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EFFECT OF *BT* AND NON-*BT* COTTON ON BIOLOGY OF *THRIPS TABACI* AND ITS MANAGEMENT USING INSECTICIDES

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ABSTRACT

The development of *Thrips tabaci* was studied on transgenic BG I, BG II, non-*Bt*, and *desi* cotton cultivars. The oviposition period was minimum on *desi* cotton, FDK 124 (11.67 days) as compared to BG II (RCH 650) and non-*Bt* cotton (LH 2076). Female longevity was minimum on FDK 124 (17.50 days) followed by RCH 650 (23.17 days) and LH 2076 (21.83 days). Maximum female longevity was recorded on BGI cotton cultivar RCH 308 (26.83 days). Nymphal, pupal period, and total development period were minimum on FDK 124 (8.17, 2.33, and 34.00 days) as compared to *Bt* and non-*Bt* cotton cultivar, LH2076. Based on the higher oviposition period, female longevity, fecundity, and nymphal period, *Bt* cotton hybrids were found to be more favourable for thrips development in comparison to non-*Bt* cotton cultivars and *desi* cotton . The new generation insecticide, spinetoram 11.7SC @ 425g/ ha was most effective and also found to be safe to the predators.

Key words: *Thrips tabaci*, *Bt* cotton, biology, insecticides, spinetoran, safety, predators

Cotton (*Gossypium* spp) is the most important commercial crop in India. The major bottleneck in cotton cultivation is the damages caused by bollworm complex and sucking pests. *Bt* cotton was widely adapted in cotton-growing countries globally for the management of the bollworm complex, but it does not provide resistance against sucking pests. As a result of this, nontarget pest insects, with piercing-sucking mouthparts, such as leafhopper, mealybug, thrips, and whiteflies, survive better and emerged as serious pests on *Bt* cotton (Xu et al., 2008; Vennila, 2008). *Thrips tabaci* Lindeman is one such pest of *Bt* cotton causing economic damage in the North-Western zone of India. Earlier, it was known to cause damage during the seedling stage during pre-*Bt* era. However, in 2017, its severe incidence was recorded during vegetative and reproductive stages on various *Bt* cotton hybrids and now it has attained the status of major pest (unpublished data). For its management, chemicals like profenophos 50EC and diafenthiuron 50 WP were used (Anonymous, 2018). It had already attained the status of a regular cotton insect pest in the Punjab province of Pakistan, probably due to overuse of insecticides (Ali et al., 1993). The pertinent literature on the development of *T. tabaci* on *Bt* cotton is not available. A field study on population dynamics showed that *Bt* genotypes were more susceptible than non-*Bt* genotypes (Akram et al., 2013; Jeyakumar et al., 2008). Thrips have a wide host range, reportedly feeding on over 300 plants, under 25 families (Lewis, 1997). No systematic and detailed study on the comparative development of *T. tabaci* on transgenic *Bt*, non-*Bt* and *desi* cotton has been carried out. The present study was undertaken to find out the development of thrips on transgenic *Bt* and non-*Bt* cotton cultivars and their management on *Bt* cotton.

MATERIALS AND METHODS

The seeds transgenic *Bt* cotton cultivars (*G. hirsutum*) like MRC 6301 (BG I), RCH 308 (BG I), Ankur 3028 (BG II), RCH 650 (BG II), and non *Bt* cotton cultivars like LH 2076 and *desi* cotton cultivar (*G. arboretum*), FDK 124 were sown at weekly intervals in the earthen pots placed in the screen house. Various stages of *T. tabaci* i.e. nymphs and adults were collected from the unsprayed cotton field and released on these potted plants. The adults thus obtained, after confirmation of desired species of thrips (from the documented specimen) were used for raising the culture of *T. tabaci*. The various biological parameters of *T. tabaci* were studied by confining the adults and immature stages in a leaf cage made of a lightweight petri dish measuring 4.8 cm dia. Six circular holes (0.75 cm dia) were made on the sides and one hole (one cm diameter) was made in the centre. One end of the hair clip was placed on cardboard, while the other end was placed above the petri dish, sandwiching the leaf between the leaf cage and cardboard.

