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SCREENING OF DIFFERENT BT COTTON (*GOSSYPIUM HIRSUTUM* L.) GENOTYPES AGAINST SUCKING AND BOLLWORM COMPLEXES

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Host plant resistance can play an important role in Integrated Pest Management (IPM) against insect pests. Relative infestation on five Bt transgenic cotton varieties/genotypes (IR-443, IR-FH-901, IR-448, IR-1524 and IR-1513) was investigated against sucking complex (jassids, thrips and whiteflies) and bollworms [pink (*Pectinophora gossypiella*) and spotted (*Earias* spp.) bollworms] during 2 consecutive years (2009 and 2010). Results reflected that IR-443 proved to be the most successful genotype rendering lowest infestation of jassids, thrips and whiteflies in both years as compared to other Bt cotton genotypes followed by IR-FH-901. Percent infestation by pink and spotted bollworms remained below Economic Threshold Level (ETL) and differed non significantly in all transgenic cotton genotypes. Highest yield was recorded from IR-443 which was significantly higher than IR-1513 and statistically at par with other three Bt cotton. Overall performance of IR-443 was found excellent followed by IR-FH-901. Thus, the latter two Bt transgenic cotton varieties/genotypes should be considered as an important tool to help in managing certain pest populations in an economically viable and environmentally safe manner.

Keywords: Bt cotton, Screening, Genotypes, Resistance, Sucking pests, Bollworms

1. Introduction

Cotton (white gold) is a major cash and fiber crop of Pakistan. This crop provides livelihood to millions of people engaged in its trade and textile industry [1]. In Pakistan, it is grown on an area of about 3031.5 thousand hectares having cotton lint production of 12452.5 thousand bales with average yield of 699 kg/ha [2]. This per hectare yield is very low as compared to other major cotton producing countries. There are many reasons responsible for the low yield of cotton but insect pest infestation is one of the major reasons. The insect pest spectrum of cotton is quite complex and about 93 insect and mite pests have been reported to attack cotton crop in Pakistan [3]. These insect pests cause 5-10 percent damage on an average but in case of serious infestation cause 30-40 percent of yield loss [4].

Bt crops are known to have a very specific mode of action against target lepidoteran pests [5]. Transgenic Bt cotton provide highly effective control of cotton bollworms and reduce reliance on conventional chemical pesticides. They have provided notably higher yields in cotton [6]. Thus, Bt-transgenic crops have the potential to be a viable alternative to conventional insecticides. In cotton fields, broad-spectrum insecticides are generally applied for the control of lepidopteran pests, i.e. the bollworm complex. Around the globe, use of Bt cotton has consistently resulted in a 60-80% decrease in insecticide applications in this crop [7]. In Pakistan the area under Bt cotton increased noticeably in 2005, when Pakistan Atomic Energy Commission (PAEC) provided 40,000.0 kg seed of the Bt cotton strains namely IR-FH-901, IR-NIBGE-2, IR-CIM-448 and IR-CIM-443, which were grown on over 3,238 ha (hectares) during the 2005-2006 cotton season [8, 9]. Transgenic Bt cotton can almost completely resist the attack of specific lepidopteran pests but lack resistance against sucking insect pests. Among these, jassid, *Amrasca devastans* (Dist.), whitefly, *Bemisia tabaci* (Genn.) and thrips, *Thrips tabaci* (Lind.) are very serious. These sucking pests have become a more considerable part of pest complex in Bt cotton [10] and hence require continuous use of pesticides and other control tactics for effective management. There are different pest control tactics, in which varietal resistance plays an important role in Integrated Pest Management (IPM), as resistant varieties can easily control

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insect pests without insecticide application [11-13].

Sucking and chewing pest complexes damage the cotton crop very severely. The intensity of their attack is, sometimes so severe that it can cause major destruction of the crop yield. One of the safe measures to evade such a situation is to grow resistant cotton cultivars [14]. It is important to screen out different Bt cotton genotypes developed by breeders from time to time against target lepidopterous and non target sucking pests. This will help the farmers' community in selecting the most suitable genotype for increased crop production. For this purpose the present study was executed to find out the response of transgenic cotton genotypes towards various sucking and chewing insect pest complexes.

