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Sucking pests and predator dynamics in *Bt* and non *Bt* cottons grown in traditional and non traditional locations

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Abstract : Population dynamics of sucking pests and predators was studied in *Bt* non *Bt* and *desi* cotton genotypes grown in traditional and non traditional areas. Mean incidence of all sucking pests and arthropod predators was relatively lower in Annigeri as compared to Hanumanamatti. At both locations the incidence of sucking pests was higher in inter specific hybrid than intra specif hybrids and *desi* genotypes. At Annigeri thrips incidence in MRC 7918 BG-II was 14.6 against 20.3 /3 leaves in Hanumanamatti. In *desi* cotton it was 2.7 and 6.1 /3 leaves in these respective locations. Incidence of leaf hoppers did not cross ETL (2 / leaf) in any genotype throughout the season but for November 1st fortnight in inter specific *Bt* and non *Bt* cotton hybrids (10/3 leaves). On the contrary it was always above ETL (upto 15/3 leaves) in all genotypes except *desi* cotton (DDhC 11) at Hanumanamatti in September and December months. On the contrary aphid incidence reached far above ET level (upto 56/3 leaves) at both locations during November to January months, higher being in *desi* cottons. Whitefly incidence was low irrespective of genotypes and locations. The dynamics of predators was mainly corresponding to aphid incidence.

Key words : *Bt* cotton, predators, sucking pests

Cotton the "King of Fibers" harbour both tissue borers and sap feeders which can cause 30-90 per cent yield loss. 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. By early 1990s sucking pests mainly leafhoppers and whiteflies started taking heavy dividends if unchecked suitably. The reliance on seed dressing with imidacloprid appeared inevitable as a tool to combat sucking pests successfully at early season, however it has further augmented the sucking pest menace in many crops (Douglas and Tooker, 2015) . Transgenic *Bt* cotton hybrids expressing Cry 1 Ac only or both Cry 1Ac+Cry 2Ab have occupied > 95 per cent cotton area in India by 2011 due to huge profitablilty. Thus *Bt* cottons are being grown beyond the specified climatic zone or traditional areas. Hence sucking pest menace remained persisting in altered dimensions under diverse agronomic situations and changing climate about which attention has been negligible. Reduced usage of insecticides in *Bt* cottons has lead to increased population of sucking insect pests (Krishna and Qaim, 2012). A study conducted at Dharwad (Phulse and Udikeri, 2014) also indicated severity of sucking pests in inter specific and intra specific BG II *Bt* cotton hybrids, non *Bt* hybrids and *desi* genotypes as well. Hence, the present study was undertaken to assess the current trend of sucking pests in two geographically isolated locations representing traditional *desi* cotton area and the place where *Bt* cottons are largely grown in Karnataka.

MATERIALS AND METHODS

The field experiments were conducted

concurrently in two locations *viz.,* Agricultural Research Station (ARS) Annigeri (Tq: Navalagund, Dist: Dharwad) and Krishi Vigyan Kendra (KVK) Hanumanmatti (Tq: Ranibennur, Dist: Haveri) of Karnataka state. Annigeri is located between 15°S latitude and 75°32 E longitude at an altitudeÿþ / ÿþ ÿþ / 1of 624.8 MSL, whereas KVK, Hanumanmatti is located between 14°392 N latitude and 75°332 E longitude at an altitude ÿþ / of 594.36 MSL. Similarly the average annual rainfall in Hanumanmatti and Annigeri is 300 and 654.9 mm, respectively.

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 DDhC 11(*Gossypium herbaceum desi* variety). The plot size was 8.1 x 5.4 m^2 with 10 rows of 10 plants for each genotype under 90 x 60 cm spacing replicated four times. The crop was sown on 11th and 20th July in above locations, respectively. 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 regions (Anonymous, 2010). Crop was protected for bollworms through need based application 500 LE HaNPV and selective biorationals. From 15 days after sowing (DAS) scouting for incidence of adults as well as nymphs of thrips, whiteflies, aphids and nymphs of leafhoppers was made at 15 days interval on three leaves (top, middle and bottom) of 10 plants selected randomly. Later the population was averaged to present as number/3 leaf basis. Similarly population of coccinellid beetles (adults and grubs), *Chrysoperla zastrowi arabica* (grubs) and spiders was observed in ten randomly selected plants and presented as number / plant.

