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Full Length Article

Studying the Sucking Insect Pests Community in Transgenic Bt Cotton

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ABSTRACT

Cotton jassid, whitefly and thrips are important sucking insect pests in cotton fields in the Punjab, Pakistan. The seasonal dynamics of these pests were compared on transgenic Bt cotton line, "IR-FH-901" expressing Cry1Ac insecticidal protein with its parent non-transgenic cotton cultivar, FH-901. There was no significant difference in population densities of theses pests in Bt and non-Bt cotton, when nothing was sprayed. However, insecticide application effectively controlled theses pests in both Bt and non-Bt cotton. In conclusion, there is no difference in transgenic Bt and non-Bt cotton for jassid, whitefly and thrips attack and application of suitable insecticide is required to theses pests on transgenic cotton. © 2010 Friends Science Publishers

Key Words: Transgenic Bt cotton; Sucking insect pests; Population density; Seed treatment; Insecticide

INTRODUCTION

Cotton (*Gossypium hirsutum* L.), known as "white gold" is an important fiber and cash crop of Pakistan. The average yield of cotton is about 570.99 kg/ha, which is low as compared to other cotton growing area of the world (Bakhsh *et al*., 2005). The low productivity of cotton is caused by many factors, but the most serious one is the intensity of insect pests attack. Among sucking insect pests, whitefly, jassid and thrips are important in Pakistan and cause significant yield reduction (Aslam *et al*., 2004; Amjad & Aheer, 2007). These are very destructive pests during seedling and vegetative phase of cotton as they suck the sap of the plant, make it weak and in case of severe infestation wilting and shedding of leaves occur (Abro *et al*., 2004).

Transgenic Bt cotton can effectively control specific lepidopterous species (Arshad *et al*., 2009), but there is lack of resistance against sucking insect pests (Hofs *et al*., 2004; Sharma & Pampapathy, 2006) and hence require continuous use of pesticides and other control tactics for effective management (Hilder & Boulter, 1999; Hofs *et al*., 2006). A little attention has been given on the population dynamics of non-target, sucking insect pest community in Bt cotton as most of the studies focus on major target pests. The reduced use of insecticides in Bt cotton can increase the population of sucking insect pests (Men *et al*., 2005) and hence sucking pests have become a more significant part of insect pest complex in Bt cotton (Wu *et al*., 2002). Previous field studies have investigated the higher population of thrips, jassid and whitefly in Bt cotton as compared to conventional cotton (Sun *et al*., 2002; Abro *et al*., 2004; Naveen *et al*., 2007). However, Sharma and Pampapathy (2006) found no significant difference of jassid and whitefly population between transgenic Bt and non-Bt cotton.

The cotton insect pest management in Pakistan is mainly dominated by the use of broad-spectrum insecticides. Foliar application of insecticides at early stages can destroy natural enemies, however seed treatment with seed protectant insecticides are not only safe for natural enemies, but provide effective control of early stage sucking pests. One option to reduce the insecticide use on cotton is the exploitation of transgenic Bt cotton as a component of integrated pest management (Gore *et al*., 2001). The insect control strategy in cotton involves both the target and non-target insect pests' species, so the population dynamics of both species should be considered for the long-term implementation of Bt cotton (Whitehouse *et al*., 2005). No doubt Bt protein is toxic only to specific lepidopteran species, while the diversity of other insect species may be affected indirectly (Wu *et al*., 2005) or the impact of Bt cotton on the non-target insect species may be positive due to elimination of insecticidal use. The change in species composition may influence IPM approach in cotton crop. A little attention has been given on the population dynamics of non-target, sucking insect pests in Bt cotton as most of the studies focus on major target pests. The sucking pests have become a more significant part of pest complex in Bt cotton. The present study was therefore carried out to know the impact of transgenic Bt cotton on the non-target sucking insect pests community under sprayed and un-sprayed conditions.

