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Effect of newer insecticide against tobacco caterpillar (*Spodoptera litura*) infesting soybean

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Abstract
The field trail was carried out under field conditions at RARS, Ujjain during *Kharif* 2021 and 2022 seasons. During the season *kharif,* 2021 the untreated control had the highest mean pest count of 13.14 larave/mrl. Chlorantraniliprole 20 SC had the lowest mean pest count of 7.64 larave/mrl, indicating its higher efficacy. While Betacyfluthrin + Imidacloprid (11.13 larvae/mrl) reported highest pest count followed by Thiamethoxam + Lambda Cyhalothrin (10.35 larvae/mrl) reflecting less reduction in pest population. During the season *kharif,* 2022 Chlorantraniliprole 20 SC observed the lowest mean pest count of 7.75 larvae/mrl, highlighting its overall effectiveness followed by Emamectin benzoate 5 SG and Novaluron 05.25% + indoxacarb 04.50% with a pest count of 8.80 and 8.98 larvae/mrl, respectively. Treatments application of Betacyfluthrin + Imidacloprid showed highest mean pest counts of 11.46 larvae/mrl followed by Thiamethoxam + Lambda Cyhalothrin (11.00 larvae/mrl), Quinalphos 20 EC (10.21 larvae/mrl) and profenophos 50 EC (9.89 larvae/mrl), respectively.

Keywords: Tobacco caterpillar, Chlorantraniliprole, bioefficacy

Introduction
Soybean [*Glycine max* L. (Merrill)] is a legume crop belonging to sub family papilionaceae and family leguminaceae. It is one of the most important principal food plants since many years. Soybean is mainly grown for their seeds and second largest oil seed after groundnut and mustard. Various important names have been given to this crop as Miracle bean, Golden bean, Cow of the field, Meat of the field, Gold from soil and Pearl of the orient Cinderella crop. It is excellent source of protein (40-41%), fat (15-20%), carbohydrates (5-6%) and phospholipids (2%). Soybean is essentially rich in the amino acid, lysine (5%) which is deficient in most of the cereals. It is useful both as food, fodder and industrial crop and therefore it is called as ‘Wonder crop’ (Shrivastava *et al.*, 2008) [8]. Soybean is the cheapest source of vegetable protein. It also supports many industries; soybean oil was used as raw material in manufacturing antibiotics, varnishes, paints, lubricants, etc.

Soybean has now become the largest source of vegetable oil and protein in the world and its large-scale cultivation has been concentrated in few countries such as Argentina, Brazil, Canada, China, India and USA which together produce about 96% of the world’s 189 million tonnes annual soybean production. Major soybean growing states in India are Madhya Pradesh, Maharashtra, Rajasthan, Karnataka, Uttar Pradesh, Telangana and Gujarat. In India in the year 2018, soybean cultivation reached to 10.40 million ha, producing 8.50 million metric tons with a productivity of 0.80 metric tons/ ha. In India, majority of the soybean production was contributed by Madhya Pradesh (6.73 MT), followed by Maharashtra (4 MT), Rajasthan (1.16 MT), Karnataka (0.34 MT), Telangana (0.24 MT) and Gujarat (0.17 MT) (Anonymous, 2019). Soybean is an important source of vegetable oil for many households in India and it is also noted as the third most important oilseed crop in the country. During earlier years of its establishment in the country, soybean cultivars did not pose any serious stress on account of insect pests. As many as 275 species of insect pests are recorded to attack various growth stages of soybean in India. Out of which 126 are defoliators, 14 insect pests attack seed, seedling and root of the plants, 10 feed on stem, 6 were known to infest flowers and 6 were recorded as stored pest.