RESULTS AND DISCUSSION

Incidence of thrips : The seasonal mean incidence of thrips (Table 1) from Hanumanmatti on MRC 7918 *Bt* and non *Bt* MRC 6918 (20.3 and 19.6 /3 leaves), RCH 2 *Bt* and non *Bt* (18.78 and 18.5 /3 leaves), respectively *desi* cotton DDhC 11 (6.1/3 leaves) was also same indicating no difference in *Bt* and conventional genotypes on thrips. The peak thrips incidence was recorded from Ist fortnight of September to October Ist fortnight due to low rainfall and low humidity. In Annigeri the incidence of thrips on MRC 7918 and non *Bt* MRC 6918 (14.6 and 14.4 /3 leaves), RCH 2 *Bt* and non *Bt* (13.9 and 13.8 /3 leaves) and DDhC 11 (2.7/3 leaves) was in similar trend indicating no difference in *Bt* and non *Bt* hybrid on thrips population. The peak thrips incidence was recorded in September 2nd fortnight to October Ist fortnight due to low rainfall and low humidity. However interspecific hybrids had relatively more incidence than interspecif hybrids and *G. herbaceum* variety as a known fact. Present results are in agreement with the reports of Onkaramurthy *et al.,* (2011) who has observed equal level of thrips incidence among BG II,BG I *Bt* and non *Bt* cotton hybrids at Dharwad. Further, Bhute *et al.,* (2012) also observed the peak incidence of thrips in second week of September because of dry spell.

Incidence of leafhoppers: The incidence of leafhoppers varied among interspecific, intraspecific and *desi* cotton genotypes used in the study with similar trend in both locations (Table 2). In Hanumanmatti the seasonal abundance of leafhoppers on MRC 7918 and non *Bt* MRC 6918 was 7.42 and 7.0 /3 leaves respectively. On RCH 2 *Bt* and non *Bt* it was 6.3 and 6.1/3 leaves which was slightly lesser than MRC hybrids. On *desi* cotton DDhC 11 the least

(1.1/ 3 leaves) leafhopper abundance was evident. The peak leafhopper incidence was recorded in September first fortnight. Similarly the incidence of leafhopper at Annigeri also followed the pattern witnessed at Hanumanmatti. On MRC 7918 and MRC 6918 seasonal mean leafhopper abundance was 4.7 and 4.4/3 leaves, respectively. In RCH 2 *Bt* and RCH 2 non *Bt* 3.7 and 3.5 leafhoppers were observed. The lowest among genotypes for abundance was DDhC 11 with 2.6 leaf hoppers/ 3 leaves. The peak leafhopper incidence was recorded during October/November months. Thus inter specific hybrids had more abundant incidence of leafhoppers than intra specific hybrids. The *G. arboreum* variety offered least scope for leafhopper activity as seen in present study in all the three locations. The incidence pattern of leafhoppers revealed in present study is in close confirmation with reports of Neelima *et al.,* (2012) who observed increased incidence in October and November months in hybrid cultivars of *G. hirsutum*. The incidence of leafhoppers is less, sometimes negligible in *G. herbaceum* cottons according to genetic makeup and sowing conditions.

Incidence of aphids: As per the data in Table 3 at Hanumanmatti *desi* cotton DDhC 11 had highest aphid incidence *i.e.,* 26.0/ 3 leaves. Further relatively higher incidence was inter specific hybrids *viz.,* MRC 7918 (23.7), MRC 6918 (23.0), as compared to intraspecific hybrids *viz.,* RCH 2 *Bt* (21.5) and RCH 2 non *Bt* (20.8) on population/3 leaves. This was indicating no difference amongst *Bt* and non *Bt* hybrid of cotton for aphid reaction. The peak aphid incidence (56.8 to 66.0/3 leaves) was recorded in December to January first fortnight . A similar trend of aphid abundance was witnessed at Annigeri where *desi* genotype DDhC 11 has highest (26.6/ 3 leaves) incidence. It was followed by MRC 7918 *Bt* and MRC 6918 with 25.0 and 24.3 aphids

Table 1. Seasonal incidence of Thrips/3 leaves in different genotypes under unprotected conditions

