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Efficacy of new generation molecules against sucking pests and bollworms in cotton

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Abstract

The field experiment was conducted during *Kharif*, 2016-17 and 2017-18 in the research field of the All India Coordinated Research Project on Cotton at the Regional Research and Technology Transfer Station, Bhawanipatna (OUAT) in Odisha to study the efficacy of new generation molecules against sucking pests and bollworms in cotton. The experiment was laid out in Randomized Block Design with eleven treatments in three replications. The mean data on insect population after two sprays indicated that application of Spinetoram 10% + Sulfoxaflor 40% WG @ 140 g a.i./ha recorded the minimum number of jassids (0.79/3 leaves), aphids (2.75/3 leaves) and thrips (0.46/3 leaves) followed by Spinetoram 10% + Sulfoxaflor 40% WG @ 120 g a.i./ha treated plot. Similar trend was observed in case of bollworms. After two sprays, significantly less incidence of *Helicoverpa armigera* and *Earias vittella* (0.17 larvae/5 plants) larvae were recorded in Spinetoram 10% + Sulfoxaflor 40% WG @ 140 g a.i./ha treated plot followed by Spinetoram 10% + Sulfoxaflor 40% WG @ 120 g a.i./ha treated plot. Maximum seed cotton yield (21.91 q/ha) was recorded in Spinetoram 10% + Sulfoxaflor 40% WG @ 120 g a.i./ha treated plot which was statistically at par with Spinetoram 10% + Sulfoxaflor 40% WG @ 120 g a.i./ha (21.71 q/ha), Spinetoram 12% SC @ 35 g a.i./ha (20.16 q/ha) and Sulfoxaflor 24% SC @ 105 g a.i./ha (20.06 q/ha) treated plots. The increase in seed cotton yield in Spinetoram 10% + Sulfoxaflor 40% WG @ 140 g a.i./ha was 36.51% more than the control (16.05 q/ha). Spinetoram 10% + Sulfoxaflor 40% WG @ 140 g a.i./ha treated plot recorded the maximum B:C ratio (2.31).

Keywords: Cotton, insecticides, sucking pests, bollworms, efficacy

Introduction

Cotton (*Gossypium hirsutum* L.), popularly known as “white gold” is an important fibre and cash crop of India having global significance. Cotton production in India during 2018-19 was 36.1 million bales of 170 kg each from an area of 12.24 million hectares with a productivity of 501 kg lint/ha. In Odisha, the crop occupied an area of 0.16 million ha during the same year with production of 0.45 million bales of 170 kg each and productivity of 484 kg lint/ha^[1]. The productivity of cotton in Odisha is less as compared to the national average due to many factors, but the most serious one is the intensity of insect pests. Cotton being a long duration and succulent crop, it is infested by a number of insect pests throughout its growth period. In India, about 162 insect pest species attack cotton crop from sowing to harvesting and causes yield loss up to 50-60 per cent^[2]. The insect pests of cotton can be primarily divided into two groups as sucking pests and bollworms. Aphid (*Aphis gossypii* Glover), jassids (*Amrasca biguttula biguttula* Ishida), thrips (*Thrips tabaci* Lind.) and whitefly (*Bemisia tabaci* Genn.) are the major sucking pests of cotton^[3]. These sucking pests are noticed at all the stages of crop growth and responsible for direct and indirect yield losses. A reduction of 22.85% in seed cotton yield due to sucking pests had been reported by^[4]. In bollworms especially, American bollworm (*Helicoverpa armigera* Hubner) and pink bollworm (*Pectinophora gossypiella* Saunders) cause considerable damage to the crop in India^[5]. Regular and indiscriminate use of insecticides and the misuse of synthetic pesticides on the crop have led to development of insecticide resistance in target pests, pest resurgence and secondary pest outbreaks, loss of bio-diversity, environmental pollution and residual toxicity and occurrence of human health hazards. However, in present day context chemical control has its own popularity over the other methods of pest control due to its immediate action and remarkable pest control. Crop protection with need based use of safer insecticides is considered as an effective and dependable component of IPM and one of the most important aspects of agro-ecosystem management with regards to the ecological and socio-economic values. In this context, some newer group of insecticides alone or in combination at recommended dose are used for

bringing about effective pest management of cotton. Keeping this in view, the present study was carried out to find the most effective new molecules of insecticides against sucking pests and bollworms in cotton.