Singh *et al*., 1989 has reported 41 insect pests attacking the plants at its different stages of growth in M.P. Singh and Singh, (1992) reported that more than 150 insect pests cause damage to soybean in various regions of Madhya Pradesh, out of which about a dozen of insect pests cause serious crop damage to the crop from sowing to harvest. Among them leaf miner (*Aproraemamodicella*), stem fly (*Melanagromyzasojae*), girdle beetle (*Obereopsisbrevis*), tobacco caterpillar (*Spdopteralitura*), semiloopers (*Chrysodeixisacuta*, *Thysanoplusiaorichalcea*) and sucking insect pests as whitefly (*Bemesiatabaci*), Jassid (*Amrascrabigutullabigutulla, Empoascakerri*) are important. *Obereopsisbrevis*, Girdle beetle was reported in Madhya Pradesh in 1969, very recently it recorded damage upto 80% of soybean plant in some endemic areas. The girdle beetle bores into the main stem and eventually into branches resulting in death of plant. Knowing the onset of incidence of different major pests of soybean may help the cultivators to develop the efficient management strategies beforehand and might also save the crop from the adverse effect of some notorious pests of soybean, secondly this will reduce the indiscriminate use of insecticides in the soybean ecosystem. Complementarily, the presence of various natural enemies and beneficial insects will also be effected. Therefore, the newer insecticide compounds are more pest specific and prevents disturbance in the natural balance of the soybean ecosystem to an extent. Keeping these views and foregoing information in consideration following research of effect of newer insecticide on girdle beetle in soybean was carried out.

Material and methods

The field trail was carried out under field conditions at RARS, Ujjain during *Kharif* 2021 and 2022 seasons. The crop was sown in randomized block design with eleven treatments and an untreated control replicated thrice. The plot size was 4 m x 3 m. Treatments were Flubendiamide 39.35 SC 100 ml /ha (T_1), Indoxicarb 14.5 SC 200 ml /ha (T_2), Tetraniliprole 18.18 SC 250 ml /ha (T_3), Novaluron 05.25% + indoxacarb 04.50%SC825 ml /ha (T_4), Chlorantraniliprole 20 SC100 ml /ha (T_5), Spinosad 45% SC 200 ml/ha (T_6), Emamectin benzoate 5 SG 100 g /ha (T_7), Quinalphos 20 EC 1500 ml /ha (T_8), Profenophos 50 EC 1250 ml /ha (T_9), Betacyfluthrin + Imidacloprid 350 ml /ha (T_{10}), Thiamethoxam +lambda Cyhalothrin 125 ml /ha (T_{11}) and Untreated (control) (T_{12}).. During the period of study, two sprays were given at 35 and 55 days after germination were given based on occurrence of insect incidence.

Observations

Larval count of tobacco caterpillar population was counted one day before the spray and three, seven and ten days after the spray by visual counts of larval populations at three randomly selected spots of one-meter row length of each field. Average number of caterpillars found per meter row length (mrl) was worked out.

Result and Discussion

The efficacy of Eleven insecticides along with untreated control was studied against *Spodoptera litura* Fab. on soybean during *kharif* seasons of 2021 and 2022 and the results obtained from the studies are presented in tables 1 and 2. The results obtained from the efficacy of insecticidal treatments against *S. litura* studied during *kharif,* 2021 after first and second sprays are described as mentioned below.

The mean pest counts across all days provide a comprehensive view of the overall effectiveness of the treatments. The untreated control had the highest mean pest count of 13.14 larave/mrl. Chlorantraniliprole 20 SC had the lowest mean pest count of 7.64 larave/mrl, indicating its higher efficacy. The second-best treatment was Emamectin benzoate 5 SG with a pest count of 8.70 larave/mrl followed by Novaluron 05.25%+ indoxcarb 04.50% SC and Spinosad 45% SC with a pest count of 8.93 larvae/mrl. Other treatments like Indoxicarb 14.5 SC (9.24 larvae/mrl) and Flubendiamide 39.35 SC (9.31 larvae/mrl) also showed effective reduction in pest control over the untreated control. Betacyfluthrin + Imidacloprid (11.13 larvae/mrl) reported highest pest count followed by Thiamethoxam + Lambda Cyhalothrin (10.35 larvae/mrl) reflecting less reduction in pest population.

