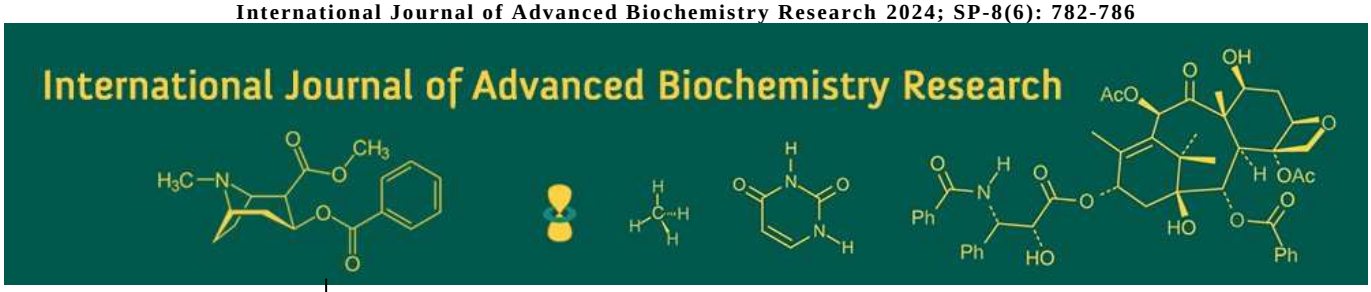

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Filed efficacy of chlorantraniliprole 600 g/l SC against American bollworm (*Helicoverpa armigera*) and tobacco caterpillar (*Spodoptera litura*) in cotton ecosystem

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Abstract
Bollworms and defoliators are the important insect pests of cotton, causing severe damage in the vegetative and boll formation stage of the crop. These insect pests developed resistance to most of the insecticides. In the present study, novel Chlorantraniliprole 600 g/l SC formulations was evaluated against American Bollworm (*Helicoverpa armigera*) and tobacco caterpillar (*Spodoptera litura*) in cotton crop. Chlorantraniliprole 600 g/l SC @ 40 g a.i./ha continued to be the most effective molecule after three, seven and ten days of second spray by recording lowest larval population of 0.09, 0.16 and 0.20 larvae per plant respectively. Larval population of *S. litura* noticed at ten days after spraying was significantly less in highest dosage treatment of in Chlorantraniliprole 600 g/l SC @ 40 g a.i./ha (0.27 larvae/plant). Significantly highest seed cotton yield was recorded by the treatment Chlorantraniliprole 600 g/l SC @ 40 g a.i./ha (17.73 q/ha). The predatory populations were statistically on par with all the dosages of Chlorantraniliprole 600 g/l SCas well as with the standard check treatments, indicating that, the test chemical does not affect the natural enemies population significantly. The phytotoxicity study revealed that, there was no phytotoxicity symptoms on cotton plants treated with both the dosages of Chlorantraniliprole 600 g/l SCi.e., 30 and 60 g a.i./ha. Hence, Chlorantraniliprole 600 g/l SC @ 30 g a.i./ha can be recommended to control *H. armiger* and *S. litura* in cotton crop.

Keywords: Bio-efficacy, phytotoxicity, natural enemies, spinetoram 25% WG

Introduction
Cotton is one of the major fibre crop with global importance, is being grown more than 70 countries, it belongs to the family Malvaceae and genus "Gossypium". This crop contributes global economy, politics, and social affairs significantly. India is the country that cultivates 24% of the world's total cotton production, making it one of the most significant commercial crops. An estimated 6 million cotton growers and 40–50 million people working in allied industries like cotton processing and trading depend heavily on it for their livelihood. The textile industry in India utilizes a wide variety of fibres and yarns, with cotton being used in India in a roughly 60:40 ratio compared to 30:70 worldwide. Cotton not only provides one of the most basic necessities for survival (clothing, which is second only to food), but it also makes up a significant portion of India's net foreign exchange earnings through exports of raw cotton, intermediate products like yarn and fabrics, and final goods like knitwear, made-ups, and clothing. Because of its significance to India's economy, it is frequently referred to as "White-Gold."
India ranked first in the world in terms of cotton acreage, with 124.69 lakh hectares under cultivation, or almost 39% of the 318.8 lakh hectare global total. India produces roughly 67% of its cotton on rain-fed land and 33% on irrigated land. India ranks 33rd in terms of productivity, yielding 441 kg/ha (https://texmin.gov.in/sites/default/files). The four types of cotton *G. Arboreum* & *G. Herbaceum* (Asian cotton), *G. Barbadense* (Egyptian cotton), and *G. Hirsutum* (American Upland cotton) are solely grown in India. Ninety percent of India's hybrid cotton production comes from *G. Hirsutum*, and all of the existing Bt cotton hybrids are *G. Hirsutum* (https://texmin.gov.in/sites/default/files).