Materials and Methods

The experiment was conducted during *Kharif*, 2016-17 and 2017-18 in the research field of the All India Coordinated Research Project on Cotton at the Regional Research and Technology Transfer Station, Bhawanipatna, Odisha University of Agriculture and Technology in Kalahandi district under Odisha. The experiment was laid out in Randomized Block Design with eleven treatments in three replications. Eleven treatments viz. T₁: Spinetoram 12% SC @ 30 g a.i./ha, T₂: Spinetoram 12% SC @ 35 g a.i./ha, T₃: Sulfoxaflor 24% SC @ 90 g a.i./ha, T₄: Sulfoxaflor 24% SC @ 105 g a.i./ha, T₅: Pyriproxyfen 5% EC @ 37.5 g a.i./ha, T₆: Fenprothrin 15% EC @ 112.5 g a.i./ha, T₇: Spinetoram 10% + Sulfoxaflor 40% WG @ 120 g a.i./ha, T₈: Spinetoram 10% + Sulfoxaflor 40% WG @ 140 g a.i./ha, T₉: Pyriproxyfen 5% EC + Fenprothrin 15% EC @ 37.5 + 112.5 g a.i./ha, T₁₀: Water spray and T₁₁: Control (No spray) were evaluated against insect pests of cotton. The sowing was done by hand dibbling with untreated seeds of cotton variety Suraj by placing two seeds/mount with a spacing of 90 cm x 60 cm on 4th July, 2016 and 8th July, 2017. Chemical fertilizers were applied @ 90:45:45 kg N: P₂O₅: K₂O/ha. Gap filling was done within 5-10 days after emergence of the crop and thinning was carried out at 15 days after emergence of the crop keeping one healthy seedling per mount. Intercultural and weeding operations were carried out as needed. Two sprays of insecticides were done, first spray at economic threshold level (ETL) of pests and subsequent sprays at 15 days interval. The observations on incidence of sucking pests like aphids, jassids and thrips were recorded by visual count from three leaves (each from top, middle and bottom) of five plants in each plot. With respect to bollworms population of American bollworm (*Helicoverpa armigera*) and Spotted bollworm (*Earias vittella*), larvae were counted on five randomly selected plants in each plot. The observations were recorded one day before spray and on 7th day after each spray. The plot yield in each treatment was recorded and expressed in q/ha.

The data recorded on sucking pests and bollworms population from the experiment were subjected to square root transformation and data were analyzed following procedures laid out by [6]. The standard error of means SE(m) ± and critical differences (CD) at 5% level of significance were calculated following the standard procedure and treatment means were compared using critical differences (CD).

Results

Jassids: The population data of jassids on the efficacy of insecticides against jassids are given in Table 1. The population of jassids was in the range of 5.08 – 7.92/3 leaves in all the treatments before first spray and there was no significant difference between the treatments. After first spraying, significantly minimum jassids population was recorded in Spinetoram 10% + Sulfoxaflor 40% WG @ 140 g a.i./ha treated plot with 1.17 jassids/3 leaves followed by Spinetoram 10% + Sulfoxaflor 40% WG @ 120 g a.i./ha with 1.25 jassids/3 leaves, which were at par with each other. Pyriproxyfen 5% EC + Fenprothrin 15% EC @ 37.5 + 112.5 g a.i./ha ranked second and recorded 1.75 jassids/3

leaves. The same trend of efficacy was observed after 2nd spray.