The observations on development of *T. tabaci* on transgenic BG I, BG II, non-*Bt* and *desi* cotton cultivars were carried out under screen house 31.43± 0.36 °C RH of 69.67± 3.09%. From the maintained culture, five freshly emerged females of *T. tabaci* were taken and released into leaf cages fixed on 40-day-old potted plants of selected cotton genotypes. There were six replications. To record the preoviposition, oviposition, and post oviposition period, the females were transferred daily to a new leaf cage made on the plants of various cultivars until their death. The preoviposition period was considered from the day of emergence of the female to the day when it started laying eggs. The number of days for which egg-laying continued was taken as the oviposition period. The post-oviposition period was observed as the number of days between the last days of oviposition until the death of female. The leaf area was observed daily for the emergence of first instar nymphs. The number of nymphs that emerged from one female represented the fecundity-cum-viability. The nymphs from each female were counted and removed daily at the time of observation. The time between the release of the female and the appearance of the nymphs was considered as the incubation period. Nymphs were observed twice a day to note the change of instars. This process was done till the prepupal stage. The interval between two moultings was taken as the duration of nymphal instars and the period between the time of the release of a freshly hatched nymph and change into the prepupal stage was taken as the total nymphal period. Prepupae were observed twice a day and when the second stage shows sluggish movement, it was considered the beginning of the prepupal stage. The prepupa was somewhat whiteyellowish and that of pupa was dark brownish. The full-length pupa had the antennae folded back over the head and well-developed wing pads. Both the stages showed slight movement when they were disturbed. The female longevity was taken as the period from the adult emergence till death.

Twelve insecticides were evaluated against thrips on *Bt* cotton hybrid, RCH 773. The experiment was repeated four times at two locations (Mansa and Abohar) which are the main cotton growing regions of Punjab, India. There were three replications with traetment being, insect growth regulator (buprofezin 25SC); neonicotinoids (clothianidin 50WDG, imidacloprid 17.8SL, thiamethoxam 25WG and thiacloprid 21.7SC); organophosphate (fipronil 5SC and profenophos 50EC) pyridine carboxamide (dinotefuran 20SG and flonicamid 50WG); synthetic pyrethroids (cypermethrin 25EC) and spinosyn (spinetoram 11.7SC); thiourea derivatives (diafenthiuron 50WP). These were sprayed with a manually operated knapsack sprayer (375e/ ha). The thrips (nymphs and adults) were recorded from three leaves plant in the upper crop canopy before spray and three, seven, and ten days after spray. The effect on the occurrence of predator plant was also recorded. The seed cotton yield was recorded on a whole plot basis. The means and standard error of biological parameters were computed. The data were statistically analyzed with ANOVA. The means were separated by critical difference (LSD) at p= 0.05 (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

There was significant difference in the preoviposition, oviposition, and postoviposition period of *T. tabaci* were recorded on various transgenic BG I, BG II, non-*Bt*, and *desi* cotton cultivars. The preovipostion period was minimum (2.50 days) on BG II cotton cultivar, RCH 650 followed by BG I cotton cultivar MRC 6301 (3.33 days); and oviposition period was minimum on *desi* cotton cultivar, FDK 124 (11.67 days). The post-oviposition period non-significant.

