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Bioefficacy of novel insecticides against cotton thrips, *Thrips tabaci* (Thysanoptera: Thripidae)

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Abstract
Cotton is the most important cash crop of southern districts of Punjab. The productivity of the cotton crop is low due to vigorous attack by insect-pests. Among the insect-pests, cotton crop is heavily damaged by sucking pests. Among the sucking pest's thrips, *Thrips tabaci* create a setback to the early stages and reduces yield of cotton crop. Therefore, an on farm trial was conducted to evaluate the bioefficacy of novel insecticides *viz.*, Spinetoram 11.7 SC, Diafenthiuron 50 WP and Thiamethoxam 25 WG against thrips on cotton crop. Results of the present study revealed that lowest population of thrips *i.e.*, 3.03 per leaf was recorded with the treatment of Spinetoram 11.7 SC followed by Diafenthiuron 50 WP and Thiamethoxam 25 WG with record of 8.70 and 12.07 thrips per leaf, respectively after 10 days of spray. Similarly, the highest yield of cotton (21.25 q/ha) and benefit cost ratio (3.48) was observed the application of Spinetoram 11.7 SC.

Keywords: *Gossypium hirsutum*; *Thrips tabaci*; bioefficacy; spinetoram; diafenthiuron

Introduction
Cotton, *Gossypium hirsutum* L. is also known as "White Gold" and it is an important cash crop of India. Cotton is mainly cultivated for obtaining fiber, but it has also great potential to be used as edible oil and feed for animals [1]. Cotton is cultivated in 80 countries across the world. In India, it is cultivated in eleven states under different climatic conditions over 122.38 lakh ha area. During 2018-19, the average production of this crop was recorded as 361 lakh bales (170 kg lint/bale) with average lint yield of 501 kg lint per ha[2]. In Punjab, it is cultivated on 2.87 lakh ha area which gives as average yield of 12.71 lakh bales [3]. But, the production of cotton per unit area is low in our country as compared to China. The most significant constraint for low productivity of cotton crop is the attack of insect-pests that damage the crop from sowing to maturity. In India, 162 species of insect-pests have been reported which attack cotton crop [4].

To resolve the problem of insect-pests, Bt cotton hybrids containing *Cry1Ac* genes from *Bacillus thuringiensis* Berliner were approved for cultivation in Punjab [5]. Bt cotton is highly effective for controlling bollworms and has become an important component of integrated pest management (IPM) programme [6-7]. In spite of the introduction of Bt cotton, the productivity of the cotton crop is low which is due to the attack of sucking pests including; *Phenacoccus solenopsis* Tinsley (Hemiptera: Pseudococcidae), *Bemisia tabaci* (Gennadius) (Hemiptera: Aleyrodidae), *Thrips tabaci* (Lindemann) (Thysanoptera: Thripidae) and *Amrasca biguttula biguttula* (Ishida) (Hemiptera: Cicadellidae) [8-9]. Amongst them, *T. tabaci* is an important polyphagous pest of which nearly six thousand species have been reported. Thrips are difficult to control as they have developed resistance to commonly used insecticide and have also modified their behavior to survive on different types of host plants [10-11].

Thrips attack nearly 300 plant species and the main economic crops include; cotton, potato, tomato, cabbage, lettuce, pea, garlic, tobacco and melon [12-13]. Thrips cause more than $1 billion loss worldwide alone in onion crop [14]. Thrips cause severe damage to cotton plants in the seedling stage. Initially, thrips feed on cotyledon leaves which results in silver appearance of leaves and lower side of true leaves becomes ragged and crinkled [15-16]. It causes heavy damage in dry weather [17-18]. Injury caused by thrips during the seedling stage of cotton leads to the delayed initiation of reproductive stages and, reduced plant height and yield [19]. Further,

T. tabaci also causes indirect damage by transmitting viruses such as Iris yellow spot virus (IYSV) and Tomato spotted wilt virus (TSWV) [20 -21].

To avoid the losses caused by thrips in cotton, conventional insecticides are being used by farmers. These insecticides are toxic to pollinators and natural enemies. Therefore, the present study was planned to evaluate the bioefficacy of novel and relatively less toxic insecticides for the management of thrips in cotton crop.

Materials and methods

On farm trials on the bioefficacy of novel insecticides on population of thrips were conducted at the farmer's field of Barnala district during *kharif* 2019. For conducting trials on cotton, recommended variety of Bt-cotton hybrid was grown with maintaining line to line distance of 67.5 cm and plant to plant 60 cm. All the recommended agronomic practices were followed in the field according to the recommendation of PAU, package of practices for *Kharif* crops. The bioefficacy of novel insecticides such as Spinetoram 11.7 SC (425 ml ha^{-1}), Diafenthiuron 50 WP (500 gm ha^{-1}) and Thiamethoxam 25 WG (125 g ha^{-1}) were evaluated against thrips under field condition. In control, no insecticide was sprayed. All the insecticides were purchased from the local market and sprayed at selected doses with knapsack sprayer using 250 liter of water per ha. The thrips population was recorded at randomly selected 10 plants in each treatment field. There were three replications in each treatment. The thrips population was observed day before spray (DBS) and after 1, 3, 7, 10 and 15 days of spray (DAS). The data thus obtained from field experiments were analyzed statistically by ANOVA at 5 per cent level of significance. The yield and benefit cost ratio of different treatments were also calculated.

