Indian Journal of Applied Entomology **24**(2) : 127-130 (2010)

DIVERSITY OF ARTHROPOD COMMUNITIES IN TRANSGENIC AND NON-TRANSGENIC COTTON CROPS

A.K. DHAWAN AND NEHA SHARMA

Department of Entomology, Punjab Agriculture University, Ludhiana-141 004
neha_sharma429@yahoo.com

ABSTRACT

A field experiment was carried out to study of the diversity of arthropod communities in cotton at Entomological Research Farm, Punjab Agricultural University, Ludhiana during 2008-09. Comparison for arthropod diversity was made between RCH134BGI, RCH134BGII and Non Bt using the Shannon and Weaver diversity indices. Arthropod diversity was higher during the vegetative phase as compared to the reproductive phase of crop growth. Predatory arthropods and casual visitors were higher in Not Bt cotton and non target pests were higher in Bt cotton. Total diversity index was maximum in Non Bt followed by RCH134BGI and RCH134BGII. Hymenoptera sub community showed the maximum diversity. Natural enemies' complex constituted one third of arthropod fauna on cotton crop. Higher diversity was attributed to greater equitability among the species while low diversity due to dominance of certain species.

Key words: Arthropod, Bt cotton, Biodiversity, Community, Diversity index.

INTRODUCTION

Cotton is cultivated over an area of 9 million ha. in India and numerous arthropod species inhabit it, which play an important role in regulating pest population. In the transgenic cotton, Cry 1 Ac gene, which provides effective management of bollworm, has been introduced. In the plant, gene produces an insecticidal protein that was modeled on a naturally occurring soil bacterium, *Bacillus thuringiensis* (Bt) *var. kurstaki*, with known insecticidal properties (Peferoen, 1997). Bollgard (Cry 1 Ac) is detrimental to tobacco budworm (*Heliothis virescens*) and American bollworms, *viz.*, *Helicoverpa armigera, Earias vittella, E. insulana* and *Pectinophora gossypiella* (Kranthi *et al.*, 1999; Tuli *et al.*, 2000). Keeping in view the above facts, the present studies on diversity of arthropod community in Bt cotton was conducted under agroclimatic conditions of Punjab.

MATERIAL AND METHODS

The experiments were conducted at the Entomological Research Farm, Punjab Agricultural University, Ludhiana in *kharif* season using cotton variety RCH134BGI, RCH134BGII and RCH Non Bt (*Gossypium hirusitum* L.) during 2008-09. The study area (Ludhiana) is a centrally located district of Punjab, which lies on the latitude of 30°54'N and longitude of 75°48'E and an altitude of 247 m above mean sea level. This central plain agro climatic region of Punjab is dominated by hot and dry westerly winds during summer season. The average annual rainfall in Ludhiana is above 700 mm, more than 75 percent of which is received during the period from June to September and rest during winter season due to western disturbances. The district has a subtropical, semi-arid and monsoon type of climate with extreme winters. The monthly average maximum and minimum temperature ranges from 18.9 to 38.9°C and from 5.2 to 25.8°C. This area was selected for diversity study because most of the important field crops of Punjab are grown either in *kharif* or *rabi* or both. The crop was sown on May 5th in plots measuring 7×40 m having row-to-row and plant-to-plant spacings of 67×67 cm and 90×90 cm respectively. Visual counts of arthropods were under taken once in week on 25 selected plants per plot. Sampling began from 15 days after sowing till picking of crop. Arthropods were collected from aerial plant parts only. Different types of sampling methods were used, including standard sweep net, aerial net, beat bucket and whole plant inspections. A regular sweeping net (38-cm diameter) was used for collecting insect species inhabing cotton. Sampling was done in four directions (North, South East and West) and middle of the field. Sampling was done at weekly intervals on a whole plant basis. Arthropod diversity was calculated by using Shannon-Weaver diversity index (1963). The arthropods collected were killed

and preserved as dry (pinning the hard bodied, relatively large sized species and double mounting the smaller ones) and wet (preservation of soft bodied species in 70 percent ethyl alcohol) for their identification. The collected samples were studied under microscope and identified for their general grouping. An aspirator was used for collecting fast, moving and flying insects.