Period of observation	Hanumanmatti						Annigeri					
	MRC 7918 *Bt* BG II	MRC 6918 N*Bt*	RCH 2 *Bt* BG II	RCH 2 N *Bt*	DDhC 11	**Mean**	MRC 7918 *Bt* BG II	MRC 6918 N*Bt*	RCH 2 *Bt* BG II	RCH 2 N*Bt*	DDhC 11	**Mean**
July FN II	0.0	0.0[a]	0.0[a]	0.0[a]	0.0[a]	**0.0**	2.00	1.93	1.43	1.03	0.75	**1.43**
Aug FN I	2.18	2.03	1.95	1.9	0.9	**1.79**	2.48	2.43	2.1	2.08	1.65	**2.15**
Aug FN II	23.6	23.3	22.1	21.8	4.2	**19.0**	23.6	22.5	21.8	22.3	3.6	**18.8**
Sept FN I	38.9	38.4	38.1	37.4	13.9	**33.3**	39.3	39.2	38.15	37.9	12.2	**33.4**
Sept FN II	41.8	38.5	37.0	37.3	10.3	**33.0**	36.7	36.5	35.8	35.6	4.98	**29.93**
Oct FN I	38.5	36.8	36.5	36.0	11.8	**31.9**	38.9	38.4	37.8	37.4	6.98	**31.91**
Oct FN II	30.8	30.0	28.0	27.0	9.0	**24.9**	22.2	22.1	21.4	21.2	2.13	**17.80**
Nov FN I	22.2	22.1	21.4	21.2	7.5	**18.9**	12.3	12.3	11.9	11.6	1.2	**9.87**
Nov FN II	12.4	12.3	11.9	11.6	4.3	**10.5**	8.9	8.83	8.5	8.23	0.8	**7.05**
Dec FN I	9.08	9.0	7.3	7.15	4.5	**7.41**	2.78	2.69	2.23	2.1	0.21	**2.00**
Dec FN II	2.8	2.7	2.0	2.10	0.21	**1.96**	0.70	0.60	0.4	0.31	0.16	**0.43**
Jan FN I	0.68	0.58	0.38	0.31	0.11	**0.41**	0.30	0.20	0.18	0.18	0.13	**0.20**
Jan FN II	0.0	0.0	0.0	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0[a]	**0.0**
Mean	**20.3**	**19.6**	**18.7**	**18.5**	**6.1**	**16.6**	**14.6**	**14.5**	**13.9**	**13.8**	**2.7**	**11.9**

FN: Fortnight

Table 2. Seasonal incidence of leafhopper/3 leaves in different genotypes under unprotected conditions

Period of observation	Hanumanmatti						Annigeri					
	MRC 7918 *Bt* BG II	MRC 6918 N*Bt*	RCH 2 *Bt* BG II	RCH 2 N *Bt*	DDhC 11	**Mean**	MRC 7918 *Bt* BG II	MRC 6918 N*Bt*	RCH 2 *Bt* BG II	RCH 2 N *Bt*	DDhC 11	**Mean**
July FN II	0.0	0.0	0.0	0.0	0.0	**0.0**	0.4	0.3	0.2	0.2	0.1	**0.2**
Aug FN I	1.3	1.1	0.8	0.7	0.4	**0.9**	0.6	0.5	0.4	0.3	0.1	**0.4**
Aug FN II	5.2	4.8	2.7	2.7	1.2	**3.3**	4.7	4.6	3.2	3.1	1.8	**3.5**
Sept FN I	15.7	14.1	11.9	11.4	3.4	**11.3**	4.9	4.5	4.0	3.5	2.5	**3.9**
Sept FN II	11.6	11.1	9.1	9.0	1.8	**8.5**	5.3	5.0	4.5	4.0	3.0	**4.4**
Oct FN I	9.2	8.5	7.3	7.2	2.5	**6.9**	7.3	7.2	7.0	6.6	5.1	**6.6**
Oct FN II	6.5	6.3	6.2	6.2	1.4	**5.3**	7.8	7.5	7.2	7.0	6.0	**7.1**
Nov FN I	6.6	6.5	6.3	6.3	1.1	**5.3**	10.9	10.0	8.0	7.5	7.0	**8.7**
Nov FN II	7.5	7.4	7.0	7.0	0.6	**5.9**	6.8	6.2	5.0	4.6	3.5	**5.2**
Dec FN I	9.2	9.1	9.0	8.8	0.4	**7.3**	3.3	3.3	2.6	2.3	1.4	**2.6**
Dec FN II	9.0	9.0	8.9	8.8	0.2	**7.2**	3.2	3.1	2.1	2.0	0.6	**2.2**
Jan FN I	4.3	4.1	4.0	3.6	0.1	**3.2**	0.7	0.7	0.4	0.6	0.0	**0.5**
Jan FN II	3.0	2.1	1.9	1.9	0.1	**1.7**	0.0	0.0	0.0	0.0	0.0	**0.0**
Mean	**7.4**	**7.0**	**6.3**	**6.1**	**1.1**	**5.6**	**4.7**	**4.4**	**3.7**	**3.5**	**2.6**	**3.8**