The results obtained from the efficacy studies of insecticidal treatments carried out during *kharif,* 2022 against *S. litura* are presented in table no.2. The pre-treatment counts of *S. litura* population before application of the treatments varied from 10.56 to 12.67 larvae/mrl. When considering the mean pest counts over the entire observation period, the untreated control had the highest mean of 13.31 larvae/mrl, underscoring the necessity of pest management. Chlorantraniliprole 20 SC had the lowest mean pest count of 7.75 larvae/mrl, highlighting its overall effectiveness followed by Emamectin benzoate 5 SG and Novaluron 05.25% + indoxacarb 04.50% with a pest count of 8.80 and 8.98 larvae/mrl, respectively. Other treatments like Tetraniliprole 18.18 SC and Spinosad 45% SC had mean pest counts of 9.10 and 9.71 larvae/mrl, respectively, reflecting their good performance. Treatments application of Betacyfluthrin + Imidacloprid showed highest mean pest counts of 11.46 larvae/mrl followed by Thiamethoxam + Lambda Cyhalothrin (11.00 larvae/mrl), Quinalphos 20 EC (10.21 larvae/mrl) and profenophos 50 EC (9.89 larvae/mrl), respectively.

Also, Sonkamble *et al.* (2018) [11] reported that spray of Spinosad 45 SC @ 0.4ml/lit recorded significantly maximum reduction of tobacco caterpillar with mean reduction of 92.75,93.00 and 91.20 and 88.58,90.22 and 89.89 per cent was at 3, 7 and 14 days respectively during both the years. It was followed by Chlorantraniliprole 18.5 EC. During second spraying he also reported that the highest mean reduction in population of tobacco caterpillar was recorded in Spinosad 45 SC @ 0.4ml/lit during both the years. It was followed by Chlorantraniliprole 18.5 EC. The findings of present study more or less are in accordance with Narayanamma and Reddy (2014) who reported that the treatments Chlorantraniliprole (1.64 and 1.01), spinosad (1.92 and 0.92 larvae/plant) and Flubendiamide (2.56 and 1.25 larvae/plant) were significantly superior for Spodoptera and castor semi looper, respectively at one day after spraying during the first spray. Lambda cyhalothrin and acephate were less effective against semi looper and recorded 1.1 and 1.25 and 1.25 and 1.58 larvae/plant respectively at one week after spraying in first and second sprays, respectively. Patil *et al.* (2014) [6] reported that among these insecticides, Chlorantraniliprole (30 g.ai/ha), Methomyl (300g.ai/ha) and Spinosad (75 g.ai/ha) were found effective and statistically at par with each other in protecting the soybean crop from the infestation of both lepidopteran pests. Chlorantraniliprole provide consistent protection from defoliation to soybean crop from *Spodopteralitura* and *Chrysodeixisacuta* with highest cost benefit ratio among the tested insecticides.

Table 1: Bio-efficacy of some newer insecticide against *Tobacco caterpillar (Spodopteralitura)* infesting soybean during Kharif, 2021

