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Seasonal incidence of sucking insect pests and predatory arthropods in desi and Bt transgenic cotton*

V. B. PHULSE AND S. S. UDIKERI

Department of Agricultural Entomology
University of Agricultural Sciences, Dharwad - 580 005, Karnataka, India
E-mail: vppmanoj60 @ gmail.com

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Abstract: Field investigations were carried out during 2011- 2012 to study the seasonal incidence of sucking pests in Bt and Desi cotton genotypes at the Agricultural Research Station, Dharwad. The highest incidence of thrips, leafhoppers and whiteflies was recorded on MRC 7918 BG-II (17.3, 5.7 and 0.31/ 3 leaves respectively) followed by MRC 6918 non-Bt, RCH-2 BG-II and RCH-2 non Bt .The lowest incidence was noticed on DDhC-11. In contrast to above pests the highest incidence of aphids was recorded on DDhC-11 (23.4/ 3 leaves) followed by 20.9 on MRC-7918BG-II.The lowest of 17.8 aphids / 3 leaves was recorded on RCH-2 Non-Bt. The highest seasonal mean of predatory coccinellids recorded was 2.6/plant on RCH-2 non Bt followed by RCH-2 Bt (1.6/plant). In MRC-7918, MRC-6918 non-Bt and DDhC-11, the mean seasonal abundance was 1.5/pl. The highest seasonal abundance of spider was on MRC-7918 BG-II (1.1/plant) followed by MRC 6918 Non- Bt, RCH-2 BG-II, RCH-2 non-Bt and DDhC-11 with 0.9/plant. The highest *Chrysoperla zastrowi sillemi* population was noticed in MRC-7918 (0.7/plant) followed by MRC-6918 non-Bt (0.6/plant), RCH-2Bt, RCH-2 non-Bt with 0.5/plant and lowest on DDhC-11 (0.3/plant).The *Bt cry* toxins either as single gene or as stacked format could not influence the sucking pest incidence and their predators.

Key words: Cotton, Leaf hopper, Predators, Sucking

Introduction

Cultivation of cotton under diversified agro climatic situations makes the crop to suffer a lot by different kinds of pests and diseases. Large area under rainfed situations and extensive replacement of conventional varieties with superior hybrids made the crop easily vulnerable to insect pests. The major reason for the low productivity in cotton is damage caused by insect pests. In India, as many as 162 species of insect-pests are known to attack cotton from sowing to maturity which cause up to 50-60 per cent loss (Agarwal *et al*., 1984). Cotton pests can be primarily divided into bollworms and sucking pests. Among sucking pests, aphid, *Aphis gossypii* (Glover), leafhoppers, *Amrasca biguttula biguttula* (Ishida), thrips, *Thrips tabaci* (Lind.) and whitefly, *Bemisia tabaci* (Genn.) are of major importance. These sucking pests occur at all the stages of crop growth and responsible for indirect yield losses. A reduction of 22.85 per cent in seed cotton yield due to sucking pests has been reported by Satpute *et al.* (1990).

By 1996 the world realized the cultivation of transgenic Bt cottons expressing *Cry 1 Ac* delta endotoxin as an ultimate resort to mitigate bollworm menace. The transgenic cotton showed great resistance against *Helicoverpa armigera* (Hub.) *Pectinophora gossypiella* (Saund.), *Earias vittella* (Fab.) and *E. insulana* (Biosd.) both under field and laboratory conditions (Kranthi and Kranthi, 2004). Bt toxins can effectively control specific lepidopterous species, but lack resistance against sucking insect pests (Hofs *et al.,* 2004; Sharma and Pampapthy, 2006). In the impact assessment of transgenic cottons a little attention has been given on the changing dynamics of sucking pests and other non target organisms. With Bt cottons it has been experienced that reduction in usage of insecticides lead to increased population of sucking insect pests (Men *et al.,* 2005). Thus, in Bt cotton era sucking pests are becoming more serious inviting indiscriminate use of pesticides. Hence, the present study was undertaken to assess the current trend of sucking pests incidence in Bt, non-Bt and desi cottons