In India, area under cotton cultivation is more in the world, but productivity is still low. Among the various causes, major cause of low productivity in cotton is the damage of insect pests. It is estimated that 200 insect pests attacks cotton crop. Insect pests that feed on cotton are aphids (*Aphis gossypii*, Glover), thrips *(Thrips tabaci*, Linn.), whiteflies (*Bemisia tabaci*, Genn.), and jassids (*Amrasca biguttula*, Ishida), bollworm complex, which includes the American bollworm (*Helicoverpa armigera* Hub.), spotted bollworm (*Earias vitella* Fab.), and pink bollworm (*Pectinophora gossypiella* Saunders), is responsible for a significant portion of yield loss up to 36.2% (Kranti *et al*., 2005) [5].

There are several management practices for the control of American Bollworm (*Helicoverpa armigera*) and tobacco caterpillar (*Spodoptera litura*) such as cultural, mechanical, physical, biological, and chemical components. Among them, chemical control is the most commonly used method, because it controls the pests quickly and is easily available. A vast array of insecticides have been shown to be efficient tools for controlling the pest population. About 20% of all insecticides used in India are on cotton, as the crop is primarily dependent on synthetic pesticides for pest control. However, the indiscriminate use of organophosphates, carbamates, and synthetic pyrethroids has created several problems, including resistance and pest resurgence (Bajya *et al*., 2010) [3]. Most of the insects already developed resistance, lost their effectiveness, caused a resurgence and are highly toxic to non-target organisms. In this context, the identification of a novel insecticide, which is having unique mode of action, is green-labeled, and effectively controls the pests is the need of the hour. With this background, the present study aimed to evaluate the bio efficacy of Chlorantraniliprole 600 g/l SC against American Bollworm (*Helicoverpa armigera*) and tobacco caterpillar (*Spodoptera litura*) in cotton and standardized the dosage, further, we assessed the effectiveness of the chemical against natural enemies, and its phytotoxicity experiments were conducted.

Materials and Methods

Bio-efficacy of Chlorantraniliprole 600 g/l SC against American bollworm (*Helicoverpa armigera*) and tobacco caterpillar (*Spodoptera litura*) in cotton

Evaluation of Chlorantraniliprole 600 g/l SC against American bollworm (*Helicoverpa armigera*) and tobacco caterpillar (*Spodoptera litura*) in cotton was undertaken in an experimental block at Main Agricultural Research Station, Raichur during *Kharif* 2021-22. The experiment was laid out in a randomized block design (RBD) with three replications. The test molecule, Chlorantraniliprole 600 g/l SC was tested at four different dosages *viz*., 20, 30,and 40 g. a. i./ha for its efficacy against American bollworm (*Helicoverpa armigera*) and tobacco caterpillar (*Spodoptera litura*) in cotton and 60 g.a.i. per hectare for its phytotoxicity evaluation. This was compared with three standard checks *viz.,* Emamectin benzoate 5% SG and Flubendiamide 39.35% SC along with an untreated control against *H. armigera* and *S. litura*. Treatments were imposed two times based on pest population build-up (above ETL). All the agronomic practices were followed as per the recommended package of practices of UAS Raichur. Observations were recorded on the number of American bollworm and tobacco caterpillar larval populations on five tagged plants per replication on one day before spray, three, seven, and ten days after each spray. The data collected on American bollworm and tobacco caterpillar larval population were averaged and expressed on a per plant basis. The natural enemy populations such as Chrysoperla, Coccinellids and Spiders were recorded on tagged five tagged plants in each plot, fourteen days after each spray.