/3 leaves). A huge incidence of aphid was noticed during December /January months (52-70/ 3 leaves) in case of DDhC 11 at Annigeri. On the contrary to leafhoppers, the incidence of aphid is always high in *G. herbaceum*. (*desi*) which was evident in present study also. Among *Bt* and conventional cotton, the difference in aphid incidence has not been significant in previous studies *viz.*, Udikeri *et al.*, (2012) and Onkarmurthy *et al.*, (2011) in rainfed cottons. The increased incidence of aphid towards end of the season in both the locations of present study

Table 3. Seasonal incidence of aphids/3 leaves in different genotypes under unprotected conditions

Period of observation	Hanumanmatti						Annigeri					
	MRC 7918 *Bt* BG II	MRC 6918 N*Bt*	RCH 2 *Bt* BG II	RCH 2 N *Bt*	DDhC 11	**Mean**	MRC 7918 *Bt* BG II	MRC 6918 N*Bt*	RCH 2 *Bt* BG II	RCH 2 N *Bt*	DDhC 11	**Mean**
July FN II	0.0	0.0	0.0	0.0	0.0	**0.0**	1.4	1.3	1.2	1.2	0.6	**1.1**
Aug FN I	1.5	1.4	1.2	1.2	0.6	**1.2**	2.5	2.4	2.2	2.0	3.0	**2.4**
Aug FN II	8.5	8.3	6.4	6.3	0.8	**6.1**	10.4	10.4	8.8	8.3	2.0	**8.0**
Sept FN I	5.6	5.3	4.2	4.2	3.8	**4.6**	7.1	6.0	5.1	5.0	4.1	**5.5**
Sept FN II	6.7	6.5	5.9	5.8	3.1	**5.6**	8.5	8.2	6.2	6.3	8.2	**7.5**
Oct FN I	15.7	15.2	14.7	14.2	4.8	**12.9**	19.0	18.0	16.0	14.8	15.0	**16.6**
Oct FN II	21.0	20.0	19.0	18.0	13.0	**18.2**	24.4	23.5	22.0	21.1	25.2	**23.2**
Nov FN I	29.0	28.0	27.0	27.0	19.0	**26.0**	34.6	33.8	32.0	32.0	37.0	**33.9**
Nov FN II	40.3	40.0	36.0	34.5	34.0	**37.0**	40.5	40.0	37.5	37.3	43.0	**39.65**
Dec FN I	42.3	42.0	39.3	37.8	44.9	**41.2**	48.8	48.0	46.0	43.8	52.1	**47.4**
Dec FN II	43.8	43.3	42.3	40.0	56.8	**45.2**	56.8	55.5	54.5	54.0	60.0	**56.2**
Jan FN I	46.5	43.3	42.5	41.3	66.0	**47.9**	46.0	45.0	45.0	44.0	70.0	**50.0**
Jan FN II	23.2	23.1	19.5	19.0	65.0	**30.0**	0.0	0.0	0.0	0.0	0.0	**0.0**
Mean	**23.7**	**23.0**	**21.5**	**20.8**	**26.0**	**22.9**	**25.00**	**24.3**	**23.0**	**22.5**	**26.6**	**24.3**

despite genotypes might be due to positive correlation of aphids with maximum temperature as disclosed by Bhute *et al.,* (2012). Such seasonal variation in aphid population and negligible difference amongst between *Bt* and non *Bt* genotypes has been reported by Udikeri *et al.,* (2012).