Material and methods

A field experiment was conducted at the Agricultural Research Station, Dharwad under unprotected conditions (for sucking pests) to study the seasonal abundance pattern of sucking insect pests and predators in popularly grown *Bt* and Desi cotton genotypes. The ARS Dharwad is located between 15 ^{0}N latitude and 76.46 ^{0} E longitude at an altitude of 678 meters above mean sea level with annual average rainfall 922.7 mm.The genotypes used were interspecific Bt hybrid MRC 7918 (BG-II), intraspecific Bt hybrid RCH-2 (BG-II), RCH-2 non Bt, MRC-6918 non Bt and desi cotton DDhC-11 (*Gossypium herbaceum*) variety. The plot size was 8.1 x 5.4 m with 10 rows of 10 plants for each genotype under 90 x 60 cm spacing replicated four times. The crop was sown on 3rd July 2011 and the seeds used for the experiment were devoid of any insecticide treatments for early sucking pest control. All the recommended agronomical practices were followed to raise the crop successfully as per package of practices prescribed for the region (Anon., 2009). Crop was protected against bollworms using 500 LE Ha NPV and other biorationals based on necessity.

The observations were recorded from 15 days after sowing (DAS) on population of adults as well as nymphs of thrips, whiteflies, aphids and nymphs of leafhoppers at 15 days interval on three leaves (top, middle and bottom) in ten plants selected randomly. Later the population was averaged to present as number per three leaves. Similarly, population of coccinellid beetles (adults and grubs), *Chrysoperla zastrowi sillemi* Esben-Petersen (grubs) and spiders were observed in ten randomly selected plants and presented as number per plant.

Results and disucssion

In general across genotyeps the incidence of thrips ranged from 0.8 to 29.4 / three leaves. The incidence was peak during

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September (Fig 1). Similarly leaf hoppers ranged from 0.5 to 7.6 / three leaves with higher incidence during early as well as later part of the season. On the contrary the aphid incidence was high during December / January months with range of 0.6 to 44.0 / three leaves. Throughout season whitefly population was negligible. From the figure it was also evident that population of coccinellids and Chrysoperla was higher than spiders and mostly corresponding to the aphid incidence. The mean incidence of these predators was 1.6±0.9, 1.2±0.6 and 1.0±0.7 per plant respectively. The incidence in individual genotypes is discussed further.

Among different sap feeder of cotton *Thrips tabaci* affected the crop mainly during initial two months *i.e*. up to first fortnight of October (Table 1) which crossed ETL (10/leaf) by first fortnight of September in all genotypes except DDhC-11 where in it remained below the ETL throughout the season with decreasing trend from second fortnight of September. The highest seasonal mean of *T. tabaci (*17.3/ three leaves*)* was recorded on MRC-7918 BG-II followed by MRC-6918 non-Bt. The lowest seasonal mean of 6.9 thrips/ three leaves was observed from desi cotton genotype DDhC-11. Thus, the seasonal incidence of thrips revealed highest population in interspecific hybrids, followed by intraspecific and least in desi genotype. Present results are in agreement with the reports of Udikeri *et al.* (2003) and Kengegowda (2003) who have observed equal level of thrips incidence among Bt and non-Bt cotton hybrids at Dharwad and Raichur respectively. In desi cottons Rafee (2010) observed far less incidence of thrips in *G. arboreum and G*. herbaceum cultivars compared to *G. hirsutum* (2.70 to 13.25/ leaf).

The leafhopper incidence was recorded in two peaks *i.e.* during second fortnights of August and November in all genotypes except DDhC-11, which recorded peak leafhopper incidence during second fortnight of September (Table 1). The highest leafhopper population recorded was 9.3/ three leaves on MRC-7918 BG-II during Aug FN I. The incidence was 9.3 and

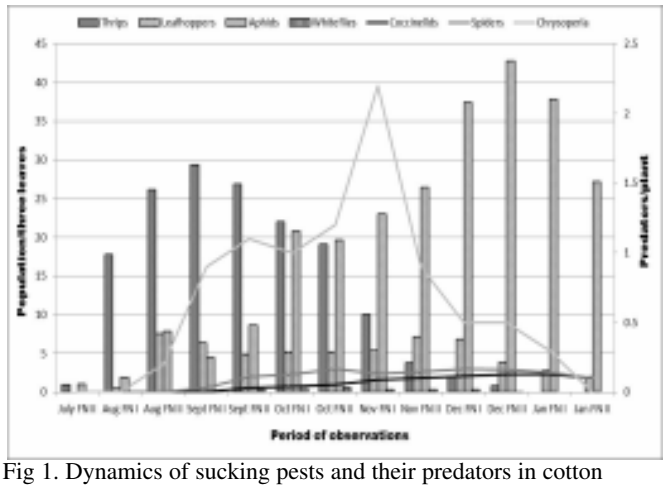

Fig 1. Dynamics of sucking pests and their predators in cotton during 2011- 12 at Dharwad (Karnataka: India)