There was a significant difference in female longevity on different cotton cultivars minimum being on the *desi* cotton cultivar, FDK 124 (17.50 days). The maximum female longevity was recorded on RCH 308 (26.83 days) (Fig. 1). Likewise, there was significant difference in fecundity-cum-viability with minimum being on *desi* cotton cultivar, FDK 124 (5.83 days) and maximum on RCH 308 (19.17 days) (Fig. 2). The incubation period varied significant by (Fig. 2), with minimum being on Ankur 3028 (3.17 days) and RCH 308 (3.17 days) and maximum on *desi* cotton cultivar FDK 124 (4.67 days). The difference in the first instar nymphal duration was non-significant (Fig. 2); the second instar nymphal period was minimum on *desi* cotton cultivar FDK 124 (4.33 days) while the total nymphal duration was minimum on *desi* cotton cultivar FDK 124 (8.17 days) and maximum on Ankur 3028 (10.83 days). There was a non-significant difference in the prepupal period on different cotton cultivars (Fig. 2) while there was a significant difference in the pupal period it was significantly lower in FDK 124 (2.33 days) and maximum with Ankur 3028 (3.67 days). Total development period from egg to death of female was on found to be minimum on *desi* cotton cultivar FDK 124 (34.00 days) and maximum with BG I hybrid RCH 308 (40.00 days).

The pooled data of the four field experiments conducted during 2017 and 2018 revealed that the incidence of thrips (nymphs and adults) did not differ significantly in the treatments before spray; and it was

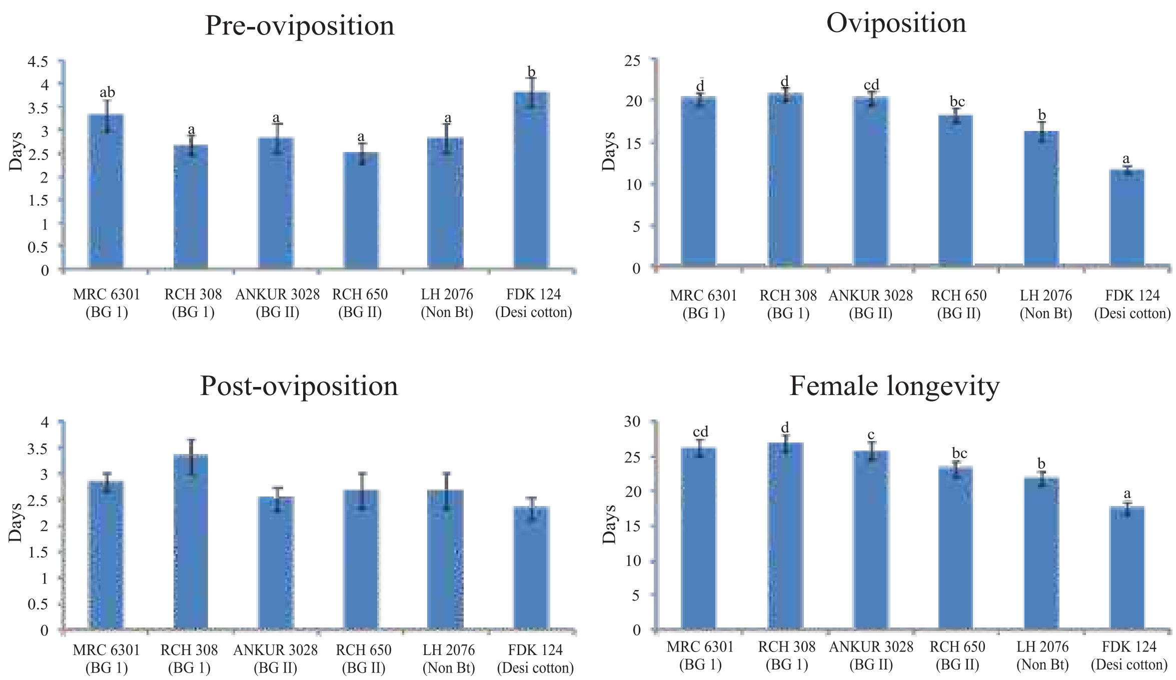

Fig. 1. Effect of various cotton cultivars on oviposition and female longevity of *Thrips tabaci*

adult was significantly less with (spinetoram) 11.7SC i.e. 8.75, 10.42, and 10.16 three leaves followed by standard check profenophos 50EC (11.60, 18.89 and 35.92) and fipronil 5 SC (19.82, 24.45 and 35.51) after 3, 7 and 10 days of application, respectively (Table 1). Seed cotton yield of *Bt* cotton was significantly higher in spinetoram (26.34 q/ha) followed by buprofezin 25SC (24.91 q/ha) (Table 1). The reduction in the population of natural enemies including coccinellids beetle, chrysopa, and spiders was recorded almost in all the treatments except control after three days of spray. After seven and ten days of spray, their occurrence higher in spinetoram 11.7SC being at par with diafenthiuron 50WP (Table 2).