Seed cotton yield

The total seed cotton yield was recorded separately from each plot at each picking and finally, the total yield was computed by adding the seed cotton yield from all pickings and was expressed per hectare basis. The yield data collected from each plot was extrapolated on a hectare basis.

Weather parameters

Weather factors *viz*., maximum temperature and minimum temperature, relative humidity and rainfall data during the cropping period were obtained from the automatic weather station, installed at MARS, Raichur.

Statistical analysis

The data generated on the thrips along with natural enemies at pre and post-count from seven randomly selected plants were averaged to per plant basis. Further, data were subjected to statistical analysis after transforming them to $\sqrt{x+1}$. The data collected were subjected to statistical analysis by single-factor ANOVA.

Phytotoxicity

The extent of phytotoxicity of Chlorantraniliprole 600 g/l SC was recorded on cotton plant on 3, 7 and 10 days after application in all treatments. The phytotoxicity observations were recorded for A) Leaf injury on tips/ surface B) Necrosis C) Epinasty D) Hyponasty E) Vein clearing F) Wilting. The following phytotoxic rating scale was followed in this trail.

Rating	Phytotoxicity %
0	No phytotoxicity
1	1 – 10
2	11 – 20
3	21 – 30
4	31 – 40
5	41 – 50
6	51 – 60
7	61 – 70
8	71 – 80
9	81 – 90
10	91 – 100

Results and Discussion

Bio-efficacy of Chlorantraniliprole 600 g/l SC against American bollworm (*Helicoverpa armigera*) in cotton (After first spray)

Pre-treatment count on number of *H. armigera* were non-significant among the treatments indicating the uniformity in the incidence of the pests in the experimental plots. Lowest *Helicoverpa armigera* population of 0.28 larvae/plant was recorded in the treatment Chlorantraniliprole 600 g/l SC @ 40 g a.i./ha which was on par with its lower dosage @ 30 g a.i./ha which recorded 0.34 larvae per plant and Chlorantraniliprole 18.5% SC @ 30 g a.i./ha (0.38 larvae/plant) at three day after first spray. The above-mentioned treatments were significantly superior to rest of the treatments. Untreated control recorded highest

Helicoverpa armigera population of 2.24 larvae per plant. A similar trend was noticed at 7th and 10th days after spraying (Table 1).

Bio-efficacy of Chlorantraniliprole 600 g/l SC against American bollworm (*Helicoverpa armigera*) in cotton (After Second spray)

Chlorantraniliprole 600 g/l SC @ 40 g a.i./ha continued to be the most effective molecule after three, seven and ten days of second spray by recording lowest larval population of 0.09, 0.16 and 0.20 larvae per plant respectively. It was on par with lower dosage of Chlorantraniliprole 600 g/l SC @ 30 g a.i./ha wherein the larval population was 0.11, 0.20 and 0.28 larvae per plant after three, seven and ten days after spray and found on par with Chlorantraniliprole 18.5% SC @ 30 g a.i./ha with 0.14, 0.28 and 0.32 larvae per plant after three, seven and ten days after spray respectively. Untreated control recorded highest *Helicoverpa armigera* population of 2.70 larvae per plant at ten days after the second spray (Table 1).

The highest percent larval reduction over control was recorded by Chlorantraniliprole 600 g/l SC @ 40 g a.i/ha with 92.59 percent and this treatment was found similar with Chlorantraniliprole 600 g/l SC @ 30 g a.i./ha (89.63 percent) and Chlorantraniliprole 18.5% SC @ 30 g a.i./ha (88.15 percent). Further, Emamectin benzoate 5% SG @ 11 g a.i./ha, Flubendiamide 39.35% SC @ 60 g a.i./ha and Chlorantraniliprole 60% SC @ 20 g a.i./ha recorded 69.63, 67.41 and 66.67 percent larval reduction over untreated control respectively.