RESULTS AND DICUSSION

Arthropod diversity was maximum in Non-Bt (0.859) followed by RCH134BGII (0.499) and was minimum in RCH134BGI (0.355) in May. The observed diversity was due to greater evenness indices in Non-Bt plots. In June, arthropod diversity varied from 1.053 to 1.055 and was higher in Non-Bt and Bt due to higher evenness indices, while the dominance parameter was higher in the BG-II. In July, diversity index of arthropods was maximum in Non-Bt, followed by BG-II, while it was minimum in BG-I. Higher evenness indices were recorded in Non-Bt (0.648) and minimum evenness indices (0.434) in BG-I, it was due to high dominance indices (0.352-0.566). In August, the diversity index was higher in Non-Bt plots (1.780) and BG-I (1.766) due greater evenness indices (0.540-0.652), while Diversity Index was low in BG-II (1.654), which was due to their high dominance indices that varied from 0.348-0.460. In September and October the diversity index was higher in BG-I (1.160) due to greater evenness indices (0.561-0.663). It was due to high Dominance indices in BG-II plot (0.446) followed by BG-I (0.439) and Non-Bt (0.337). (Table 1) Sisterson *et al.* (2004) compared the abundance and diversity of arthropods in Bt cotton, Non-Bt cotton, and a row mixture of 75 per cent Bt cotton and 25 per cent Non-Bt cotton and reported that more arthropods were collected from row mixture plots than Bt plots, but arthropod abundance did not differ significantly between Bt and Non-Bt cotton crop. Within row mixture plots, arthropod abundance and diversity did not differ significantly between Bt and Non-Bt and the difference between Bt and Non-Bt cultivars had relatively minor effects on the arthropod community in cotton.

During the vegetative phase of the crop (12 May to 4 August), the diversity index was maximum in Non-Bt (1.780) followed by BG-I (1.766), and BG-II plots. The observed diversity was due to greater evenness indices in Non-Bt (0.781) BG-II (0.720) and BG-I (0.652). During the reproductive phase of the crop (5th August to 5th October 2009), the diversity index was maximum in Non-Bt plots (1.590), followed by BG-II (1.399) and minimum in BG-I plots (1.160). The observed diversity in Non-Bt cotton crop was due to greater evenness indices (0.401-0.781), while in BG-II of cotton crop, it was due to higher dominance indices (0.349-0.631) (Table 1).

Lie *et al.* (2004) investigated the effect of transgenic cotton carrying CrylA+CpTI and Cry1 Ac genes on diversity of arthropod community and reported that the diversity of arthropod communities in transgenic cotton was similar to that in conventional cotton without spraying, but Shannon's index for total arthropod community and the neutral arthropod guild in Bt cotton fields was significantly higher than those in sprayed crop in the mid and late growing stages of cotton. The results also indicated that planting of Bt cotton increase the stability of arthropod communities in cotton ecological systems and benefit the management of insect pests in cotton. Liu *et al.* (2002) observed that diversity index and evenness index of Bt cotton without pest control was 0.7706 and 0.1883, whereas the Bt cotton field which utilized pesticides to control pests, 0.3968 and 0.0931 and the Bt cotton field with natural enemies to control the pests, 0.2211 and 0.0549, respectively. The dominant concentration index of Bt

Table 1. Diversity indices of arthropods at Ludhiana (2009)