2. Materials and Methods

The experiment was laid out in Randomized Complete Block Design (RCBD) with 5 treatments and four replications for two consecutive years (2008-09 and 2009-10). Plot size of each experimental unit was 15 m x 10 m having row to row and plant to plant distance of 0.75 m and 0.30 m respectively. The five Bt cotton cultivars (IR-443, IR FH-901, IR-448, IR 1524 and IR-1513) were sown in the experimental area of Nuclear Institute of Agriculture Tandojam. All the five Bt cotton were grown under natural field conditions and normal agronomic practices were followed for raising the crop. No control measures were adapted for different pests during the crop-growing season even if the pest population reached to economic threshold level. The data were collected regularly at fortnightly interval throughout the cotton crop. The plant inspection method was used for sampling and the populations of three major sucking pests jassids, *Amrasca devastans* (Dist.), thrips, *Thirps tabaci* (Lind.) and whiteflies, *Bemisia tabaci* (Genn.) were recorded early in the morning at fortnightly interval by observing the three leaves (one each from top, middle and bottom) from randomly selected three plants and transformed on per leaf basis [15]. Infestation of bollworms was recorded by observing the buds, flowers and dissecting the bolls on randomly selected three plants from each replication. Percent infestation of pink bollworm and spotted bollworm was calculated separately by recording total number of fruiting parts (buds, flowers and bolls) and numbers of damaged fruiting parts from three plants in each replication using formula:

$$\text{Percent Infestation} = \frac{\text{No. of damaged fruiting parts}}{\text{Total No. of fruiting parts}} \times 100$$

The data obtained from these test genotypes on sucking complex and bollworms in comparison to yield were used to assess the resistance or susceptibility depicted by them. In each plot yield was recorded by picking the cotton two times during cropping season.

Finally the data were subjected to the analysis of variance (ANOVA) and treatment means were compared using LSD at 5% level of probability.

3. Results and Discussion

3.1. Screening of transgenic cotton against sucking and bollworm complexes (2009)

Results on the screening of transgenic cotton against sucking and bollworm complexes (2009) are presented in Table 1. At natural conditions regarding infestation of jassids, the data confirmed that on average basis, IR-443 was the most efficient for holding reduced jassid infestation per leaf (0.3). IR-FH-901, IR-448 and IR-1524 were found non significantly different among each other where mean per leaf population of jassids was 0.66, 0.77 and 0.85 respectively. IR-1513 exhibited more jassid susceptibility where maximum per leaf infestation (1.1) was investigated. Thrips population was non significantly different between IR-443 (2.78) and IR-FH-901 (2.16), but was significantly lower than all other Bt cotton. IR-1513 was found most suceptible where hieghest thrips infestation of 5.85 per leaf was recorded. Lowest whiteflies population of 0.33 per leaf was recorded on IR-443 which was significantly the lowest compared to all other Bt cotton genotypes. IR-1513 proved more suceptible to whiteflies attack where highest infestation of 0.80 per leaf was recorded. No pink bollworm infestation was observed on IR-443 and IR-FH-901, however, a minor non significant attack of the same was investigated on all other transgenic cotton genotypes. Percent infestation of spotted bollworm was also non significantly different among all Bt cotton, however lowest (0.13) was recorded in IR-443 and hieghest (0.64) in IR-1513. The cotton yield was correlated with the degree of pests infestation, and yield increased with decrease in infestation level. Maximum yield of 1628 in kg/acre was recorded in IR-443 followed by IR-FH-901(1507). IR-1513 rendered heavy pest attack and thereby producing lowest yield of 1149 kg/acre.

Table 1. Screening of transgenic cotton against sucking and bollworm complexes (2009)

Genotypes	jassids/leaf	thrips/ leaf	whiteflies/leaf	pink bollworm (%)	spotted bollworm (%)	Yield kg/acre
IR-443	0.3 c	2.78 c	0.33 c	0.00 a	0.13 a	1628 a
IR-FH-901	0.66 b	2.16 c	0.58 b	0.00 a	0.19 a	1507 ab
IR-448	0.77 b	4.28 b	0.59 b	0.13 a	0.22 a	1494 ab
IR-1524	0.85 b	4.88 b	0.70 ab	0.23 a	0.37 a	1453 ab
IR-1513	1.1 a	5.85 a	0.80 a	0.28 a	0.64 a	1149 b
LSD	0.23	0.82	0.18	0.43	0.84	440.96

Means within a column followed by different letters are significantly different (P<0.05).