Bio-efficacy of Chlorantraniliprole 600 g/l SC against tobacco caterpillar (*Spodoptera litura*) in cotton

After the First spray

Significantly Minimum *S. litura* larval population was noticed in Chlorantraniliprole 600 g/l SC @ 40 g a.i./ha with 0.27 larvae/plant, which was on par with treatment Chlorantraniliprole 600 g/l SC @ 30 g a.i./ha (0.31 larvae/plant) and Chlorantraniliprole 18.5% SC @ 30 g a.i./ha (0.36 larvae/plant) three days after first spray. Whereas untreated control recorded significantly maximum population of *S. litura* larval population with 1.34 larvae/plant (Table 4). Similar trend was observed 7 days after first spray. Ten days after first spray also, significantly highest *S. litura* larval population was recorded din the treatment Chlorantraniliprole 600 g/l SC @ 40 g a.i./ha (0.62 larvae/plant). The remaining treatment recorded larval population ranged from 0.69 to 1.14 larave/plant. Untreated control recorded larval population of 1.43 larvae/plant (Table 2).

After Second spray

Population of *S.litura* noticed at three days after spraying was significantly less in highest dosage treatment of in Chlorantraniliprole 600 g/l SC @ 40 g a.i./ha (0.27 larvae/plant) which was on par with its lower dosage of 30 g a.i./ha (0.30 larvae/plant) and Chlorantraniliprole 18.5% SC @ 30 g a.i./ha (0.36 larvae/plant). The treatments were significantly superior over standard checks *viz*., Emamectin benzoate 5% SG @ 11 g a.i./ha (0.67larvae/plant) and Flubendiamide 39.35% SC @ 60 g a.i./ha (0.79larvae/plant). Highest *S. litura* population of 1.48 was recorded in untreated control treatment. Similar, the observations registered at 7 and 10 days after spraying (Table 4). The highest percent larval reduction over control was recorded by Chlorantraniliprole 600 g/l SC @ 40 g a.i./ha with 83.54 percent and this treatment was found similar with Chlorantraniliprole 600 g/l SC @ 30 g a.i./ha (81.71 percent) and Chlorantraniliprole 18.5% SC @ 30 g a.i../ha (76.83 percent). Further, Emamectin benzoate 5% SG @ 11 g a.i./ha, Flubendiamide 39.35% SC @ 60 g a.i./ha and Chlorantraniliprole 60% SC @ 20 g a.i./ha recorded 59.15, 56.10 and 51.83 percent larval reduction over untreated control respectively (Table 2).

Effect of Chlorantraniliprole 600 g/l SC against Seed cotton yield

Significantly maximum seed cotton yield of 17.73 q/ha was recorded by the treatment Chlorantraniliprole 600 g/l SC@ 40 g a.i./ha, which was on par with its lower dosage of Chlorantraniliprole 600 g/l SC @ 30 g a.i./ha (17.22 q/ha) and Chlorantraniliprole 18.5% SC (17.14 q/ha). Significantly lowest seed cotton yield of 8.21 q per hectare was recorded in untreated control (Table 3).

Effect of Chlorantraniliprole 600 g/l SC on natural enemies population in cotton ecosystem

The coccinellids were the potent predators prevalent in the cotton eco-system. The results further revealed that natural enemy population *viz.,Coccinellid* adults, *Chrysoperla* adults and spiders were statistically on par in all the dosages of Chlorantraniliprole 600 g/l SC formulations (20 to 40 g a.i./ ha). The observation indicated that the test chemical did not affect the natural enemy population (Table 4).

Phytotoxic effects of Chlorantraniliprole 600 g/l SC on cotton

The study showed that there were no phytotoxic symptoms such as chlorosis, epinasty, hyponasty and necrosis was observed on cotton crop due to the application of Chlorantraniliprole 600 g/l SC formulations i.e., 30 and 60 g a.i./ ha.