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MATERIALS AND METHODS

Experimental study area and design: The field experiments were conducted for two cotton seasons from 2006 to 2007 at Postgraduate Agriculture Research Station (PARS), Faisalabad, Punjab, Pakistan (31º21.52 North & 72º59.40 East), where wheat and cotton are commonly intercropped. The experimental fields were laid out in a Randomized Complete Block Design (RCBD) consisting of four treatments each with four replications. Each replicated plot was about 0.05 ha (hectare). A gap of 5 m was left between plots to avoid the influence of treatments on insect population in neighbouring plots (Men *et al*., 2003). The transgenic Bt cotton line, "IR-FH-901" (NIBGE, Faisalabad, Pakistan) producing the Cry1Ac insecticidal protein of *Bacillus thuringiensis* was compared with its parent non-transgenic, conventional cotton cultivar, "FH-901" (AARI, Faisalabad, Pakistan). The experimental plots were planted in the 3rd week of May. The experimental area selected was relatively isolated from other sprayed cotton to reduce the chance of insecticidal drift across the un-sprayed area. The seed rate was used to expect the plant population of 60,000 per ha with row to row and plant to plant distance of 0.75 and 0.25 m, respectively. The experimental fields were maintained according to the recommended agronomic practices for this area. The treatments included were: (a) transgenic Bt cotton without insecticide application (Bt cotton un-sprayed); (b) transgenic Bt cotton with insecticide application (Bt cotton sprayed); (c) non-transgenic cotton without insecticide application (non-Bt cotton un-sprayed); (d) non-transgenic cotton with insecticide application (non-Bt cotton sprayed).

Insect pests in sprayed plots of Bt and non-Bt cotton were monitored after every 3-4 days. The insecticides used in sprayed plots were based on the economic thresholds level (ETL) for insect pests of cotton crop. Insecticides were sprayed with knapsack sprayer and used hollow cone nozzles, held 0.3-0.5 m above the cotton plants (Wu *et al*., 2002). The same insecticides were applied in both years, while no insecticides were applied in un-sprayed plots. Experimental design and sampling procedures were similar in both years of field studies.

Sampling: The surveillance of cotton crop was initiated at the seedling emergence and continued up to the mid October on weekly basis. The plant inspection method was used for sampling and the populations of three major non-target sucking pests (whitefly, jassid & thrips) were recorded early in the morning at weekly interval from 15 leaves of 15 plants selected randomly. The sampling was done in such a way that the 1st leaf from upper portion of the 1st plant, the 2nd leaf from middle portion of the 2nd plant and the 3rd leaf from bottom potion of the 3rd plant and so on (Sohail *et al*., 2003; Amjad & Aheer, 2007).

Statistical analysis: All data on population dynamics of non-target sucking insect pests in different treatments in 2006 and 2007 were analyzed using analysis of variance (ANOVA) and means were separated by using Tukey's honestly significant difference (HSD) test. All analysis was done using SPSS (SPSS Institute, Chocago, Illinois) and STATISTICA-6 software. The multifactor effects of year, variety and pesticide were analyzed using GLM procedure in STATISTICA-6 statistical software.

RESULTS

Seasonal abundance of jassid: The results indicated no significant difference in cotton jassid populations between varieties, but a significant difference were found among sprayed and un-sprayed plots. The results showed that seed treatment in sprayed plots of Bt and non-Bt cotton significantly reduced the population up to 30-35 days after sowing (Fig. 1a & b). The jassid appeared on cotton leaves during the 2nd week of June (two week after sowing) and from then on the population increased gradually. The maximum population appeared during 30 July (3.3/leaf) and 20 August (3.5/leaf) in un-sprayed plots of Bt and non-Bt cotton in 2006 and 2007 season, respectively. After that period it fluctuated up to the 2nd week of October and slowly decreased. The population in sprayed plots of Bt and non-Bt cotton were kept under threshold level with the use of pesticides. The overall mean data of all observations showed significant differences ($P < 0.05$) among the treatments in 2006 ($F = 348.86$; df = 3; $P = 0.00$) and 2007 ($F = 1756.59$; df = 3; $P = 0.00$). The highest populations were observed on un-sprayed Bt and non-Bt cotton as compared to sprayed Bt and non-Bt cotton. The differences were mainly due to the use of insecticides in sprayed plot of Bt and non-Bt cotton, which significantly reduced the populations than those of un-sprayed plots. However, no significant differences were observed in jassid populations between the varieties under un-sprayed plots (Fig. 2).