Table 2. Screening of transgenic cotton against sucking and bollworm complexes (2010)

Genotypes	jassids/ leaf	thrips/ leaf	whiteflies/leaf	pink bollworm(%)	spotted bollworm(%)	Yield kg/acre
IR-443	0.42 c	1.65 c	0.29 c	0	0.11 a	1599 a
IR-FH901	0.69 b	2.51 bc	0.44 bc	0	0.25 a	1424 ab
IR-448	0.88ab	2.63 bc	0.46 b	0.12 a	0.29 a	1421 ab
IR-1524	0.87ab	2.85 ab	0.56 b	0.18 a	0.33 a	1327 ab
IR-1513	1.00 a	3.82 a	0.82 a	0.32 a	0.58 a	1075 b
LSD	0.26	1.03	0.16	0.28	0.55	463.56

Means within a column followed by different letters are significantly different (P<0.05)

3.2. Screening of transgenic cotton against sucking and bollworm complexes (2010):

Result revealed that population of sucking complex was significantly different on all the tested genotypes of Bt cotton (Table 2). Genotype IR-443 was characterized by extremely low per leaf jassid infestation (0.42) followed by IR-FH-901 (0.69). IR-1513 exhibited more jassid susceptibility where maximum jassids per leaf (1.00) were recorded. The most tolerant genotype regarding thrips infestation was IR-443 where lowest per leaf population (1.65) was examined followed by IR-FH-901 (2.51). Highest thrips population was recorded on IR-1513 (0.82) which was non significant with IR-1524 but was significantly higher than all other genotypes. Whiteflies population was also significantly higher on IR-1513 than all other genotypes; however, the lowest (0.29) was recorded on IR-443. No pink bollworm infestation was observed in IR-443 and IR-FH-901 whereas a non significantly different attack of the same was observed in all other transgenic cotton genotypes with maximum of 0.32 % in IR-1513. Spotted bollworm infestation was non significantly different in all Bt cotton genotypes however highest was recorded in IR-1513 (0.58%). Results showed (Table 2) that the best yielded genotype was IR-443 having a yield of 1599 kg/acre. IR FH-901, IR-448 and IR 1524 contributed in similar style having 1424, 1421 and 1327 kg yield per acre respectively. The increase yield in genotypes IR-443, IR FH-901and IR-448 was their contributions to hold lower sucking pests populations and higher genetic yield potential. IR-1513 gave the smallest yield of 1075 kg/acre as compared to other genotypes tested, which was significant statistically. This genotype showed its poorest plant stand due to infestation of sucking complex resultantly, the least yield was obtained.

The attack of different insect pests varied greatly on all the tested genotypes and so was the yield. The sucking pests were more considerable part of pest complex in all tested Bt cotton genotypes, however, bollworms infestation was insignificant. It is obvious from the data described above that the most tolerant genotype in both years was IR-443 exhibiting least pest infestation and higher yield, this was followed by IR-FH-901. These results are in accordance with the results of other research workers. Arshad and Anjum [16] conducted experiment on IR-FH-901 and reported considerable variations in the number of the above-mentioned insect pests. Similarly study conducted by Men *et al*. [17] and Bambawale *et al*. [18] revealed that transgenic Bt cotton had no impact on the sucking pest population and consequently required suitable management strategies. Similar results were also presented by Sharma and Pampapathy [10] who, in different field experiments, found that Bt cotton had proved to be effective against certain target lepidopterous pests but lacked the resistance against non target insect pests. Bambawale *et al.* [18] stated that Bt MECH-12 was highly sensitive to jassids, whereas some of the Bt hybrids in the pipeline are susceptible to whiteflies. In our studies, a non significantly different pink and spotted bollworm infestation was observed in all transgenic cotton genotypes tested in both the consecutive years which suggested that Bt cotton can resist bollworms infestations. The same was also pointed out by many early workers. Jingyuan [19] reported significantly lower larval population of cotton bollworms on Bt cotton genotypes than those on the check (conventional cotton). Bt cotton can easily withstand the attack of bollworms because of presence of toxins but lack resistance against sucking pests. As a highly selective form of host plant resistance, Bt cotton has a very specific mode of action against target lepidoteran pests and has become a key factor in overall integrated pest management (IPM). Bt cotton has led to large reductions in the abundance of targeted pests and so did the broad spectrum pesticides [6, 7]. Similarly Kamran *et al.* [14] confirmed that Bt transgenic varieties IRCIM-443 and IRFH-901 were less infested by spotted, american and pink bollworms.

4. Conclusion

It can be concluded from the findings of the present studies that:

- All transgenic cotton genotypes, although were given the identical agronomic practices, yet they responded in a different way towards pests infestation and yield capabilities.
- The genotype IR-443 was least preferred by sucking pests and bollworms over other genotypes and gave the highest yield under field conditions.
- This resistant variety may help to minimize the possible use of insecticides and to improve future integrated pest management programme.

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