Aphids: The population data presented in Table 1 revealed that aphids population varied from 16.08 – 26.58/3 leaves before first spraying. Significant differences between treatments were recorded after first spray. Spinetoram 10% + Sulfoxaflor 40% WG @ 140 g a.i./ha (3.75 aphids / 3 leaves) was the most effective combination for managing the aphids population followed by Spinetoram 10% + Sulfoxaflor 40% WG @ 120 g a.i./ha (4.33 aphids/3 leaves) and Pyriproxyfen 5% EC + Fenprothrin 15% EC @ 37.5 + 112.5 g a.i./ha (5.00 aphids/3 leaves). The same efficacy trend was observed after second sprays recording minimum aphids population in Spinetoram 10% + Sulfoxaflor 40% WG @ 140 g a.i./ha (1.75 and 2.75 aphids / 3 leaves) and Spinetoram 10% + Sulfoxaflor 40% WG @ 120 g a.i./ha (3.08 and 3.71 aphids / 3 leaves) and Pyriproxyfen 5% EC + Fenprothrin 15% EC @ 37.5 + 112.5 g a.i./ha (3.42 and 4.21 / 3 leaves).

Thrips: The data presented in Table 1 indicated that before first spraying the thrips population varied from 4.67 – 8.00/3 leaves. After first spray significantly minimum population of 0.67 thrips/3 leaves was recorded in Spinetoram 10% + Sulfoxaflor 40% WG @ 140 g a.i./ha treated plot followed by Spinetoram 10% + Sulfoxaflor 40% WG @ 120 g a.i./ha (0.92/3 leaves) which was at par with Pyriproxyfen 5% EC + Fenprothrin 15% EC @ 37.5 + 112.5 g a.i./ha (1.08/3 leaves). Similar trend was observed in after second sprays.

Bollworms: The population of bollworms a day before spraying ranged from 0.33 – 0.67/5 plants in case of *H. armigera* and 1.33 – 2.00/5 plants for *Earias vittella* and there was no significant difference among different treatments (Table 2). After first spray no *H. armigera* population was recorded in Spinetoram 10% + Sulfoxaflor 40% WG @ 140 g a.i./ha and Spinetoram 10% + Sulfoxaflor 40% WG @ 120 g a.i./ha treated plots followed by Spinetoram 12% SC @ 35 g a.i./ha and Pyriproxyfen 5% EC + Fenprothrin 15% EC @ 37.5 + 112.5 g a.i./ha (0.33/5 plants). After second spray same efficacy trend was observed. After two sprays the minimum mean population of *H. armigera* larvae (0.17/5 plants) was observed in Spinetoram 10% + Sulfoxaflor 40% WG @ 140 g a.i./ha and Spinetoram 10% + Sulfoxaflor 40% WG @ 120 g a.i./ha treated plots followed by Spinetoram 12% SC @ 35 g a.i./ha (0.50/5 plants) as compared to the control plot (3.33/5 plants).

Minimum population of *Earias vittella* after first spray (0.33 larvae/5 plants) was observed in Spinetoram 10% + Sulfoxaflor 40% WG @ 140 g a.i./ha and Spinetoram 10% + Sulfoxaflor 40% WG @ 120 g a.i./ha followed by Spinetoram 12% SC @ 30 g a.i./ha, Spinetoram 12% SC @ 35 g a.i./ha and Sulfoxaflor 40% WG @ 105 g a.i./ha (0.67/5 plants). After second spray no population was recorded in Spinetoram 10% + Sulfoxaflor 40% WG @ 140 g a.i./ha treated plot followed by Spinetoram 10% + Sulfoxaflor 40% WG @ 140 g a.i./ha, Spinetoram 12% SC @ 35 g a.i./ha and Sulfoxaflor 40% WG @ 105 g a.i./ha (0.33 larvae/5 plants).

Data presented in Table 3 showed that the Spinetoram 10% + Sulfoxaflor 40% WG @ 140 g a.i./ha treated plot recorded significantly maximum number of bolls/plant (36.5) which was at par with Spinetoram 10% + Sulfoxaflor 40% WG @ 120 g a.i./ha (36.4), Spinetoram 12% SC @ 35 g a.i./ha (35.6) and Sulfoxaflor 24% SC @ 105 g a.i./ha (35.1) treated plots.