Observation Period	Treatments								
	RCH134 BG-I			RCH134 BG-II			RCH Not-Bt		
	H'	J	D	H'	J	D	H'	J	D
May*	0.355	0.512	0.488	0.499	0.720	0.280	0.859	0.781	0.219
June**	1.0536	0.457	0.542	0.882	0.369	0.631	1.055	0.401	0.599
July**	1.000	0.434	0.566	1.251	0.569	0.431	1.490	0.648	0.352
August**	1.766	0.652	0.348	1.654	0.651	0.349	1.780	0.540	0.460
Sept + Oct***	1.160	0.561	0.439	1.399	0.584	0.446	1.590	0.663	0.337
Overall Mean #	1.067	0.523	0.477	1.137	0.579	0.247	1.355	0.607	0.393

Total observation period from 12th May to 5th October, 2009

Observation recorded from 12th May to 5th October, 2009; H' = Diversity index, J = Evenness index, D = Dominance index; May - *Monthly mean of 3 observations; June- ***Monthly mean of 5 observations; July - **Monthly mean of 4 observations; August - **Monthly mean of 4 observations; Sept + Oct - *** Monthly mean of 5+1 observations.;

Table 2. Total arthropod fauna in cotton agro ecosystem

S.No.	Order	Total insect species in Ludhiana	Percentage
1.	Neuroptera	1	0.63
2.	Ephemeroptera	1	0.63
3.	Odoneta	2	1.26
4.	Orthroptera	7	4.43
5.	Diptera	15	9.49
6.	Lepidoptera	19	12.02
7.	Hemiptera	20	12.62
8.	Coleoptera	23	14.55
9.	Hymenoptera	27	17.08
10.	Isoptera	1	0.63
11.	Mites	2	1.26
12.	Spiders (other arachiveds)	40	25.31
	Total	158	100

cotton was 0.9264 in a field with natural enemies to control pests, 0.8625 in a Bt cotton field with pesticides and 0.6881 in a common cotton field. So the stability of arthropods in the common cotton field was better than that of the transgenic cotton field.

Transgenic cotton increases the community diversity in cotton fields by decreasing the negative impact of insecticides on the arthropod community through reducing the use of insecticides (Fitt, 1994). Transgenic cotton will alter the arthropod community directly by reducing the abundance of *Helicoverpa* spp. (Hoffman *et al.*, 1992) and some other lepidopteron species (Flint *et al.*, 1995). Bai *et al.* (2004) evaluated the composition and diversity of the arthropod community in 4 Bollgard cultivars (109B, 154, 690 and 972) at Jiangsu, China and revealed that no marked difference in arthropod species of Bollgard cultivars and traditional cultivar (Sumian 16) existed. The numbers (abundance) of the dominant species were very close. The parameters of arthropod community structure, including species richness (S), total individual (N), community diversity (H), evenness (J) and concentration (C), in each of Bollgard cultivars fluctuated near the control value. The path analysis of H' with other parameters showed that it was dominant C and J that mainly decide the change of H' for arthropod community. The arthropod community average value of species similarity (V1) was 0.5758-0.0.7742, while the average value of the coefficient of community similarity (V2) was 0.4961-0.6484, respectively. The stability of arthropod community of 4 Bollgard cultivars was not significantly different from that of traditional cotton, and the risk increased by Bollgard cultivars was not significant. In similar studies on the effect of Bt cotton on arthropod community, Lawrence *et al.* (2005) revelead slight but significant differences in the whole arthropod community between Bt and conventional cotton. The protected crop (Bt or conventional) accounted for 9 to 17 per cent of the variability and if sprayed plots were discounted, then Bt or conventional cotton accounted for only 4 to 6 per cent of the variability in the arthropod community. A total of 1056 anthropods were collected. They were grouped into different orders. Maximum number of species belonged to Hymenoptera (27 species) constituting 12 families, followed by Coleoptera (23 species) constituting 13 families, Hemiptera (20 species) constituting 13 families, Lepidoptera (19 species) constituting 9 families, Diptera (15 species) constituting 4 families, Orthoptera (7 species), Arachnida (42 species), Odonata (2 species), Dictyoptera, Isoptera, mites (2 species each), Neuroptera and Thysanoptera (1 species each) (Table 2).