The results of the present study is in line with the report of Anuradha *et al.* (2023) [2] who evaluated the effect of Chlorantraniliprole 600 g/L SC against cotton *Spodoptera litura* and *Helicoverpa armigera* for it damage and yield in India. Two foliar applications of Chlorantraniliprole (40 and 30 g a. i/ha) at ten days interval period reduced significantly the larval populations of *H. armigera*, *S. litura* without any phytotoxic symptoms in cotton. Chlorantraniliprole application in open field condition was found to be harmless to natural enemy (coccinellids and spiders). Even though, a temporary lessening of natural enemy populations was noticed after spray, progressively the population was increased within a week time. Cotton yield was high in chlorantraniliprole @ 40 g a. i/ha treated plot (22.66, 22.12 q/ha) when compared to untreated control. Simialrly, Mishra *et al*. (2024) [7] studied the efficacy of insecticides against *Spodoptera litura* (F) and *Helicoverpa armigera* (Hubn) on groundnut. Amongst these, chlorantraniliprole 18.5SC @ 30g a.i. ha-1 found to be the most effective with least larval counts (0.93 and 1.00 plant-1, respectively) and efficacy (63.27 and 63.70%, respectively) against *S. litura* and *H. armigera*, respectively after two sprays. The evaluation of economics revealed that chlorantraniliprole 18.5SC gave the highest monetary return, net income (Rs. 55765.00) and cost: benefit ratio (1:6.80). Similarly, Patidar *et al*. (2023) [8] reported that Flubendamide 39.35% SC was found to be the

most effective treatment of all. In both sprays, the descending order of efficacy was noted as chlorantraniliprole 18.5% SC>Emamectin benzoate 5% SG>Indoxacarb 14.5% SC>Quinalphos 25% EC>Novaluron 10% EC.

Our results are also in conformity with the reports of Barwa and Kumar (2022) [4], who studied the bio efficacy of Chlorantraniliprole 18.5% SC against pod borer *H. armigera* in chickpea. The result reveled that Chlorantraniliprole 18.5% SC 0.5ml/lit (84.32%) was found to be the most effective chemical followed by Spinosad 45% SC 0.5ml/lit (79.57%), Nisco sixer plus 1ml/lit (73.87%), *Bacillus thuringiensis* 5ml/lit (68.88%), HaNPV 1ml/lit (60.09%), *Beauveria bassiana* 4ml/lit (54.63%) and the Neem oil 3ml/lit (47.74%). Higher yield was recorded in Chlorantraniliprole 18.5% SC (27.08 q/ha) followed by Spinosad 45% SC (24.58 q/ha), Nisco sixer plus (21.66 q/ha), *Bacillus thuringiensis* (17.50 q/ha), HaNPV (15.83 q/ha), *Beauveria bassiana* (14.83 q/ha) and Neem oil (12.08 q/ha) as compared to control (10.83q/ha). The highest cost benefit ratio was obtained in the treatment of Chlorantraniliprole 18.5% SC (1:3.35), followed by Spinosad 45% SC (1:3.06), respectively. Similarly, Kumar *et al*. (2015) [6] investigated bioefficacy of nine modern insecticides under field condition against *S. litura* on groundnut revealed that Emamectin benzoate 0.005 percent, Chlorpyriphos 0.05 percent, Cypermethrin 0.016 percent and Chlorantraniliprole 0.006 percent were found to be the most effective. Looking to the efficacy of all the insecticides emamectin benzoate 0.005 percent, chlorpyriphos 0.05 percent, cypermethrin 0.016 percent and chlorantraniliprole 0.006 percent can be suggested to the farmers for the management of S. litura in groundnut.