In case of number of bolls/plant and plant height no treatments (Table 3). significant difference were observed among the insecticides

Table 1: Effect of different new generation molecules on population of jassids, aphids and thrips in cotton (Pooled data, *Kharif* 2016-17 and 2017-18)

Treatment	Mean Jassid population/ 3 leaves			Pooled Mean after spray	Mean Aphids population / 3 leaves			Pooled Mean after spray	Mean Thrips population / 3 leaves			Pooled Mean after spray
	Before Spray	After 1 st spray	After 2 nd spray		Before Spray	After 1 st spray	After 2 nd spray		Before Spray	After 1 st spray	After 2 nd spray	
T ₁ :Spinetoram 12% SC @ 30 g a.i/ha	6.50 (2.64)	2.25 (1.66)	2.17 (1.63)	2.21 (1.64)	21.25 (4.66)	7.33 (2.80)	5.08 (2.36)	6.21 (2.58)	7.00 (2.74)	1.75 (1.50)	1.50 (1.41)	1.63 (1.46)
T ₂ :Spinetoram 12% SC @ 35 g a.i/ha	5.08 (2.36)	2.08 (1.61)	1.75 (1.50)	1.92 (1.55)	23.08 (4.85)	6.58 (2.66)	4.83 (2.31)	5.71 (2.48)	6.17 (2.56)	1.42 (1.38)	1.33 (1.35)	1.38 (1.36)
T ₃ :Sulfoxaflor 24% SC @ 90 g a.i/ha	6.33 (2.61)	2.67 (1.78)	2.25 (1.66)	2.46 (1.72)	23.75 (4.92)	7.73 (2.87)	5.67 (2.48)	6.70 (2.68)	4.92 (2.32)	1.83 (1.52)	1.63 (1.46)	1.73 (1.49)
T ₄ :Sulfoxaflor 24% SC @ 105 g a.i/ha	6.08 (2.57)	2.00 (1.58)	1.83 (1.53)	1.92 (1.55)	16.08 (4.07)	5.67 (2.47)	3.75 (2.06)	4.71 (2.26)	5.83 (2.51)	1.67 (1.47)	1.42 (1.38)	1.54 (1.43)
T ₅ :Pyriproxyfen 5% EC @ 37.5 g a.i/ha	6.83 (2.71)	3.08 (1.89)	2.67 (1.78)	2.88 (1.84)	22.50 (4.79)	7.17 (2.77)	6.75 (2.69)	6.96 (2.73)	7.67 (2.86)	2.92 (1.84)	3.08 (1.89)	3.00 (1.86)
T ₆ :Fenprothrin 15% EC @ 112.5 g a.i/ha	7.92 (2.90)	3.00 (1.87)	2.50 (1.73)	2.75 (1.80)	18.42 (4.30)	6.67 (2.67)	6.33 (2.61)	6.50 (2.64)	4.67 (2.26)	2.67 (1.77)	2.42 (1.70)	2.54 (1.74)
T ₇ :Spinetoram 10% + Sulfoxaflor 40% WG @ 120 g a.i/ha	6.59 (2.66)	1.25 (1.32)	0.75 (1.11)	1.00 (1.22)	23.17 (4.86)	4.33 (2.20)	3.08 (1.89)	3.71 (2.04)	7.25 (2.78)	0.92 (1.19)	0.50 (0.99)	0.71 (1.09)
T ₈ :Spinetoram 10% + Sulfoxaflor 40% WG@ 140 g a.i/ha	6.58 (2.66)	1.17 (1.29)	0.42 (0.95)	0.79 (1.12)	20.17 (4.55)	3.75 (2.06)	1.75 (1.49)	2.75 (1.78)	6.83 (2.70)	0.67 (1.08)	0.25 (0.86)	0.46 (0.97)
T ₉ :Pyriproxyfen 5% EC + Fenprothrin 15% EC @ 37.5 + 112.5 g a.i/ha	7.33 (2.80)	1.75 (1.50)	1.25 (1.32)	1.50 (1.41)	25.42 (5.08)	5.00 (2.34)	3.42 (1.98)	4.21 (2.16)	7.58 (2.84)	1.08 (1.25)	0.67 (1.07)	0.88 (1.16)
T ₁₀ : Water spray	6.25 (2.60)	9.33 (3.13)	10.75 (3.35)	10.04 (3.24)	23.50 (4.90)	42.50 (6.56)	29.58 (5.48)	36.04 (6.02)	8.00 (2.91)	13.83 (3.78)	12.42 (3.59)	13.13 (3.69)
T ₁₁ : Control (No spray)	6.92 (2.72)	9.34 (3.13)	11.58 (3.47)	10.46 (3.30)	26.58 (5.19)	44.58 (6.71)	33.42 (5.81)	39.00 (6.26)	6.75 (2.67)	14.50 (3.87)	13.42 (3.73)	13.96 (3.80)
SE(m)	0.08	0.08	0.09	0.08	0.28	0.15	0.16	0.15	0.18	0.12	0.12	0.12
CD(0.05)	0.17	0.16	0.18	0.17	0.57	0.30	0.33	0.31	0.37	0.24	0.24	0.24