ACKNOWLEDGEMENT

Financial support for this project was provided by the Sir Ratan Tata Trust. The authors are grateful to Department of Entomology, College of Agriculture, Punjab Agricultural University, Ludhiana, for providing facilities to conduct field experiment.

REFERENCES

Bai, L., Zhang, L., Xiao, L., Feng, H. and Zou, Z. (2004). Effects of transgenic cotton on the components and the diversity of the arthropod community in Jiangsu coastal region. *Jiangsu J. Agric Sciences,* **20** :233-39.

Fitt, G.P. (1994). Field evaluation of transgenic cotton in Australia: environmental consideration and consequences of expanding trial size. In: D.D. Jones (ed.) *Proceedings of 3rd International Symposium on*

Biosafety Results of Field Tests of Genetically Maodified Plants and Micro-organisms, The University of California, Oakland, CA, pp. 37-48.

Flint, H.M., Henneberry, T.J., Wilson, F.D. Holguin, E., Parks, N. and Buehler, R.E. (1995). The effects of transgenic cotton, *Gossypium hirsutum* L., containing *Bacillus thuringiesis* toxin genes for the control of the pink bollworm, *Pectinophora gossypiella* (Saunders) Lepidoptera, Gellechiidae and arthropods. *S West Ent,* **20**:281-292.

Hoffmann M.P., Zalom, F.G., Wilson, L.T., Smilanick, J.M., Malyj, L.D. Kiser, L.D. Hilder, V.A. and Barnes W.M. (1992). Field evaluation of transgenic tobacco containing genes encoding *Bacillus thuringiensis* d-endotoxin or cowpea trypsin inhibitor efficacy against *Helicoverpa zea* (Lepidoptera: Noctuidae). *Journal of Economic Entomology,* **85**:2516-2522.

Kranthi S., Kranthi K.R. and Lavhe, N.V. (1999). Geographical variation in susceptibility of *Earias vittella* to Cry toxins. *Crop Protection,* **18**:537-55.

Lawrence, L., Whitehouse, M., Wilson, L. and Fitt, G. (2005). Comparing invertebrate communities in transgenic Bt and conventional cotton. *Outlook Pest Management,* **16**:193-240.

Lie, W., Wu, K., Chen, X., Feng, H., Xu, G. and Guo, Y. (2004). Effects of transgenic cotton carrying Cry1A + CpTI and Cry1Ac genes on diversity of arthropod communities in cotton fields in North China, *Chinese Journal of Agricultural Biotech*nology, **1**:17-21.

Liu, X.X., Wang, F., Xu, J., Zhang, Q.W., Feng, H.B. and Song R. (2002). Transgenic Bt cotton's expression on cotton bollworm resistance and effect on the arthropod community in the field of South Xinjiang. *Journal of China Agricultural University,* **7**:70-74.

Perferoen, M. (1997). Insect control with transgenic plants expressing *Bacillus thruingiensis* crystal proteins, In: N Carozzi and Koziel M (eds) *Advances insect control*: *The role of transgenic plants*: pp. 21-48. Taylor and Francis, Bristol, PA, pp. 21-48.

Tuli, R.K., Bhatia, C.R., Singh, P.K. and Chaturvedi, R. (2000). Release of Insecticidal transgenic crops and gap areas in developing approaches for more durable resistance. *Current Science*, **79**:163-169.

Sisterson, M.S., Biggs, R.W., Olson, C., Carriere, Y., Dennehy, T.J. and Tabashnik, B.E. (2004). Arthropod abundance and diversity in Bt and non Bt cotton fields. *Environmental Entomology*, **33**:921-929.

Shannon, C.E. and Weaver W. (1963). The Mathematical theory of Communication. pp. 117. University Illinois Press, Urbana.