The results are contradictory to the report of Sapekar *et al*. (2020) [9] who reported the bio-efficacy of different insecticides against major defoliators on soybean. Flubendiamide 39.35% SC @ 3 ml superior insecticide amongst all treatments which gives maximum protection against American bollwarm with 0.92 larvae / mrl, and it was followed by Spinosad 45% SC @4 ml, Chlorantraniliprole 18.5% SC @ 3 ml and Lambda-cyhalothrin 5% CS @ 6 ml which larval population of 1.12, 1.29 and 1.49 larvae per mrl respectively. The maximum larval population of American bollworm was recorded in untreated control 3.81 larvae / mrl. The highest population of Tobacco leaf eating caterpillar was recorded in untreated control 3.78 larvae / mrl. Among the insecticide least effective treatments are Fenpropathrin 30% EC @ 5 ml, Cyanatraniliprole 10.26% OD @ 12 ml and Profenofos 50% EC @ 20 ml which recorded population of 1.67, 1.51 and 1.39 larvae per mrl respectively. Contrastingly, Wakil *et al*. (2012) [10] evaluated the bioefficacy of *Azadirachta indica*, NPV and Chlorantraniliprole formulations against 2nd and 5th larval instars of *H. armigera*. The combinations of NPV with *A. indica* and Chlorantraniliprole caused higher mortality, pupation and produced an additive effect compared to their application singly in all the tested populations. The results herein suggest that the effectiveness of NPV and *A. indica* can be improved by the presence of Chlorantraniliprole against the larvae of *H. armigera.*

Table 1: Bio-efficacy of Chlorantraniliprole 600 g/l SC against *Helicoverpa armigera* on cotton

Tr. No.	Treatment Details	Dose (g a.i./ha)	Pre - count	No. of larvae per plant						% Reduction over control at 10 DASS
				I Spray			II Spray			
				3 DAS	7 DAS	10 DAS	3 DAS	7 DAS	10 DAS	
T_1	Chlorantraniliprole 600 g/l SC	20	2.18 (1.63)	0.95 (1.20)	0.84 (1.15)	1.04 (1.24)	0.86 (1.16)	0.75 (1.11)	0.90 (1.18)	66.67
T_2	Chlorantraniliprole 600 g/l SC	30	1.97 (1.57)	0.34 (0.91)	0.25 (0.86)	0.42 (0.95)	0.11 (0.78)	0.20 (0.83)	0.28 (0.88)	89.63
T_3	Chlorantraniliprole 600 g/l SC	40	2.10 (1.61)	0.28 (0.88)	0.20 (0.83)	0.40 (0.94)	0.09 (0.76)	0.16 (0.81)	0.20 (0.83)	92.59
T_4	Chlorantraniliprole 18.5% SC	30	2.00 (1.58)	0.38 (0.93)	0.30 (0.89)	0.46 (0.97)	0.14 (0.80)	0.28 (0.88)	0.32 (0.90)	88.15
T_5	Emamectin benzoate 5% SG	11	2.14 (1.62)	0.82 (1.14)	0.75 (1.11)	0.94 (1.20)	0.54 (1.01)	0.78 (1.13)	0.82 (1.14)	69.63
T_6	Flubendiamide 39.35% SC	60	1.95 (1.56)	0.92 (1.19)	0.80 (1.14)	1.01 (1.22)	0.70 (1.09)	0.84 (1.15)	0.88 (1.17)	67.41
T_7	Untreated control	--	2.02 (1.58)	2.24 (1.65)	2.32 (1.67)	2.48 (1.72)	2.63 (1.76)	2.68 (1.78)	2.70 (1.78)	
	S.Em(±)		0.07	0.03	0.03	0.04	0.05	0.03	0.04	
	CD @ 5%		NS	0.08	0.10	0.12	0.15	0.09	0.12	

DAS – Days after spray; NS: Non-Significant *Figures in parenthesis are square root transformed values, DASS- days after second spray

Table 2: Bio-efficacy of Chlorantraniliprole 600 g/l SC against *Spodoptera litura* on cotton