Incidence of whiteflies: In general, whitefly abundance was very low throughout the season at both places (Table 4). However, at Hanumanmatti whitefly incidence on MRC 7918 *Bt* and MRC 6918 was 0.45 and 0.39/3 leaves respectively as higher seasonal mean observations. *Desi* genotype projected a trend of far below ETL of whiteflies with 0.25/3 leaves throughout the season . Similarly, in Annigeri also the whitefly population recorded on MRC 7918 *Bt* and RCH 2 *Bt* (seasonal mean of 0.37and 0.25/ 3 leaves), and MRC 6918 and RCH 2 non *Bt* (0.29 and 0.22/ 3 leaves) could not vary much. The least incidence (0.18/ 3 leaves) was observed again in DDhC 11 and it was also below ETL throughout the season. The present findings are in close agreement with Onkaramurthy *et al.,* (2011). Futher, a similar trend of whitefly incidence has been observed by Muhammad Akram *et al.,* (2013) in Pakistan.

Abundance of coccinellid in different cotton genotypes : In Hanumanmatti the coccinellid population recorded on MRC 7918 *Bt* and RCH 2 *Bt* was 1.15 and 1.26 / plant as seasonal mean. In MRC 6918 and RCH 2 non *Bt* cotton it ranged from 1.16 to 1.42/ plant (Table 5). A relatively low incidence (1.03/plant) was observed on DDhC 11. Similarly at Annigeri coccinellid abundance varied from 1.48 (RCH 2 N*Bt*) to 1.05/plant (DDhC 11). The generalist predatory coccinelids in general did not vary between *Bt* and conventional cotton presenting a prey density dependency. The trend was not affected by the geographic isolation of experimental units. The present findings are close agreement with Dhillon *et al.,* (2012) reported that there was no significant difference

Table 4. Seasonal incidence of whitefly/3 leaves in different genotypes under unprotected conditions

Period of observation	Hanumanmatti						Annigeri					
	MRC 7918 *Bt* BG II	MRC 6918 N*Bt*	RCH 2 *Bt* BG II	RCH 2 N*Bt*	DDhC 11	**Mean**	MRC 7918 *Bt* BG II	MRC 6918 N*Bt*	RCH 2 *Bt* BG II	RCH 2 N*Bt*	DDhC 11	**Mean**
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**
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**
Aug FN II	0.0	0.0	0.0	0.0	0.0	**0.0**	0.17	0.15	0.11	0.11	0.09	**0.13**
Sept FN I	0.26	0.21	0.18	0.15	0.11	**0.18**	0.20	0.21	0.11	0.17	0.15	**0.17**
Sept FN II	0.30	0.22	0.17	0.16	0.16	**0.20**	0.38	0.33	0.25	0.25	0.18	**0.28**
Oct FN I	0.48	0.43	0.35	0.35	0.28	**0.38**	0.41	0.22	0.38	0.25	0.24	**0.30**
Oct FN II	0.59	0.58	0.51	0.42	0.34	**0.49**	0.62	0.57	0.45	0.40	0.25	**0.46**
Nov FN I	0.75	0.67	0.57	0.52	0.39	**0.58**	0.41	0.37	0.26	0.25	0.24	**0.31**
Nov FN II	0.53	0.47	0.38	0.35	0.34	**0.41**	0.54	0.26	0.33	0.24	0.24	**0.32**
Dec FN I	0.46	0.38	0.35	0.34	0.26	**0.36**	0.24	0.18	0.14	0.08	0.08	**0.14**
Dec FN II	0.25	0.18	0.13	0.09	0.09	**0.15**	0.0	0.0	0.0	0.0	0.0	**0.0**
Jan 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**
Jan 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**
Mean	**0.45**	**0.39**	**0.33**	**0.30**	**0.25**	**0.34**	**0.37**	**0.29**	**0.25**	**0.22**	**0.18**	**0.26**

Table 5. Seasonal abundance of coccinellids/plant in different genotypes under unprotected conditions