During 2017, an outbreak of thrips *T. tabaci* was recorded in Punjab and Haryana and for its sustainable IPM, host plant resistance plays a vital role. It is imperative to understand its development on transgenic BG I, BG II, non-*Bt* and *desi* cotton cultivars. The present study revealed that its oviposition period, fecundity and female longevity were minimum on *desi* cotton cultivars and maximum on transgenic BG I, BG II, and non-*Bt* cotton cultivars. The maximum female longevity was on BG I cotton cultivar. These results revealed that female of thrips not only oviposit more on *Bt* cotton but also survive longer. Transgenic plants might possess certain biophysical and biochemicals characteristics which led to more survival and oviposition in comparison to non-*Bt* cotton cultivars. A field study on population dynamics showed that *Bt* genotypes found more susceptible for thirps than non-*Bt* genotypes (Akram et al., 2013; Jeyakumar et al., 2008). Salas et al. (1993) and Arrieche et al. (2006) reported the oviposition period of 19.50 days 34.5°C and 65% RH on onion. Present results corroborate the findings of Patel et al. (2013) who reported the oviposition period of 22.98 days on onion. The present study revealed that female longevity was minimum on *desi* cotton cultivar, FDK 124 whereas it was maximum on transgenic BG I cotton Lall and Singh (1968) also reported that female longevity was of 20.1 and 20.2 days on onion at 23.4 °C and 30.8 °C; Patel et al. (2013) reported this as 27.97 days on onion. Salas et al. (1993) and Guzmann et al. (1996) reported adult longevity of 21.5 at 32 °C. Arrieche et al. (2006) reported it as 11.5 days on onion.

Nymphal period was maximum on BGII cotton cultivar, Ankur 3028 and minimum on *desi* cotton cultivar. The present findings agree with those of Fekrat et al. (2009) and Changela (1993), and in contrast with that of Lall and Singh (1968) on onion. The pupal duration was significantly lower on *desi* cotton cultivar whereas it was higher on BG II cotton cultivar. Patel et al. (2013) reported a pupal period of 3.56 ± 0.50 days. Lall and Singh (1968) also recorded pupal period of 2.4 days and Salas et al. (1993) recorded the prepupal and pupal periods of 1.17 and 2.4 days, respectively.