Tr. No.	Treatment Details	Dose (g a.i./ha)	Pre - count	No. of larvae per plant						% Reduction over control at 10 DASS
				I Spray			II Spray			
				3 DAS	7 DAS	10 DAS	3 DAS	7 DAS	10 DAS	
T_1	Chlorantraniliprole 600 g/l SC	20	1.16 (1.28)	0.98 (1.21)	1.09 (1.26)	1.15 (1.28)	0.89 (1.17)	0.97 (1.21)	0.79 (1.13)	51.83
T_2	Chlorantraniliprole 600 g/l SC	30	1.17 (1.29)	0.31 (0.90)	0.46 (0.97)	0.69 (1.09)	0.30 (0.89)	0.39 (0.94)	0.30 (0.91)	81.71
T_3	Chlorantraniliprole 600 g/l SC	40	1.20 (1.30)	0.27 (0.87)	0.38 (0.93)	0.62 (1.05)	0.27 (0.87)	0.32 (0.90)	0.27 (0.87)	83.54
T_4	Chlorantraniliprole 18.5% SC	30	1.14 (1.28)	0.36 (0.92)	0.50 (1.00)	0.74 (1.11)	0.36 (0.92)	0.44 (0.96)	0.38 (0.94)	76.83
T_5	Emamectin benzoate 5% SG	11	1.13 (1.27)	0.54 (1.02)	0.84 (1.15)	0.97 (1.21)	0.67 (1.08)	0.88 (1.17)	0.67 (1.08)	59.15
T_6	Flubendiamide 39.35% SC	60	1.17 (1.29)	0.99 (1.22)	1.10 (1.26)	1.14 (1.28)	0.79 (1.13)	0.83 (1.15)	0.72 (1.11)	56.10
T_7	Untreated control	--	1.14 (1.28)	1.34 (1.35)	1.38 (1.37)	1.43 (1.38)	1.48 (1.40)	1.59 (1.44)	1.64 (1.46)	
	S.Em(±)		0.07	0.03	0.04	0.03	0.04	0.03	0.03	
	CD @ 5%		NS	0.08	0.12	0.09	0.12	0.09	0.09	

DAS – Days after spray; NS: Non-Significant *Figures in parenthesis are square root transformed values, DASS- days after second spray

Table 3: Impact of Chlorantraniliprole 600 g/l SC on seed cotton yield

Tr. No.	Treatment Details	Dose (g a.i./ha)	Yield (q/ha)
T_1	Chlorantraniliprole 600 g/l SC	20	15.16
T_2	Chlorantraniliprole 600 g/l SC	30	17.22
T_3	Chlorantraniliprole 600 g/l SC	40	17.73
T_4	Chlorantraniliprole 18.5% SC	30	17.14
T_5	Emamectin benzoate 5% SG	11	14.31
T_6	Flubendiamide 39.35% SC	60	14.90
T_7	Untreated control	--	8.21
	S.Em (±)		0.39
	CD @ 5%		1.18

Table 4: Population of natural enemies in cotton ecosystem

Tr. No.	Treatment details	Dosage (g a.i./ha)	Natural enemy population/plant								
			Coccinellid adults			*Chrysoperla* adults			Spiders		
			Pre- count	14 DA 1 Spray	14 DA II spray	Pre-count	14 DA I Spray	14 DA II Spray	Pre-count	14 DA I Spray	14 DA II Spray
T1	Chlorantraniliprole 600 g/l SC	20	2.69 (1.86)	1.25 (1.36)	1.39 (1.39)	0.48 (1.03)	0.12 (0.78)	0.20 (0.84)	2.12 (1.61)	1.21 (1.33)	1.35 (1.37)
T2	Chlorantraniliprole 600 g/l SC	30	2.70 (1.82)	1.20 (1.31)	1.32 (1.33)	0.52 (1.06)	0.15 (0.81)	0.16 (0.83)	2.10 (1.63)	1.20 (1.32)	1.31 (1.36)
T3	Chlorantraniliprole 600 g/l SC	40	2.73 (1.84)	1.24 (1.30)	1.30 (1.32)	0.51 (1.04)	0.11 (0.78)	0.18 (0.81)	2.15 (1.64)	1.19 (1.30)	1.32 (1.37)
T4	Chlorantraniliprole 18.5% SC	30	2.65 (1.83)	1.23 (1.34)	1.36 (1.36)	0.50 (1.03)	0.13 (0.80)	0.20 (0.83)	2.12 (1.62)	1.21 (1.31)	1.30 (1.38)
T5	Emamectin benzoate 5% SG	11	2.70 (1.83)	1.28 (1.34)	1.32 (1.36)	0.49 (1.02)	0.10 (0.81)	0.21 (0.84)	2.15 (1.64)	1.19 (1.31)	1.33 (1.37)
T6	Flubendiamide 39.35% SC	60	2.78 (1.8)	1.22 (1.33)	1.28 (1.35)	0.50 (1.01)	0.11 (0.78)	0.22 (0.86)	2.13 (1.64)	1.20 (1.30)	1.36 (1.38)
T7	Untreated control	--	2.62 (1.81)	2.89 (1.87)	3.10 (1.91)	0.48 (1.00)	0.54 (1.06)	0.60 (1.12)	2.09 (1.61)	2.20 (1.64)	2.26 (1.65)
S.Em (±)			-	-	-	-	-	-	-	-	-
CD @ 5%			NS	NS	NS	NS	NS	NS	NS	NS	NS