Period of observation	Hanumanmatti						Annigeri					
	MRC 7918 *Bt* BG II	MRC 6918 N*Bt*	RCH 2 *Bt* BG II	RCH 2 N*Bt*	DDhC 11	**Mean**	MRC 7918 *Bt* BG II	MRC 6918 N*Bt*	RCH 2 *Bt* BG II	RCH 2 N*Bt*	DDhC 11	**Mean**
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**
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**
Aug FN II	0.0	0.0	0.0	0.0	0.0	**0.0**	**0**.3	0.1	0.2	0.1	0.1	**0.2**
Sept FN I	0.4	0.0	0.0	0.4	0.0	**0.2**	0.7	0.8	1.0	1.0	0.5	**0.8**
Sept FN II	0.4	0.3	0.4	0.5	0.2	**0.4**	0.7	0.8	0.9	1.0	0.6	**0.8**
Oct FN I	0.5	0.4	0.6	0.6	0.1	**0.4**	0.9	0.9	1.0	1.1	0.8	**1.0**
Oct FN II	0.5	0.5	0.5	0.6	0.4	**0.5**	1.1	0.9	0.8	0.7	0.5	**0.8**
Nov FN I	0.7	0.9	1.0	1.2	0.7	**0.9**	1.2	0.9	1.0	0.8	0.5	**0.9**
Nov FN II	1.1	1.2	1.3	1.5	0.9	**1.2**	2.2	2.1	2.2	1.4	0.7	**1.7**
Dec FN I	1.4	1.5	1.7	1.8	1.3	**1.5**	2.1	2.2	2.2	2.3	1.6	**2.1**
Dec FN II	1.9	2.0	2.2	2.3	1.8	**2.0**	2.7	2.8	3.0	3.2	2.2	**2.8**
Jan FN I	2.3	2.4	2.5	2.7	2.4	**2.5**	1.9	2.4	2.0	3.2	3.0	**2.5**
Jan FN II	2.3	2.4	2.4	2.6	2.5	**2.4**	0.0	0.0	0.0	0.0	0.0	**0.0**
Mean	**1.1**	**1.2**	**1.3**	**1.4**	**1.0**	**1.20**	**1.4**	**1.6**	**1.4**	**1.5**	**1.1**	**1.4**

in eggs, grubs and adults' coccinelids abundance in *Bt* transgenic and non transgenic cottons. The peak activity of coccinellids was recorded in December second fortnight and January first fortnight (2.3/plant). The maximum number of coccinellids coincided with increased population of aphid (Table 4). The results are in close agreement with the Udikeri *et al.,* (2012) observed a strong positive correlation between incidence of predators and aphid on *Bt* and non *Bt* cotton.

Abundance of spider in different cotton genotypes: Spider population did not differ in *Bt*, non *Bt* as well as *desi* genotype in Hanumanmatti and Annigeri as well (Table 6). However, the seasonal range across genotypes was 1.1 to 1.3 and 0.9 to 1.4/plant in Hanumanmatti and Annigeri, respectively. The variation in spider population was not observed as Cry protein intoxication through their preys if any may not affect adversely them. Present investigation results corroborates with the findings of Dhillon *et al.,* (2012). Further, Neelima *et al.,* (2012) also reported the peak activity of spiders during first week of November which was evident in the present study..

Abundance of *Chrysoperla zastrowi arabica* in different cotton genotypes : Population of green lace wing predator (Table 7) in Hanumanmatti remained same in MRC 7918 *Bt* and MRC 6918 (seasonal mean of 0.6 and 0.5/ plant), RCH 2 *Bt* and RCH 2 non *Bt* (seasonal mean of 0.4/ plant) and DDhC 11 (seasonal mean of 0.3/plant) cotton hybrids. Similarly at Annigeri Chrysperla population ranged from 0.4 to 0.7/pl as seasonal mean. Being a predator on aphids and bollworms (eggs/ neonates) it could show only a low profile survival rather the high degree of variation. Thus *Cry* protein intoxication did not bring negative impact. Present investigation results corroborates with the reports of Dhillon *et al.,* (2012) and Udikeri *et al.,* (2012), who reported non significant difference in grubs of Chrysoperla between *Bt* transgenic and non

Table 6. Seasonal abundance of spiders/plant in different cotton genotypes under unprotected conditions