9.1/ three leaves on MRC-6918 during second fortnight of August and November. In RCH-2 Bt and non Bt the highest leafhopper population was recorded during the same period. In DDhC-11 peak incidence of leafhoppers (2.5/ 3 leaves) was recorded during second fortnight of September. Thereafter it declined. The highest seasonal mean of 5.7/ three leaves was recorded on MRC-7918 BG-II, followed by 5.5 on MRC-6918 Non-Bt, 5.3 on RCH-2 Bt and 5.18 on RCH-2 non-Bt. Among all genotypes lowest seasonal mean of 0.7 in three leaves was recorded on DDhC-11.The leafhopper abundance was above seasonal average in all genotypes right from August till December. Thus interspecific hybrids had more abundant incidence of leafhoppers than intraspecific hybrids. The *G. herbaceum* variety offered least scope for leafhopper activity as seen in present study. Thus the *Cry* toxin could not target these pests. Raja *et al.* (2007) and Prasad and Rao (2008) have reported similar phenomenon from Andhra Pradesh. The incidence of leafhoppers would be always less, sometimes negligible in *G. herbaceum* cottons according to genetic makeup and sowing conditions. This was evident in the reports of Rafee (2010).

Table 1. Seasonal incidence of thrips (*Thrips tabaci*) and leafhopper (*Amrasca biguttula biguttula*) in different cotton cultivars under unprotected conditions (observed at fortnightly [FN] interval)

Period of observation (2011-12)	Thrips / three leaves					Leafhoppers / three leaves				
	MRC- 7918 Bt BG-II	MRC-6918 NBt	RCH-2 Bt BG-II	RCH-2 NBt	DDhC-11	MRC-7918 Bt BG-II	MRC-6918 NBt	RCH-2 Bt BG-II	RCH-2 NBt	DDhC-11
July FN II	1.48	01.23	1.08	0.80	00.60	0.0	0.0	0.0	0.0	0.0
Aug FN I	22.0	21.93	20.0	19.0	06.95	0.7	0.6	0.5	0.4	0.2
Aug FN II	31.6	30.00	28.3	27.5	13.50	9.3	9.3	9.1	9.1	1.1
Sept FN I	34.2	34.00	33.0	32.0	13.75	7.8	7.7	7.3	7.3	1.8
Sept FN II	31.8	31.50	29.0	28.5	13.75	5.8	5.7	5.5	5.3	2.5
Oct FN I	25.2	25.00	24.0	23.0	13.00	6.3	6.3	5.9	5.9	1.4
Oct FN II	23.3	22.55	22.0	20.3	07.25	6.6	6.5	6.1	6.0	0.8
Nov FN I	12.4	12.00	10.2	9.75	06.00	6.9	6.7	6.6	6.4	0.5
Nov FN II	04.9	04.75	04.0	3.25	02.00	9.2	9.1	8.9	8.8	0.2
Dec FN I	02.5	02.63	02.3	2.00	00.75	9.0	8.4	8.5	8.3	0.1
Dec FN II	1.20	01.10	01.0	0.75	00.05	5.2	5.1	4.7	4.7	0.1
Jan FN I	0.00	0.00	0.00	0.00	00.00	3.6	3.6	3.5	3.4	0.1
Jan FN II	0.00	0.00	0.00	0.00	00.00	3.1	2.6	2.1	2.0	0.1
Mean ± S.D.	17.3± 13.6	16.9± 13.4	15.8± 12.8	15.2± 12.5	6.9± 5.8	5.7± 3.1	5.5± 3.0	5.3± 3.0	5.2± 3.00	0.7± 0.8

Table 2. Seasonal incidence of aphids (*Aphis gossypii*) and whitefly (*Bemisia tabaci*) in different cotton cultivars under unprotected conditions (observed at fortnightly [FN] interval)