Treatments			***Tobacco caterpillar larva/ mrl***								
			PTP	**Days After 1^{st} Spray**			**PTP**	**Days After 2^{nd} Spray**			**Mean**
S. No.	**Details of treatments (Insecticides)**	**(Dose ml/ha)**		**1 DAS**	**3 DAS**	**7 DAS**		**1 DAS**	**3 DAS**	**7 DAS**	
1	Flubendiamide 39.35 SC	100 ml	11.12	11.00	9.23	8.89	9.78	10.11	8.23	6.11	9.31
			(20.47)	(19.48)	(2.73)	(3.85)	(18.44)	(18.65)	(5.07)	(4.29)	(13.81)
2	Indoxacarb 14.5 SC	200 ml	12.56	12.34	6.89	6.78	11.23	11.56	7.34	5.23	9.24
			(21.42)	(20.76)	(2.73)	(1.93)	(18.75)	(18.54)	(4.7)	(3.33)	(14.13)
3	Tetraniliprole 18.18 SC	250 ml	11.78	11.67	8.45	8.12	10.67	10.23	8.23	6.00	9.39
			(20.76)	(20.07)	(1.93)	(0)	(18.86)	(18.75)	(3.85)	(3.85)	(13.9)
4	Novaluron 05.25% + indoxacarb 04.50%SC	825 ml	11.78	11.78	6.78	6.78	10.56	10.34	6.67	6.78	8.93
			(20.85)	(20.08)	(3.34)	(4.29)	(16.9)	(17.01)	(4.29)	(4.7)	(13.5)
5	Chlorantraniliprole 20 SC	100 ml	11.67	11.67	5.34	4.89	9.45	9.23	5.45	3.45	7.64
			(20.56)	(19.98)	(1.93)	(0)	(15.96)	(15.84)	(5.08)	(2.73)	(12.94)
6	Spinosad 45% SC	200 ml	11.89	11.89	5.45	5.45	10.78	11.00	8.67	6.34	8.93
			(19.64)	(20.17)	(9.41)	(9.62)	(19.64)	(18.12)	(9.21)	(9.79)	(15.21)
7	Emamectin benzoate 5 SG	100 g	10.56	10.34	6.78	6.78	10.00	10.34	7.23	7.56	8.70
			(19.87)	(18.96)	(9)	(10.17)	(17.68)	(17.35)	(9.21)	(11.22)	(14.79)
8	Quinalphos 20 EC	1500 ml	12.67	12.23	10.23	10.23	10.23	9.78	8.12	10.00	10.43
			(21.42)	(20.85)	(12.33)	(14.71)	(18.65)	(18.55)	(14.32)	(14.18)	(17.14)
9	Profenophos 50 EC	1250 ml	12.22	12.12	8.34	8.34	10.00	9.67	8.56	8.34	9.70
			(20.66)	(20.46)	(12.78)	(14.31)	(18.01)	(17.9)	(14.71)	(14.31)	(16.85)
10	Betacyfluthrin + Imidacloprid	350 ml	11.34	11.23	10.89	10.89	12.00	11.78	10.00	10.89	11.13
			(20.17)	(19.68)	(16.66)	(19.67)	(18.01)	(18.01)	(18.22)	(19.68)	(18.79)
11	Thiamethoxam +lambda Cyhalothrin	125 ml	10.67	10.89	10.11	10.11	10.56	10.34	9.89	10.22	10.35
			(20.47)	(20.12)	(17.24)	(19.27)	(21.7)	(21.6)	(18.44)	(19.17)	(19.79)
12	Untreated (control)		12.00	12.45	13.00	13.00	13.56	13.78	13.67	13.67	13.14
			(20.47)	(20.57)	(22.52)	(23.66)	(23.58)	(23.75)	(23.75)	(23.58)	(22.77)
Sem (±)			0.060	0.050	0.049	0.066	0.029	0.030	0.051	0.033	0.025
CD (5%)			0.173	0.143	0.141	0.188	0.082	0.086	0.147	0.094	0.072

Table 2: Bio-efficacy of some newer insecticide against *Tobacco caterpillar (Spodopteralitura)*infesting soybean during Kharif, 2022