A multi-factor analysis on the effects of year, variety and pesticide showed that year and pesticide significantly ($P < 0.05$) influenced the mean population density of jassid, whereas varieties did not influenced the population density. There were significant interactions ($P < 0.05$) among year and pesticide, while all other interactions were not significant ($P > 0.05$, Table I).

Seasonal abundance of whitefly: The Fig. 3a and b indicated that whitefly populations were recorded initially on 17 June (two week after sowing), that increased gradually and reached at maximum during the last week of August in the un-sprayed Bt and non-Bt cotton during both seasons, 2006-2007. This pest was active up to the 2nd week of October. The seed treatment significantly reduced the population up to 9 July (almost 40 days after sowing). In general, the population remained below the threshold level in the sprayed plots of Bt and non-Bt cotton. The pooled data of all observations showed significant differences ($P < 0.05$) among treatments in 2006 ($F = 148.03$; df = 3; $P = 0.00$) and 2007 ($F = 298.34$; df = 3; $P = 0.00$). The mean populations were significantly higher in un-sprayed Bt

Fig. 1: Seasonal abundance (Mean ± SE) of jassid in Bt and non-Bt cotton during, (a) 2006 and (b) 2007

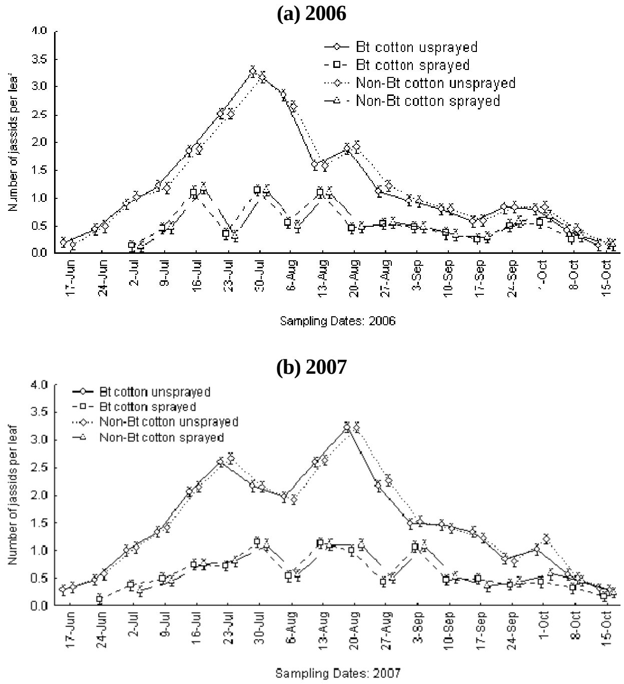


Fig. 2: Seasonal abundance (Overall mean ± SE) of jassid in 2006, 2007, bars indicated by different letters are significantly different (Tukey's HSD, P<0.05)

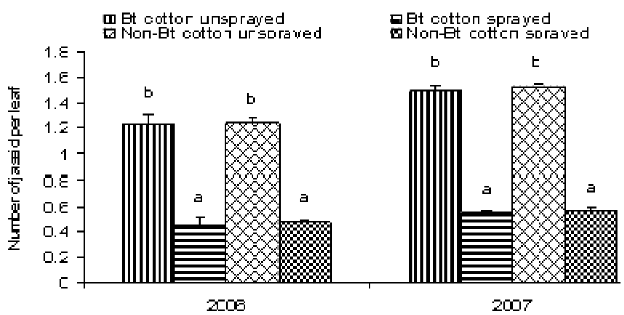


Fig. 3: Seasonal abundance (Mean ± SE) of whitefly in Bt and non-Bt cotton during, (a) 2006 and (b) 2007