DA I: Days after I sprays; DA II : Days after II sprays. Figures in the parentheses are square root transformed values. NS- Non-significant.

Conclusion

Chlorantraniliprole 600 g/l SC @ 40 g a.i./ha proved to be best treatment by recording lowest larval population of *Helicoverpa armigera* and *Spodoptera litura* and highest yield which was on par with its lower dosage of Chlorantraniliprole 600 g/l SC @ 40 g a.i./ha. The predatory populations were statistically on par with all the dosages of Chlorantraniliprole 600 g/l SC as well as with the standard check treatments. There was no phytotoxicity symptoms on cotton plants treated with both the dosages of Chlorantraniliprole 600 g/l SC i.e., 30 and 60 g a.i./ha. Hence, Chlorantraniliprole 600 g/l SC @ 30 g a.i./ha can be recommended to control *H. armiger* and *S. litura* in cotton crop.

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References

1. Annonymous. Area, production and productivity of Cotton in India; c2024; https://texmin.gov.in/sites/default/files.
2. Anuradha P, Sudhanan M, Priyanka M, Emaiya R, Karthik P, Suganthi A and Krishnamoorthy S V. Determination of chlorantraniliprole for managing *Helicoverpa armigera* and *Spodoptera litura* in cotton ecosystem. Environmental Research. 2023;239:117301.
3. Bajya DR, Tyagi MP, Monga D. Seasonal monitoring of insecticide resistance in *Helicoverpa armigera* on cotton and chickpea. Indian Journal of Plant Protection. 20103;8(1):41-46.
4. Barwa J and Kumar A. Field efficacy of chlorantraniliprole with some biopesticides against pod borer (*Helicoverpa armigera* (Hubner)) on chickpea (*Cicer arietinum* L.). The Pharma Innovation Journal. 2022;11(6):1912-1916.
5. Kranthi KR, Jadhav DR, Kranthi S, Wanjari R. Insecticide resistance in five major insect pests of cotton in India. Crop Protection. 2005;24(3):114-121
6. Kumar NN, Acharya MF, Srinivasulu DV, Sudarshan P. Bioefficacy of modern insecticides against *Spodoptera litura* Fabricius on groundnut. International Journal of Agriculture Innovations and Research. 2015;4(3):2319-1473.
7. Mishra MK, Pandey R, Singh BK, Singh SK. Efficacy of Insecticides Against Tobacco Catterpillar *Spodoptera Litura* (F) and Gram Caterpillar *Helicoverpa Armigera* (HUBN) on Groundnut. Indian Journal of Entomology. 2024, 1-4.
8. Patidar R, Raipuriya N, Singh S, Kakade S. Efficacy of insecticides against fruit borer, *Helicoverpa armigera* on *Lycopersicon esculentum* Mill; c2023.
9. Sapekar AS, Sonkamble MM, Matre YB. Bio-efficacy of Different Insecticides against of Major Defoliators on Soybean. International Journal of Current Microbiology and Applied Sciences. 2020;Special Issue-11:2561-2569.
10. Wakil W, Ghazanfar MU, Nasir F, Qayyum MA, Tahir M. Insecticidal efficacy of *Azadirachta indica*, nucleopolyhedral virus and chlorantraniliprole singly or combined against field populations of *Helicoverpa armigera* Hübner (Lepidoptera: Noctuidae). Chilean Journal of Agricultural Research. 2012;72(1): 53.