Table 2: Effect of different new generation molecules on population of bollworms in cotton (Pooled data, *Kharif* 2016-17 and 2017-18)

Treatment	Mean <i>H. armigera</i> population/5 plants			Pooled Mean after spray	Mean Spotted bollworm population / 5 plants			Pooled Mean after spray
	Before Spray	After 1 st spray	After 2 nd spray		Before Spray	After 1 st spray	After 2 nd spray	
T ₁ :Spinetoram 12% SC @ 30 g a.i/ha	0.33 (0.88)	0.67 (1.05)	1.00 (1.22)	0.83 (1.14)	1.33 (1.34)	0.67 (1.05)	0.67 (1.05)	0.67 (1.05)
T ₂ :Spinetoram 12% SC @ 35 g a.i/ha	0.33 (0.88)	0.33 (0.88)	0.67 (1.05)	0.50 (0.97)	1.33 (1.34)	0.67 (1.05)	0.33 (0.88)	0.50 (0.97)
T ₃ :Sulfoxaflor 24% SC @ 90 g a.i/ha	0.67 (1.05)	0.67 (1.05)	1.33 (1.34)	1.00 (1.20)	1.67 (1.44)	1.00 (1.22)	0.67 (1.05)	0.83 (1.14)
T ₄ :Sulfoxaflor 24% SC @ 105 g a.i/ha	0.67 (1.05)	0.67 (1.05)	0.67 (1.05)	0.67 (1.05)	1.33 (1.34)	0.67 (1.05)	0.33 (0.88)	0.50 (0.97)
T ₅ :Pyriproxyfen 5% EC @ 37.5 g a.i/ha	0.33 (0.88)	1.00 (1.22)	1.67 (1.46)	1.33 (1.34)	1.67 (1.46)	1.00 (1.22)	0.67 (1.05)	0.83 (1.14)
T ₆ :Fenprothrin 15% EC @ 112.5 g a.i/ha	0.67 (1.05)	0.67 (1.05)	1.67 (1.46)	1.17 (1.26)	2.00 (1.56)	1.33 (1.34)	1.00 (1.22)	1.17 (1.28)
T ₇ :Spinetoram 10% + Sulfoxaflor 40% WG @ 120 g a.i/ha	0.33 (0.88)	0.00 (0.71)	0.33 (0.88)	0.17 (0.79)	1.67 (1.46)	0.33 (0.88)	0.33 (0.88)	0.33 (0.88)
T ₈ :Spinetoram 10% + Sulfoxaflor 40% WG@ 140 g a.i/ha	0.67 (1.05)	0.00 (0.71)	0.33 (0.88)	0.17 (0.79)	2.00 (1.56)	0.33 (0.88)	0.00 (0.71)	0.17 (0.79)
T ₉ :Pyriproxyfen 5% EC + Fenprothrin 15% EC @ 37.5 + 112.5 g a.i/ha	0.33 (0.88)	0.33 (0.88)	1.00 (1.22)	0.67 (1.05)	2.00 (1.56)	1.00 (1.22)	0.33 (0.88)	0.67 (1.05)
T ₁₀ : Water spray	0.33 (0.88)	1.67 (1.46)	5.00 (2.35)	3.33 (1.90)	1.67 (1.46)	3.33 (1.95)	4.00 (2.12)	3.67 (2.04)
T ₁₁ : Control (No spray)	0.33 (0.88)	2.00 (1.58)	4.67 (2.27)	3.33 (1.93)	1.67 (1.46)	3.33 (1.95)	4.67 (2.27)	4.00 (2.11)
SE(m)	0.26	0.19	0.17	0.18	0.22	0.18	0.20	0.19
CD(0.05)	0.53	0.40	0.34	0.37	0.46	0.37	0.42	0.39