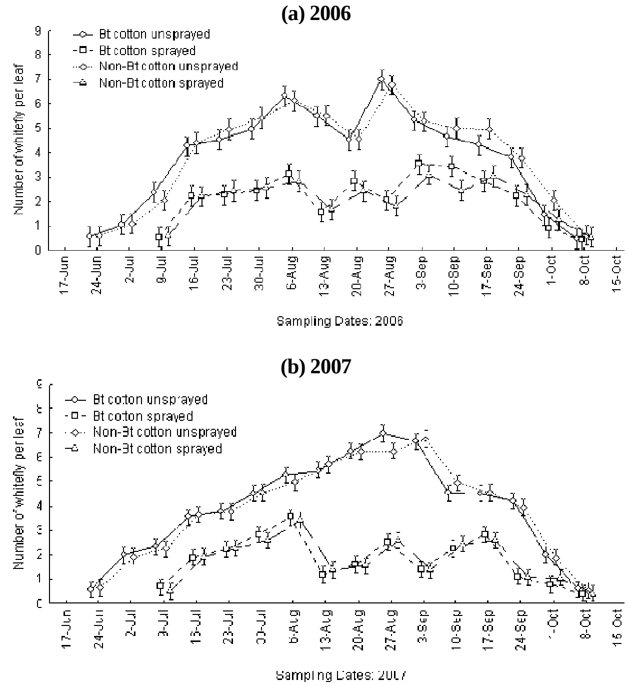
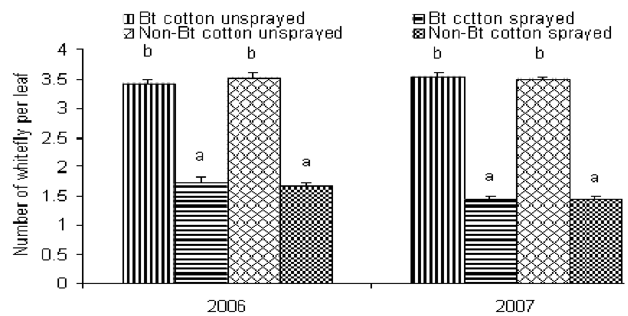


Fig. 4: Seasonal abundance (Overall mean ± SE) of whitefly in 2006, 2007, bars indicated by different letters are significantly different (Tukey's HSD, P<0.05)



(3.41/leaf in 2006; 3.54/leaf in 2007) and non-Bt cotton (3.52/leaf in 2006; 3.49/leaf in 2007) than those of sprayed Bt (1.72/leaf in 2006; 1.43/leaf in 2007) and non-Bt cotton (1.66/leaf in 2006; 1.42/leaf in 2007) (Fig. 4). The insecticide applications significantly reduced the population in sprayed plots of Bt and non-Bt cotton. However, there were no significant differences between varieties, that indicated no impact of Bt cotton on the population density of whitefly in both seasons.

A summary of multi-factor (year, variety & pesticide) effects on the mean populations of whitefly showed significant ($P < 0.05$) effects of year and pesticide. Pesticide significantly influenced the population density of whitefly, while varieties had no impact on population. Interactions between year and pesticide were significant ($P<0.05$), while all other interactions were not significant ($P>0.05$, Table I).