			Tobacco caterpillar larva/ mrl								
			PTP	**Days After 1^{st} Spray**			**PTP**	**Days After 2^{nd} Spray**			**Mean**
S. No.	**Details of treatments (Insecticides)**	**(Dose ml/ha)**		**1 DAS**	**3 DAS**	**7 DAS**		**1 DAS**	**3 DAS**	**7 DAS**	
1	Flubendiamide 39.35 SC	100 ml	11.56	11.45	8.56	8.34	10.67	10.67	7.67	6.11	9.38
			(3.47)	(3.46)	(3.01)	(2.97)	(3.34)	(3.34)	(2.86)	(2.57)	(3.14)
2	Indoxacarb 14.5 SC	200 ml	11.89	11.89	6.34	6.45	11.67	11.34	7.12	5.78	9.06
			(3.52)	(3.52)	(2.61)	(2.64)	(3.49)	(3.44)	(2.76)	(2.51)	(3.09)
3	Tetraniliprole 18.18 SC	250 ml	11.34	11.12	7.34	7.67	10.89	10.34	7.78	6.34	9.10
			(3.44)	(3.41)	(2.8)	(2.86)	(3.38)	(3.29)	(2.88)	(2.61)	(3.1)
4	Novaluron 05.25% + indoxacarb 04.50%SC	825 ml	12.34	12.34	6.23	6.89	10.23	10.23	6.67	6.89	8.98
			(3.58)	(3.58)	(2.59)	(2.72)	(3.28)	(3.28)	(2.68)	(2.72)	(3.08)
5	Chlorantraniliprole 20 SC	100 ml	12.45	12.34	5.89	4.45	9.23	8.89	5.00	3.78	7.75
			(3.6)	(3.58)	(2.53)	(2.22)	(3.12)	(3.06)	(2.35)	(2.07)	(2.87)
6	Spinosad 45% SC	200 ml	12.56	12.67	8.45	7.00	10.89	11.00	8.45	6.67	9.71
			(3.61)	(3.63)	(2.99)	(2.74)	(3.37)	(3.39)	(2.99)	(2.68)	(3.2)
7	Emamectin benzoate 5 SG	100 g	11.45	12.00	6.24	6.68	10.56	10.12	7.11	6.22	8.80
			(3.46)	(3.54)	(2.6)	(2.68)	(3.33)	(3.26)	(2.76)	(2.59)	(3.05)
8	Quinalphos 20 EC	1500 ml	12.00	11.34	9.78	9.78	10.45	10.34	8.22	9.78	10.21
			(3.54)	(3.44)	(3.21)	(3.21)	(3.31)	(3.29)	(2.95)	(3.21)	(3.27)
9	Profenophos 50 EC	1250 ml	12.23	11.78	8.34	8.45	10.34	10.45	8.23	9.34	9.89
			(3.57)	(3.5)	(2.97)	(2.99)	(3.29)	(3.31)	(2.95)	(3.14)	(3.22)
10	Betacyfluthrin + Imidacloprid	350 ml	11.22	11.89	12.00	11.00	12.45	12.00	10.78	10.34	11.46
			(3.42)	(3.52)	(3.54)	(3.39)	(3.6)	(3.54)	(3.36)	(3.29)	(3.46)
11	Thiamethoxam +lambda Cyhalothrin	125 ml	11.56	11.78	10.56	11.11	11.12	10.89	10.34	10.67	11.00
			(3.47)	(3.5)	(3.33)	(3.41)	(3.41)	(3.38)	(3.29)	(3.34)	(3.39)
12	Untreated (control)		12.56	12.78	13.00	13.45	14.00	14.00	13.67	13.00	13.31
			(3.61)	(3.64)	(3.67)	(3.73)	(3.81)	(3.81)	(3.76)	(3.67)	(3.72)
Sem (±)			0.035	0.034	0.026	0.039	0.020	0.020	0.030	0.034	0.014
CD (5%)			0.102	0.096	0.074	0.113	0.056	0.057	0.086	0.099	0.040