Table 3: Effect of different new generation molecules on plant height (cm), number of boll/plant and boll weight (g), seed cotton yield and economics of cotton (Pooled data, Kharif 2016-17 and 2017-18)

Treatment	Plant height (cm)	No. of bolls/plant	Boll weight (g)	Seed Cotton Yield (q/ha)	Gross returns (Rs./ha)	Cost of cultivation (Rs./ha)	Net returns (Rs./ha)	B:C ratio
T ₁ :Spinetoram 12% SC @ 30 g a.i/ha	104.8	31.5	3.6	19.28	83,290	45,450	42,840	2.06
T ₂ :Spinetoram 12% SC @ 35 g a.i/ha	105.6	35.6	3.8	20.16	87,091	45,600	46,491	2.15
T ₃ :Sulfoxaflor 24% SC @ 90 g a.i/ha	105.3	31.5	3.6	18.72	80,870	45,810	40,060	1.98
T ₄ :Sulfoxaflor 24% SC @ 105 g a.i/ha	105.5	35.1	3.7	20.06	86,659	46,115	45,544	2.11
T ₅ :Pyriproxyfen 5% EC @ 37.5 g a.i/ha	104.3	32.8	3.6	18.83	81,346	47,100	39,246	1.93
T ₆ :Fenprothrin 15% EC @ 112.5 g a.i/ha	104.4	32.5	3.7	18.52	80,006	45,940	39,066	1.95
T ₇ :Spinetoram 10% + Sulfoxaflor 40% WG @ 120 g a.i/ha	106.7	36.5	4.0	21.71	93,787	45,760	53,027	2.30
T ₈ :Spinetoram 10% + Sulfoxaflor 40% WG @ 140 g a.i/ha	106.0	36.4	3.8	21.91	94,651	45,920	53,731	2.31
T ₉ :Pyriproxyfen 5% EC + Fenprothrin 15% EC @ 37.5 + 112.5 g a.i/ha	105.2	34.7	3.7	19.14	82,689	47,300	40,389	1.95
T ₁₀ : Water spray	103.0	26.4	3.5	16.15	69,768	44,950	31,818	1.84
T ₁₁ : Control (No spray)	102.9	25.5	3.5	16.05	69,336	44,800	31,536	1.83
SE(m)	1.14	0.78	0.15	1.20	-	-	-	-
CD(0.05)	NS	1.62	NS	2.47	-	-	-	-