Period of observation	Hanumanmatti						Annigeri					
	MRC 7918 *Bt* BG II	MRC 6918 N*Bt*	RCH 2 *Bt* BG II	RCH 2 N*Bt*	DDhC 11	**Mean**	MRC 7918 *Bt* BG II	MRC 6918 N*Bt*	RCH 2 *Bt* BG II	RCH 2 N*Bt*	DDhC 11	**Mean**
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**
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**
Aug FN II	0.0	0.0	0.0	0.0	0.0	**0.0**	0.2	0.2	0.4	0.3	0.1	**0.2**
Sept FN I	0.4	0.3	0.2	0.6	0.3	**0.4**	1.1	1.2	1.0	0.9	0.4	**0.9**
Sept FN II	1.2	2.2	1.2	1.4	0.9	**1.4**	1.2	1.1	1.1	0.8	1.0	**1.1**
Oct FN I	1.2	1.2	1.3	1.6	1.1	**1.3**	1.2	1.0	1.1	0.8	1.0	**1.0**
Oct FN II	1.4	1.2	1.5	1.4	1.4	**1.4**	1.6	1.1	1.4	1.2	0.8	**1.2**
Nov FN I	1.5	1.4	1.8	1.9	1.6	**1.6**	2.1	2.6	2.7	2.4	1.1	**2.2**
Nov FN II	1.5	1.4	1.8	1.7	1.6	**1.6**	0.7	0.8	1.3	0.6	1.0	**0.9**
Dec FN I	1.2	1.3	1.5	1.4	1.3	**1.3**	0.6	0.5	0.6	0.4	0.4	**0.5**
Dec FN II	1.2	1.3	1.0	1.1	0.8	**1.1**	0.6	0.5	0.6	0.4	0.4	**0.5**
Jan FN I	1.2	1.2	0.9	1.0	0.8	**1.0**	0.5	0.4	0.3	0.2	0.3	**0.3**
Jan FN II	1.1	1.1	0.6	0.5	0.7	**0.8**	0.0	0.0	0.0	0.0	0.0	**0.0**
Mean	**1.2**	**1.3**	**1.2**	**1.3**	**1.1**	**1.2**	**1.4**	**1.2**	**1.2**	**1.2**	**0.9**	**1.2**

Table 7. Seasonal abundance of *Chrysoperla zastrowi arabica* /plant in different cotton genotypes under unprotected conditions

Period of observation	Hanumanmatti						Annigeri					
	MRC 7918 *Bt* BG II	MRC 6918 N*Bt*	RCH 2 *Bt* BG II	RCH 2 N*Bt*	DDhC 11	**Mean**	MRC 7918 *Bt* BG II	MRC 6918 N*Bt*	RCH 2 *Bt* BG II	RCH 2 N*Bt*	DDhC 11	**Mean**
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**
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**
Aug 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**
Sept 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**
Sept FN II	0.0	0.0	0.0	0.0	0.0	**0.0**	0.2	0.2	0.2	0.1	0.1	**0.2**
Oct FN I	0.4	0.3	0.2	0.2	0.1	**0.2**	0.5	0.4	0.3	0.4	0.2	**0.4**
Oct FN II	0.5	0.5	0.4	0.3	0.2	**0.4**	0.5	0.4	0.4	0.4	0.2	**0.4**
Nov FN I	0.7	0.6	0.5	0.4	0.3	**0.5**	0.8	0.8	1.2	0.6	0.5	**0.8**
Nov FN II	1.0	0.9	0.8	0.6	0.5	**0.8**	1.2	1.1	1.0	0.9	0.8	**1.0**
Dec FN I	0.8	0.9	0.6	0.6	0.5	**0.7**	1.1	1.0	0.8	0.9	0.8	**0.9**
Dec FN II	0.8	0.5	0.4	0.4	0.3	**0.5**	0.8	0.7	0.6	0.8	0.4	**0.7**
Jan FN I	0.5	0.4	0.3	0.4	0.3	**0.4**	0.4	0.3	0.2	0.3	0.1	**0.3**
Jan FN II	0.3	0.2	0.20	0.2	0.1	**0.2**	0.0	0.0	0.0	0.0	0.0	**0.0**
Mean	**0.6**	**0.5**	**0.4**	**0.4**	**0.3**	**0.5**	**0.7**	**0.6**	**0.6**	**0.5**	**0.4**	**0.6**

transgenic cottons.

Thus it was evident that cultivation of *Bt* cottons in non traditional areas was not having much advantage in terms of sucking pest incidence. However selection of tolerant or resistant genotypes would serve the purpose of cotton cultivation better in conventional as well as non traditional areas.

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