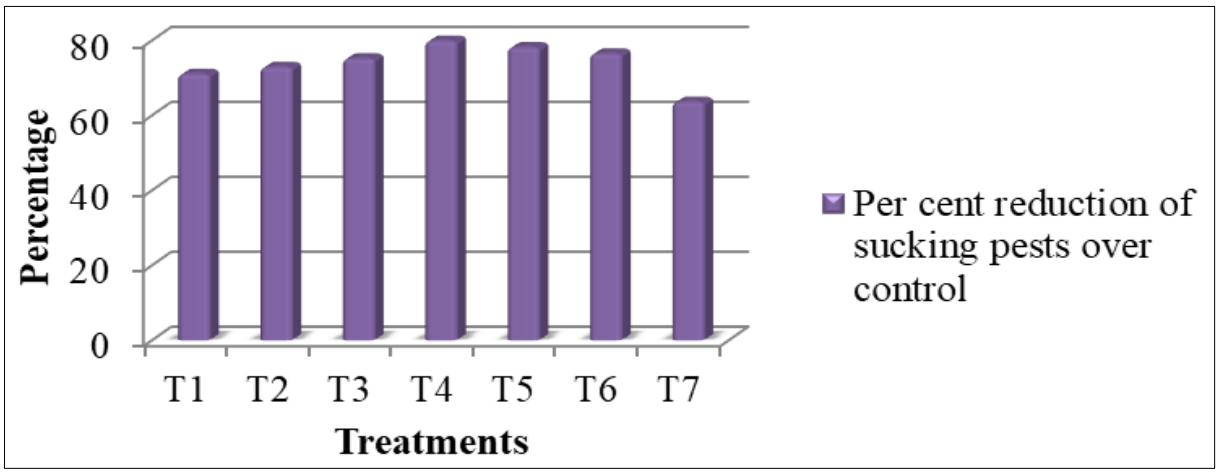

Fig 2: Mean efficacy of treatments against sucking pests of soybean

Treatment details

T1: Beta-cyfluthrin 8.49 + Imidacloprid 19.81% w/w @ 350 ml ha^{-1}
T2: Thiomethoxam 12.6% + Lambda cyhalothrin 9.5% ZC @ 200 ml ha^{-1}
T3: Emamectin benzoate 3% + Thiomethoxam 12% WG @ 312.5 g ha^{-1}
T4: Acephate 50% + Imidacloprid 1.8% SP @ 1000 g ha^{-1}
T5: Fipronil 4% + Acetamiprid 4% SC @ 1000 ml ha^{-1}
T6: Chlorantraniliprole 8.8% + Thiomethoxam 17.5%SC @ 500 ml ha^{-1}
T7: Profenophos 50% EC @ 1000 ml ha^{-1}

Conclusion

From the present investigation it can be concluded that the spraying of Chlorantraniliprole 8.8% + Thiomethoxam 17.5% SC @ 500ml ha^{-1} twice at 30 days and 50 days after sowing can be recommended as per admissibility for effective and economical management of both defoliators (*Spodoptera litura* & *Chrysodeixis acuta*) and sucking pests like aphids and whiteflies in soybean crop. So that maximum yield of soybean can be achieved by minimising expenditure on chemical control of defoliators and sucking pests. Other effective treatments with high B:C include Emamectin benzoate 3% + Thiomethoxam 12% WG @ 312.5 g ha^{-1} followed by Fipronil 4% + Acetamiprid 4% SC @ 1000 ml ha^{-1} and Beta-cyfluthrin 8.49 + Imidacloprid 19.81% w/w @ 350 ml ha^{-1} with 1.72, 1.57 and 1.56, respectively.

Acknowledgement

The authors gratefully acknowledge the financial and technical support provided by Professor Jayashankar Telangana State Agricultural University and the Regional Sugarcane and Rice Research Station, Rudrur for conducting of the experiment.

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