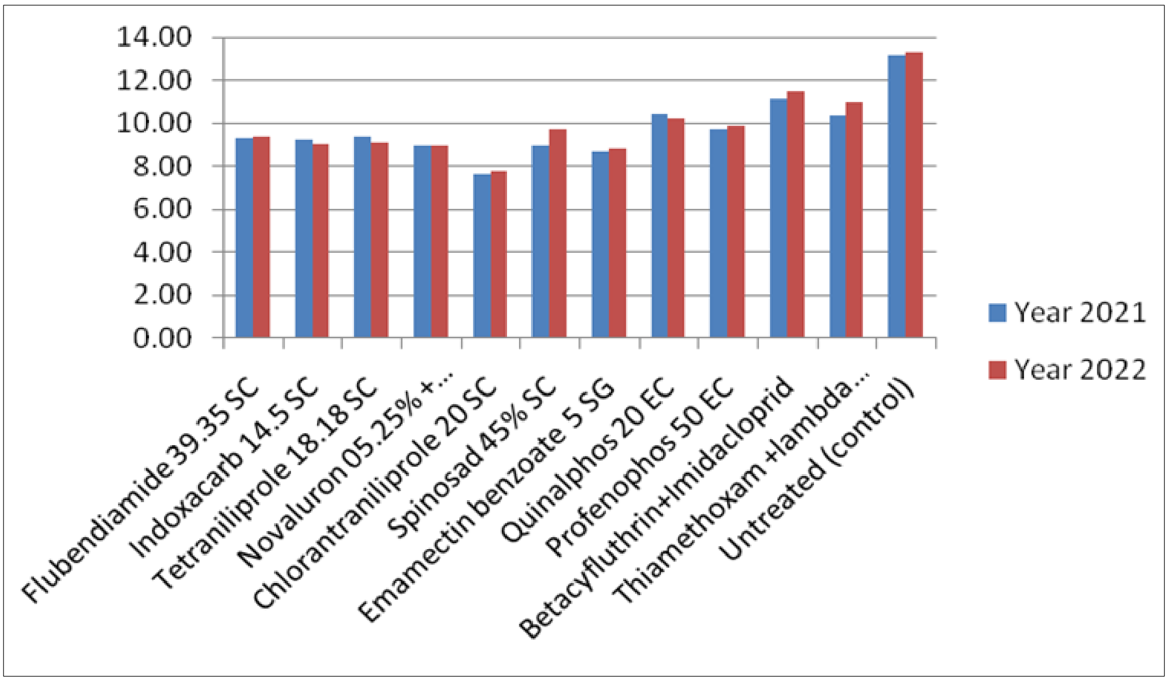

Fig 1: Population of Tobacco caterpillar (*Spodoptera litura*) infesting soybean during Kharif,2021-22

In Contrast to the finding of above experiment Mishra and Gupta, 2017 reported that the treatment Flubendiamide 480 SC exhibited its superiority by registering the lowest larval population of 0.90 and 0.20 per meter row length during first and second spray, respectively. The overall order of effectiveness of these insecticides against *S. litura* was found to be Flubendiamide 480 SC followed by Indoxacarb 14.5 Sc, Spinosad 45 SC and Emmamectin benzoate 5 SG, respectively. Sapekar *et al*. (2020) reported Spinosad 45% SC @4 ml as the second-best treatment after the Flubendiamide 39.35% SC @ 3 ml/lit. Motaphale *et al*. (2018) [3] reported that the efficacy and economics of different IGR's, insecticides and bio-rational against *Spodoptera litura* (Fabr.) in soybean, revealed that at three days after first and second sprays the rynaxypyr (64.52%) and emamectin benzoate (58.84% reduction) respectively proved to be the most effective.

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Conclusions
The study evaluated the effectiveness of various insecticides against *Spodoptera litura* in soybean crops. Chlorantraniliprole 20 SC was the most effective, showing a significant reduction in pest populations. Emamectin benzoate and Novaluron + Indoxacarb also demonstrated good results. The untreated control plots had the highest pest counts, indicating the necessity of insecticide application for pest management. The research confirms the effectiveness of newer insecticide compounds and highlights the importance of strategic pest control to prevent crop damage and maintain ecosystem balance. These findings provide valuable insights for future soybean pest management strategies.

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