Results and discussion

The results of the present study revealed that prior to application of insecticides, population of thrips was distributed homogeneously in field. Thrips population ranged from 15.30 to 16.00 per leaf and there was no significant difference amongst the treatments and control, day before the spray of insecticides (Table 1). After 1 day of spray, a significant maximum reduction in thrips population was recorded in the field treated with Spinetoram 11.7 SC (9.90 thrips/leaf) followed by Thiamethoxam 25 WG and Diafenthiuron 50 WP with which the respective values of thrips population were recorded as 12.47 and 13.07 per leaf. Similarly, after 3 days of spray, the maximum reduction of thrips population was again found in the crop treated with Spinetoram 11.7 SC (3.17/leaf). The corresponding figure was 5.60 and 9.33 thrips per leaf in the crops treated with Diafenthiuron 50 WP and Thiamethoxam 25 WG, respectively. The observation recorded after 7 days of spray showed that there was gradual increase of thrips population with the treatment of Diafenthiuron 50 WP and Thiamethoxam 25 WG. After 10 days of spray, a significant maximum reduction of thrips population was recorded with application of Spinetoram 11.7 SC (3.03 thrips/leaf) followed by Diafenthiuron 50 WP and Thiamethoxam 25 WG with record of 8.70 and 12.07 thrips per leaf. The same trend of reduction of thrips population was observed after 15 days of spray with different insecticides. However, in all the treatments thrips population per leaf was significantly lower than control after the application of insecticides. The maximum population of thrips was recorded with control i.e., 27.03 per leaf after 15 days. Among all treatments, Thiamethoxam 25 WG was the least effective insecticide against thrips. Initially, the thrips population was observed as 15.47 which reduced to 12.47, 9.33, 9.13, 12.07 and 14.47 thrips per leaf after 1, 3, 7 10 and15 days of spray, respectively. However, with the application of Spinetoram 11.7 SC, the initial thrips population was 16.00 which reduced to 9.90, 3.17, 3.83, 3.03 and 5.97 thrips per leaf after 1, 3, 7 10 and 15 days of spray respectively. The data pertaining to cotton yield revealed that the highest yield was recorded with the application of Spinetoram 11.7 SC (21.25 q/ha) followed by Diafenthiuron 50 WP and Thiamethoxam 25 WG with average yield of 20.32 and 19.80 q/ha respectively. Similarly, the highest benefit cost ratio was also observed with the treatment of Spinetoram 11.7 SC (3.48) followed by Diafenthiuron 50 WP and Thiamethoxam 25 WG with benefit cost ratio of 3.34 and 3.26, respectively (Table 2). The results of present study are in line with findings of Wale *et al.*, 2011 [22] who have also reported that the application of novel insecticide, Spinetoram @ 56g a.i. per ha effectively managed the thrips population and gave the highest cotton yield. Spinetoram is novel insecticide and it is derived from the fermentation of bacteria namely, *Saccharopolyspora spinosa* [23]. It is effective against different insect orders such as Thysanoptera, Lepidoptera and Diptera. Singh *et al.*, (2012) [24] has documented the efficacy of Spinetoram against two economically important pests namely; *T. tabaci* and *Spodoptera sp.* which belong to different insect orders. It enters into the digestive system of insect through ingestion of food or it may be absorbed in insect through cuticle by direct contact with insecticide. Spinetoram kills the insect-pests by disruption of gamma amino butyric acid (GABA) [25]. The results of present study also revealed that Spinetoram has quick knocked down effects on *T. tabaci*. The present finding has derived the support from the findings of Watson, (2001) [26] who has also reported that Spinetoram kills the target pest within 24 h by causing paralysis. However, this insecticide is a more selective against natural enemies and it has less impact on predators [27-28]. Hence, Environmental protection agency (EPA) has also described this insecticide as toxicologically reduced risk product. Earlier several studies by different researchers showed the greater efficacy of Spinetoram against *T. tabaci* [29- 30- 31]. In addition, this insecticide is also effective against thrips of chilli crop [32]. Beside this, the efficacy of other insecticide including Diafenthiuron 50 WP and Thiamethoxam 25 WG against cotton thrips and other sucking pests have also been reported by previous studies [33-34-35].

Table 1: Bioefficacy of different insecticides against thrips, *Thrips tabaci* in cotton during *Kharif* 2019

Treatment	Number of thrips/leaf					
	1 DBS	1 DAS	3 DAS	7 DAS	10 DAS	15 DAS
Thiamethoxam 25 WG	15.47 (4.06)	12.47 (3.67)	9.33 (3.21)	9.13 (3.18)	12.07 (3.61)	14.47 (3.93)
Diafenthiuron 50 WP	15.30 (4.04)	13.07 (3.75)	5.60 (2.56)	7.73 (2.95)	8.70 (3.11)	10.43 (3.38)
Spinetoram 11.7 SC	16.00 (4.12)	9.90 (3.30)	3.17 (2.03)	3.83 (2.18)	3.03 (2.00)	5.97 (2.64)
Control	15.60 (4.07)	15.67 (4.08)	17.87 (4.34)	20.37 (4.62)	24.43 (5.04)	27.03 (5.29)
C.D (p=0.05)	NS	0.19	0.22	0.27	0.40	0.21

SE(m)	0.02	0.05	0.06	0.08	0.12	0.06
SE(d)	0.03	0.08	0.09	0.11	0.16	0.08

Mean of three replication; figures in parenthesis are square root transformation; DBS-day before spray; DAS-day after spray; NS-No Significant difference

Table 2: Effect of different insecticides on the grain yield and benefit cost ratio

Treatment	Yield (q/ha)	Net Return (Rs.)	B:C ratio
Thiamethoxam 25 WG	19.80	69658	3.26
Diafenthiuron 50 WP	20.32	72286	3.34
Spinetoram 11.7 SC	21.25	76954	3.48

B: C ratio- Benefit cost ratio

Conclusion: Our results suggested that Spinetoram 11.7 SC was the most effective insecticide resulted in significant reduction of thrips population as compared to all other insecticides.

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