Seasonal abundance of thrips: The results presented in Fig. 5a and b indicated the significant lower populations in sprayed plots of Bt and non-Bt cotton throughout the seasons in both years, 2006-2007. The seed treatment in sprayed plots had a significant impact and reduced the population during early growth stages of plant (approximately, 35-40 DAS). The maximum population was observed in unsprayed Bt and non-Bt cotton in the 3rd week of August in both years. The pest remained active throughout the season in un-sprayed plots of Bt and non-Bt cotton, but the population was below the damaging levels. No pesticide application was needed in sprayed plots of Bt and non-Bt cotton to keep the pest below the threshold level. The pesticides used against other sucking pests in sprayed plots also reduced the thrips populations' density. The mean data of all observations (Fig. 6) showed a significant

Fig. 5: Seasonal abundance (Mean ± SE) of thrips in Bt and non-Bt cotton during, (a) 2006 and (b) 2007

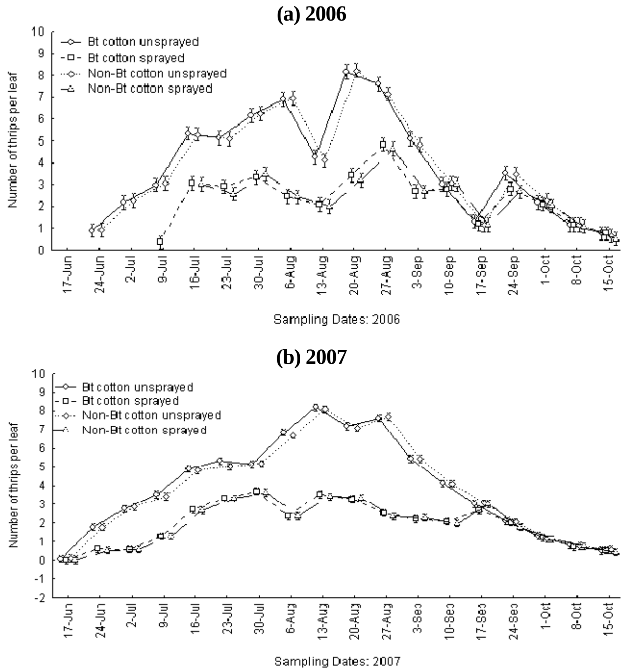
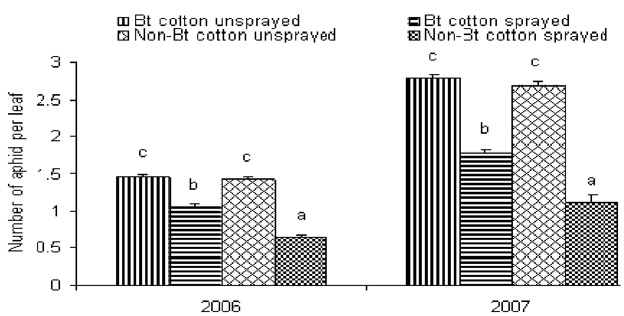


Fig. 6: Seasonal abundance (Overall mean ± SE) of thrips in 2006, 2007, bars indicated by different letters are significantly different (Tukey's HSD, P<0.05)



difference (P < 0.05) in thrips populations among the treatments in 2006 (F = 387.41; df = 3; P = 0.00) and 2007 (F = 800.77; df = 3; P = 0.00). The maximum mean population was observed on unsprayed Bt (3.70/leaf in 2006; 3.93/leaf in 2007) and non-Bt cotton (3.66/leaf in 2006; 3.94/leaf in 2007) as compared to sprayed Bt (2.0/leaf in 2006; 1.96/leaf in 2007) and non-Bt cotton (1.92/leaf in 2006; 2.0/leaf in 2007).

A multi-factor (year, variety & pesticide) analysis showed that only year and pesticide significantly (P < 0.05) influenced the population density of thrips, while varieties had no effects on population. There were no significant differences in all possible interaction (P > 0.05, Table I).