*Market price of seed cotton: Rs. 43.20/kg

Seed cotton yield and economics: The data on the seed cotton yield (Table 3) revealed that all the chemical treated plots gave significantly superior yield over control. Among the treatments, maximum seed cotton yield of 21.91 q/ha was obtained in Spinetoram 10% + Sulfoxaflor 40% WG@ 140 g a.i./ha treated plot, which was statistically at par with Spinetoram 10% + Sulfoxaflor 40% WG@ 120 g a.i./ha (21.71 q/ha), Spinetoram 12% SC @ 35 g a.i./ha (20.16 q/ha) and Sulfoxaflor 24% SC @ 105 g a.i./ha (20.06 q/ha) treated plots. The minimum seed cotton yield of 16.05 q/ha was recorded in untreated control plot. The increase in seed cotton yield in Spinetoram 10% + Sulfoxaflor 40% WG@ 140 g a.i./ha treated plot was 36.51% more over the control (16.05 q/ha). Net return was higher in Spinetoram 10% + Sulfoxaflor 40% WG@ 140 g a.i./ha (Rs. 53,737/ha) treated plot followed by Spinetoram 10% + Sulfoxaflor 40% WG@ 120 g a.i./ha (Rs. 53,027/ha) and Spinetoram 12%SC @ 35 g a.i/ha (Rs. 46,491/ha). Spinetoram 10% + Sulfoxaflor 40% WG@ 140 g a.i./ha recorded the maximum B:C ratio (2.31) followed by Spinetoram 10% + Sulfoxaflor 40% WG@ 120 g a.i./ha (2.30).

Discussion

Sucking pests are the major important pests in cotton crop. For the management of sucking pests like jassids, aphids and thrips, application of Spinetoram 10% + Sulfoxaflor 40% WG@ 140 g a.i/ha was most effective recording lower number of these pests. The same combination insecticides also recorded lower number of *H. armigera* and *Earias vittella* larvae. In the management of sucking pests and bollworms in cotton, superiority of Spinetoram 10% + Sulfoxaflor 40% WG is because of their combined action where Spinetoram being xylem mobile insecticide affects nicotinic acetylcholine receptors and γ -amino butyric acid (GABA) receptors existing on postsynaptic membranes in insect nervous system, thereby causing abnormal neural transmission and Sulfoxaflor acts as an agonist at insect nicotinic acetylcholine receptors. Moreover, Sulfoxaflor is part of chemical class of insecticides known as the sulfoximines, a group that has not previously been associated with crop protection chemistries thus offers efficient control of the pests. The present findings are in agreement with

Shivaray ^[7] who reported that Spinetoram 10% + Sulfoxaflor 40% WG@ 140 g a.i/ha is very effective in managing cotton leaf hopper, aphid and thrips. Similar results were obtained by Hanchinal ^[8] and Ambarish ^[9] who observed that maximum mortality of jassids and thrips was found in Spinetoram 10% + Sulfoxaflor 40% WG@ 140 g a.i/ha treated plot. Bhanu ^[10] reported that Sulfoxaflor 24 SC at both doses viz., 75 and 90 g a.i/ha reduced the build-up of rice plant hoppers in both the seasons and was superior to other insecticides. Siebert ^[11] reported that Spinetoram applied at 13.0 to 26.0 g a.i./ha is very effective in managing cotton thrips.

In the management of *H. armigera* and *Earias vittella*, Spinetoram 10% + Sulfoxaflor 40% WG@ 140 g a.i/ha was most effective. These findings were in agreement with Hanchinal ^[8] and Shivaray ^[7] who reported that the treatment with Spinetoram 10% + Sulfoxaflor 40% WG@ 140 g a.i/ha caused significantly maximum mortality of *H. armigera* and *Pectinophora gossypiella*. Whereas, in our study Spinetoram 10% + Sulfoxaflor 40% WG is superior because of their combined and novel mode of action as explained earlier.

Conclusion

It can be concluded from the two years experiment that sucking pests of cotton like aphids, jassids and thrips and bollworms like American bollworm (*H. armigera*), Spotted bollworm (*Earias vittella*) can be effectively controlled with spray of Spinetoram 10% + Sulfoxaflor 40% WG@ 140 g a.i/ha. The seed cotton yield recorded by this treatment was 21.91 q/ha which was 36.51% more over the control. Maximum net return (Rs. 53,737/ha) and B:C ratio (2.31) was recorded by this treatment.

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