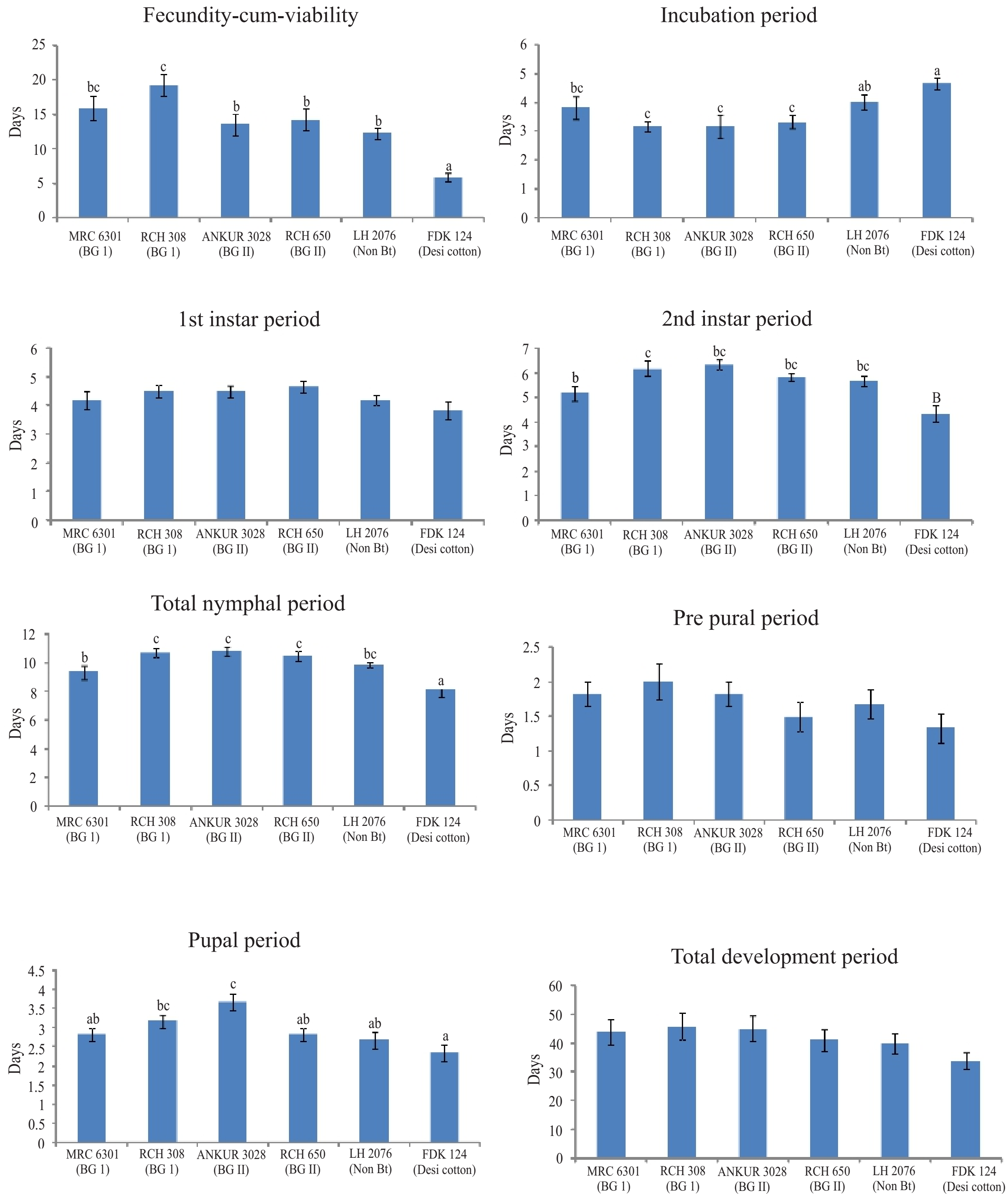

Fig. 2. Effect of various cotton cultivars on fecundity and development period of various stages of *Thrips tabaci*

Similarly, the total development period was minimum on *desi* cotton cultivar and maximum on transgenic BG I cultivar. These results corroborate with those of Patel et al. (2013) on onion; in contrast Salas (1994) reported it as 12.03 days from egg to adult. Patel et al. (2013) observed incubation period of 4.52 days on onions, and 4.00 to 4.33 days was reported by Salas (1994). Lall and Singh (1968) recorded an egg period of 9.8 days on onion.

Spinetoram 11.7SC was observed to be the most effective insecticide. Among the convention insecticides