DISCUSSION

Although, field experiments have revealed that Bt cotton proved to be effective against certain target

Table I: Multi-factor effects of year, variety and pesticide on the mean seasonal population density of non-target major sucking pests

Factors	F-value		
	Jassid	Whitefly	Thrips
Year	359.38*	4.64*	35.19*
Variety	3.08	0.01	4.12
Pesticide	8133.77*	1568.53*	10193.95*
Year * Variety	0.27	0.31	1.16
Year * Pesticide	85.27*	10.15*	50.79*
Variety * Pesticide	0.08	0.56	0.31
Year * Variety * Pesticide	0.20	1.21	0.04

lepidopterous pests, but it lacked the resistance against non-target insect pests (Sharma & Pampapathy, 2006). There were no significant differences in population densities of major non-target sucking pests (jassid, whitefly & thrips) between Bt and non-Bt cotton and the populations were more or less uniform. In general, the populations were significantly higher in unsprayed Bt and non-Bt plots than those of sprayed Bt and non-Bt plots. No significant differences were found in sucking pest management between Bt and non-Bt cotton. In addition to seed treatment, 3-4 insecticide applications were used in sprayed plots to keep sucking pests' populations below the threshold level. The seed treatment significantly reduced the populations of jassid, whitefly and thrips during early growth of plant upto 35-40 days after sowing. Dandale *et al.* (2001) reported that seed treatment in cotton with imidacloprid was effective against sucking pests and kept the population below the economic threshold level up to 40 days after sowing (DAS) (Patil *et al.*, 2003). Similar, results have been found by Kannan *et al.* (2004), who mentioned the lower populations of sucking pests during early growth stages of plant in seed treated plots than those of control. The sucking pest populations were also noticed during later part of crop growth and mean population was higher in sprayed Bt cotton than those of sprayed non-Bt cotton. It may be due to reduced pesticide spray against target lepidopterous pests in Bt cotton, which built up the sucking pests population particularly at later stages. Cotton jassid and whitefly populations exceeded the threshold level and pesticides were used to control these pests in sprayed plots of Bt and non-Bt cotton. However, thrips population was below the threshold level throughout the seasons in all treatments. The decreased population densities of this pest in sprayed plots were mainly due to the impact of pesticides used against other sucking pests. The current and previous studies (Men *et al*., 2003; Bambawale *et al*., 2004) revealed that transgenic Bt cotton had no impact on the sucking pest population and consequently required suitable management strategy.

The results indicated that transgenic Bt cotton proved not to be effective against sucking insect pests and insecticides were needed to control these pests. The seed treatment provided the better protection against early-season sucking pests in transgenic cotton but for long term implementation of Bt cotton as a component of IPM, it is important that such varieties should be transformed with Bt genes that have also other resistance characters against non-target sucking pests to reduce the number of pesticide applications.

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REFERENCES

Abro, G.H., T.S. Syed, G.M. Tunio and M.A. Khuhro, 2004. Performance of transgenic Bt cotton against insect pest infestation. *Biotechnology*, 3: 75–81

Amjad, A. and G.M. Aheer, 2007. Varietal resistance against sucking insect pests of cotton under Bahawalpur ecological conditions. *J. Agric. Res*., 45: 205–208

Arshad, M., A. Suhail, M.J. Arif and M.A. Khan, 2009. Transgenic Bt and non-transgenic cotton effects on survival and growth of *Helicoverpa armigera*. *Int. J. Agric. Biol*., 11: 473–476

Aslam, M., M. Razaq, S.A. Shah and F. Ahmad, 2004. Comparative efficacy of different insecticides against sucking pests of cotton. *J. Res. Sci.*, 15: 53–58

Bakhsh, K., I. Hassan and A. Maqbool, 2005. Factors affecting cotton yield: A case study of Sargodha, Pakistan. *J. Agric. Soc. Sci*., 1: 332–334

Bambawale, O.M., A. Singh, O.P. Sharma, B.B. Bhosle, R.C. Lavekar, A. Dhandapani, V. Kanwar, R.K. Tanwar, K.S. Rathod, N.R. Patange and V.M. Pawar, 2004. Performance of Bt cotton (MECH-162) under Integrated Pest Management in farmers' participatory field trial in Nanded district, Central India. *Curr. Sci*., 86: 1628–1633