Period of	Aphids/ three leaves					Whiteflies/ three leaves				
observation (2011-12)	MRC- 7918 Bt BG-II	MRC-6918 NBt	RCH-2 Bt BG-II	RCH-2 NBt	DDhC-11	MRC- 7918 Bt BG-II	MRC-6918 NBt	RCH-2 Bt BG-II	RCH-2 NBt	DDhC-11
July FN II	1.42	01.35	1.15	1.10	0.60	0.00	0.00	0.00	0.00	0.00
Aug FN I	2.40	02.23	2.00	1.90	0.80	0.00	0.00	0.05	0.05	0.05
Aug FN II	10.4	10.18	8.80	8.30	1.70	0.24	0.20	0.15	0.15	0.09
Sept FN I	5.75	05.70	4.90	4.80	1.30	0.20	0.21	0.11	0.17	0.15
Sept FN II	10.9	10.80	9.30	9.10	3.50	0.48	0.43	0.35	0.35	0.28
Oct FN I	27.5	24.50	19.1	20.3	12.5	0.65	0.47	0.48	0.36	0.34
Oct FN II	20.5	20.00	20.0	18.8	19.0	0.75	0.67	0.55	0.50	0.35
Nov FN I	24.0	23.00	22.0	19.8	26.0	0.51	0.39	0.37	0.35	0.34
Nov FN II	31.6	29.50	27.0	26.0	33.0	0.51	0.38	0.36	0.34	0.27
Dec FN I	39.5	38.00	34.7	33.5	42.0	0.44	0.36	0.34	0.34	0.26
Dec FN II	41.0	42.00	39.5	37.0	54.5	0.24	0.18	0.14	0.08	0.08
Jan FN I	32.5	32.50	30.5	30.0	64.0	0.00	0.00	0.00	0.00	0.00
Jan FN II	24.4	23.50	22.0	21.1	45.0	0.00	0.00	0.00	0.00	0.00
Mean ± S.D.	20.9± 13.6	20.3± 13.7	18.5± 12.6	17.8± 11.9	23.4± 22.5	0.31± 0.26	0.25± 0.21	0.22± 0.16	0.21± 0.14	0.17± 0.11

In contrast to the observations on thrips and leafhoppers highest aphid population (23.4 / three leaves) was observed on DDhC-11 followed by MRC-7918 BG-II (20.9/ three leaves) and lowest aphid population (17.8/ three leaves) was recorded on RCH-2 Non-Bt as presented in table 2. The aphid population crossed ETL (10/leaf) by second fortnight of November in MRC-7918BG-II and DDhC-11 whereas in RCH-2 Bt and RCH-2 non-Bt by first fortnight of December. The observations among genotypes also revealed highest incidence of aphids in desi cotton (DDhC-11) followed by interspecific hybrids and intraspecific hybrids There was steady and significant increase in aphid incidence in all genotypes from first fortnight of October till January due to favourable environmental conditions. The increased incidence of aphid towards tail end of the season irrespective of genotypes might be due to positive correlation of aphids with maximum temperature as disclosed by Mohapatra (2008). Such seasonal variation in aphid population and negligible difference amongst Bt and non Bt genotypes has been reported by Udikeri *et al.* (2012).

The whitefly population was considerably low but varying significantly among genotypes as data furnished in table 2. The peak incidence of whiteflies was recorded in second fortnight of October in all genotypes with decreasing trend from first fortnight of November. The peak incidence of 0.75 whiteflies per three leaves was recorded on MRC-7918BG-II, followed by 0.67per three leaves on MRC-6918 non-Bt. The lowest incidence (0.3 per three leaves) was recorded on DDhC-11.The seasonal mean was highest (0.31/ three leaves) in MRC-7918 followed by MRC-6918 Non-Bt, RCH-2 BG-II, RCH-2 Non-Bt, while lowest seasonal mean of 0.17/ three leaves was recorded on DDhC-11. The present findings are in close agreement with Udikeri *et al.* (2003). They observed very low population of whitefly which could not differ significantly amongst Bt and conventional genotypes of cotton.

The highest predatory coccinellid (*Menochilus sexmaculatus* F.) population recorded was 2.6/pl on RCH-2 non Bt with range of 0.6 to 2.6 from second fortnight of September to first fortnight of January 2012 as presented in table 3. The same trend was followed on RCH-2 Bt with the range of 0.6 to 2.4 and the seasonal abundance of 1.6/pl. In MRC-7918, MRC-6918 non-Bt and DDhC-11 the mean seasonal abundance was 1.5/plant. The highest seasonal abundance was on RCH-2 non-Bt with 1.8 /plant. The generalist predatory coccinelids in general could not vary between Bt and conventional cotton presenting a prey density dependency. The results are in close agreement with Udikeri *et al.* (2012) who observed a strong positive correlation between incidence of predators and aphid on Bt and non Bt cottons.

Insect predatory spider complex (*Oxyopes* sp.*, Theridion* sp. *and Pardosa* sp.) was noticed from September I fortnight till January I fortnight with a peak population during October II fortnight on all genotypes. From table 3 it was evident that the average spiders population ranged from 0.9 to 1.1 /pl. However the highest population was in MRC-7918 (2.4 /pl) as observed during FN II of October. Spider population did not differ between Bt, non Bt as well as desi genotype. Present investigation results corroborates with the findings of Dhillon *et al.* (2012), Sagar *et al.* (2011), Prasad and Rao (2008) who reported a non significant difference in spider abundance between Bt transgenic and non- transgenic cottons.