Table 1. Efficacy of insecticides against *T. tabaci*

Treatment	Dose (ml/ g / ha)	Population of thrips/ 3 leaves				Seed cotton yield (q/ ha)
		Before spray	3 DAS	7 DAS	10 DAS	
Buprofezin 25SC	1000	59.79	37.49 (6.17)	39.82 (6.36)	47.63 (6.93)	24.91
Clothianidine 50WDG	50	61.02	57.92 (7.63)	64.81 (8.07)	68.62 (8.31)	23.33
Cypermethrin 25EC	120	63.39	44.81 (6.72)	34.38 (5.95)	38.05 (6.25)	23.33
Diafenthiuron 50WP	500	62.67	20.98 (4.66)	27.17 (5.24)	35.43 (5.91)	23.46
Spinetoram 11.7SC	420	65.30	8.75 (3.11)	10.42 (3.36)	10.56 (3.36)	26.34
Dinotefuran 20SG	150	66.59	70.08 (8.38)	74.16 (8.63)	78.95 (8.90)	23.28
Fipronil 5SC	2000	64.79	19.82 (4.55)	24.45 (4.98)	35.51 (6.01)	22.64
Flonicamid 50WG	200	59.07	54.79 (7.44)	56.14 (7.55)	61.04 (7.86)	24.06
Imidacloprid 17.8SL	100	63.80	43.54 (6.60)	45.74 (6.80)	57.28 (7.61)	23.19
Profenofos 50EC	1250	60.34	11.60 (3.55)	18.89 (4.39)	35.92 (6.03)	23.88
Thiamethoxam 25WG	100	66.41	65.69 (7.93)	50.96 (7.18)	54.23 (7.42)	23.84
Thiacloprid 21.7SC	125	59.37	56.35 (7.54)	58.09 (7.68)	60.95 (7.87)	23.92
Control	--	63.96	66.77 (8.20)	78.72 (8.89)	82.14 (9.10)	19.95
LSD (p= 0.05)		NS	(0.82)	(0.52)	(0.60)	2.08

Mean of three replications; Figures in parenthesis square root transformation; DAS: days after spray Data subjected to ANOVA and means separated (LSD, p= 0.05)

Table 2. Safe insecticides to predators in cotton

Treatment	Dose (ml/ g/ ha)	Population of predators/ plant			
		Before spray	3DAS	7DAS	10DAS
Buprofezin 25SC	1000	3.96	3.19	3.08	3.66
Clothianidine 50WDG	50	3.66	2.53	3.23	3.99
Cypermethrin 25EC	120	4.35	2.33	3.03	3.82
Diafenthiuron 50WP	500	4.04	3.23	3.44	3.79
Spinetoram 11.7SC	420	5.03	3.29	3.48	4.11
Dinotefuran 20SG	150	4.16	2.51	3.23	3.79
Fipronil 5SC	2000	4.17	1.90	2.87	3.16
Flonicamid 50WG	200	3.93	2.35	3.01	3.78
Imidacloprid 17.8SL	100	4.65	2.04	2.96	3.41
Profenofos 50EC	1250	4.33	1.93	2.75	3.25
Thiamethoxam 25WG	100	4.48	2.71	2.79	3.37
Thiacloprid 21.7SC	125	3.80	2.42	3.14	3.76
Control	--	4.95	5.50	5.54	5.82
LSD (p=0.05)		NS	1.21	0.75	0.97

Mean of three replications; Predators include coccinellids, chrysopa and spiders

synthetic pyrethroids cause resurgence of whitefly on *Bt* cotton (Abdullah et al., 2006; Virk et al., 2004). The predators natural enemies decreased with insecticide treatments but spinetoram 11.7 SC proved to be more safe to the predators.

Thus, the present study on the development of *T. tabaci* on transgenic BG I, BG II and non-*Bt* cotton cultivars revealed that the oviposition period, female longevity and nymphal period was minimum on *desi* cotton and maximum female longevity and nymphal period was on *Bt* cotton cultivar. Therefore, transgenic BG II and BG I cultivars are more favourable. Also, pupal duration was significantly lower on *desi* cotton cultivar whereas it was higher on BG II cotton cultivar Ankur 3028. Thus, *T. tabaci* took minimum time to develop on *desi* cotton cultivar. Among the insecticides evaluated on *Bt* cotton spinetoram 11.7SC @ 425 g/ ha was effective in reducing thrips and safe to predators.

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AUTHOR CONTRIBUTION STATEMENT

VK: Conceptualized, planned the work and corrected manuscript, AK: conducted the experiment, data analysis, VJ: data analysis, writing of manuscript

CONFLICT OF INTEREST

No conflict of interest.

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