Dandale, H.G., A.Y. Thakare, S.N. Tikar, N.G.V. Rao and S.N. Nimbalkar, 2001. Effect of seed treatment on sucking pests of cotton and yield of seed cotton. *Pestology*, 25: 20–23

Gore, J., B.R. Leonard and J.J. Adamczyk, 2001. Bollworm (Lepidoptera: Noctuidae) survival on 'Bollgard' and 'Bollgard II' cotton flower bud and flower components. *J. Econ. Entomol*., 94: 1445–1451

Hilder, V.A. and D. Boulter, 1999. Genetic engineering of crop plants for insect resistance-a critical review. *Crop Prot*., 18: 177–191

Hofs, J.L., A. Schoeman and M. Vaissayre, 2004. Effect of Bt cotton on arthropod biodiversity in South African cotton fields. *Commun. Agric. Appl. Biol. Sci*., 69: 191–194

Hofs, J.L., M. Fok and M. Vaissayre, 2006. Impact of Bt cotton adoption on pesticide use by smallholders: A 2-year survey in Makhatini Flats (South Africa). *Crop Prot*., 25: 984–988

Kannan, M., S. Uthamasamy and S. Mohan, 2004. Impact of insecticides on sucking pests and natural enemy complex of transgenic cotton. *Curr. Sci.*, 86: 726–729

Men, X.Y., F. Ge, X.H. Liu and E.N. Yardim, 2003. Diversity of arthropod communities in transgenic Bt cotton and nontransgenic cotton agroecosystems. *Environ. Entomol*., 32: 270–275

Men, X., F. Ge, C.A. Edwards and E.N. Yardim, 2005. The influence of pesticide applications on *Helicoverpa armigera* Hubner and sucking pests in transgenic Bt cotton and non-transgenic cotton in China. *Crop Prot*., 24: 319–324

Naveen, A., D.S. Brar and G.S. Buttar, 2007. Evaluation of Bt and non-Bt version of two cotton hybrids under different spacing against sucking insect-pests and natural enemies. *J. Cotton Res. Dev*., 21: 106–110

Patil, B.C., S.B. Patil, S.S. Vdikeri and B.M. Khadi, 2003. Effect of imidacloprid seed treatment on growth, yield, seedling vigour and biophysical parameters in cotton (*Gossypium* spp.) genotypes. *Proc. World Cotton Res. Conf. 3, Cape Town, South Africa, 9–13 March*

Sharma, H.C. and G. Pampapathy, 2006. Influence of transgenic cotton on the relative abundance and damage by target and non-target insect pests under different protection regimes in India. *Crop Prot*., 25: 800–813

Sohail, A., N. Shahid, R. Zia-Ur and B. Mohsin, 2003. Comparative incidence of insect pest complex on cotton varieties subjected to organic and synthetic fertilizers. *Int. J. Agric. Biol*., 5: 236–238

Sun, C., J. Xu, Q. Zhang, H. Feng, F. Wang and R. Song, 2002. Effect of transgenic Bt cotton on population of cotton pests and their natural enemies in Xinjiang. *Chinese J. Biol. Cont*., 18: 106–110

Whitehouse, M.E.A., L.J. Wilson and G.P. Fitt, 2005. A comparison of arthropod communities in transgenic Bt and conventional cotton in Australia. *Environ. Entomol*., 34: 1224–1241

Wu, K., W. Li, H. Feng and Y. Guo, 2002. Seasonal abundance of the mirids, *Lygus lucorum* and *Adelphocoris* spp. (Hemiptera: Miridae) on Bt cotton in northern China. *Crop Prot*., 21: 997–1002

Wu, K., K. Lin, J. Miao and Y. Zhang, 2005. Field abundances of insect predators and insect pests on Delta-Endotoxin-producing transgenic cotton in northern China. *2nd Int. Symp. Biol. Cont. Arthrop., Davos, Switzerland, 12-16 September*, pp: 362–368

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