The abundance of generalist predator *Chrysoperla zastrowi sillemi* (green lace wing) was noticed in I fortnight of November in all genotypes as presented in table 3. The maximum abundance noticed in MRC-7918 and, MRC-6918 non-Bt was 1.2 and 1.4/ plant respectively. In RCH-2Bt it was 1.3/plant. The average Chrysoperla population was 0.7 and 0.6/plant on MRC-7918 Bt and MRC-6918 non-Bt respectively. DDhC-11 had lowest abundance with a seasonal mean of 0.3 /plant. Chrysoperla being a predator on aphids and bollworms (eggs/ neonates) could show only a low profile survival rather than high degree of variation. Thus Cry protein intoxication could not bring negative impact.Present investigation results corroborates with the reports

Table 3. Seasonal abundance of coccinellids, spider and *Chrysoperla zastrowi sillemi* in different cotton cultivars under unprotected conditions (observed at fortnightly [FN] interval)

Time of	Coccinellids/plant					Spider/plant					Chrysoperla/plant				
obser vation (2011-12)	MRC-7918 Bt BG-II	MRC -6918 NBt	RCH -2 Bt BG-II	RCH -2 NBt	DDhC -11	MRC-7918 Bt BG-II	MRC-6918 NBt	RCH -2 Bt BG-II	RCH-2 NBt	DD hC-11	MRC-7918 Bt BG-II	MRC-6918 NBt	RCH-2 Bt BG-II	RCH-2 NBt	DD hC-11
July FN II	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Aug FN I	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Aug FN II	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.4	0.3	0.1
Sept FN I	0.0	0.0	0.0	0.0	0.0	0.4	0.8	0.6	0.4	0.8	1.1	1.2	1.0	0.9	0.4
Sept FN II	0.8	0.5	0.6	0.6	0.3	1.5	1.8	1.0	1.4	1.3	1.2	1.1	1.1	0.8	1.0
Oct FN I	0.6	0.7	0.7	1.0	0.4	2.0	1.4	1.6	1.6	1.4	1.2	1.0	1.1	0.8	1.0
Oct FN II	0.8	1.0	1.1	1.2	0.7	2.4	1.8	2.2	2.0	1.6	1.6	1.1	1.4	1.2	0.8
Nov FN I	1.3	1.6	1.7	2.0	1.4	1.0	1.0	0.7	0.8	0.6	2.1	2.6	2.7	2.4	1.1
Nov FN II	1.6	1.8	2.0	2.1	1.7	1.0	0.8	0.8	1.0	0.6	0.7	0.8	1.3	0.6	1.0
Dec FN I	2.0	2.1	2.1	2.5	2.0	1.2	1.0	0.8	0.7	1.1	0.6	0.5	0.6	0.4	0.4
Dec FN II	2.3	2.1	2.3	2.6	2.2	0.3	0.5	1.0	0.4	0.8	0.6	0.5	0.6	0.4	0.4
Jan FN I	2.3	2.1	2.4	2.6	2.3	0.3	0.3	0.2	0.2	0.1	0.5	0.4	0.3	0.2	0.3
Jan FN II	1.4	1.5	1.8	1.9	2.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mean ± S.D.	1.5± 0.88	1.5± 0.88	1.6± 0.9	1.8± 1.0	1.5± 1.0	1.1± 0.8	1.0± 0.7	1.0± 0.7	0.9± 0.7	0.9± 0.6	1.4± 0.6	1.2± 0.7	1.2± 0.8	1.2± 0.7	0.9± 0.4

of Dhillon *et al.* (2012), Udikeri *et al*. (2012), Sagar *et al*. (2011) and Badiger *et al.* (2012) who reported non significant difference in grubs of Chrysoperla between Bt transgenic and non-transgenic cottons. Rafee (2010) reported a maximum number of Chrysoperla during November second fortnight. It might be due to the availability of aphid prey in the respective season.

Thus the seasonal incidence of sucking insect pests revealed that either in presence of Bt genes or other wise incidence of thrips, leafhoppers and whiteflies was highest in interspecific cotton hybrids followed by intraspecific genotypes and least in desi cultivar. In contrast aphid population was quite abundant in desi cotton and least in intraspecific hybrids.

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