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Risk assessment of transgenic cotton against non-target whiteflies, thrips, jassids and aphids under field conditions in Pakistan

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Abstract
Transgenic cotton showing resistance against target insects pests was found successful in Pakistan. It showed more resistance against lepidopteran insects pests. In this research we conducted field experiments in which sucking insect pests including white flies, thips, jassids, aphids were observed for population dynamics in Bt cotton as compared to non-Bt cotton. Transgenic cotton varieties included FH-Lalazar, FH- 142, FH- 118 were used as compared to NIAB- 2008 as non-Bt cotton. Sampling method used in this research was a plastic bag method in which three different leaves were collected from the same plant. And different samples were collected in Bt cotton as compared to non-Bt cotton fields. Results showed that no difference was found in population dynamics of white flies, thrips, jassids and aphids. Although some numerical differences were found in its population dynamics and densities but non significant difference was observed in Bt cotton as compared to non-Bt cotton. Results showed that Bt cotton not showing any ecological issue regarding non-target pests in Bt cotton ecosystem.

Keywords: non-target effects, risk assessment, bt cotton, sucking pests

1. Introduction
A large number of insect pests attack on cotton during whole season like aphid (*Aphis gossypii*), jassid (*Amrasca biguttula*), whitefly (*Bemesia tabaci)* and thrips (*Thrips tabaci)* are important pest of cotton [1]. Insects have ability to destroy the cotton crop upto 39.50%. [2,3]. A large no of broad-spectrum pesticides use to avoid insect pest damage, but injudicious use of pesticides cause deadly effect on human health and causes environmental pollution [4].
Transgenic cotton is the revolutionary step in agriculture to control the bollworm complex but the survival of piercing sucking insects more [5]. Whitefly (*Bemesia tabaci)* is disreputable sucking pest of cotton from the previous few years [6, 7] and many horticultural crops [8, 9]. It injured plant by sucking the cell sap and act as vector of cotton leaf curl virus (CLCV) [10]. It causes about 50% reduce in the formation of boll [11]. *Thrips tabaci* is little minute insect cause damage to plant by sucking the cell sap from underside of leaves and due to this silvery appearance on leaves clearly seen. At later stages, show cup shape structure. Jassid (*Amrasca bigutulla bigutulla)* is the notorious pest of cotton [12, 13]. The pest mostly live underside the leaves of plant and suck sap from lower parts and inject the toxic material into plant tissues. Due to this leaves of plants become wrinkled and this the features of jassid attack [14]. Whiteflies, thrips, jassids and aphids cause damage to cotton plants and reduce the production of cotton in the country [15, 16].
Agriculture is an important sector sharing about 22% in annual gross domestic production (GDP) of Pakistan. Cotton (*Gossypium hirsutum* L) is an important fiber crop belongs to genus *hirsutm* and family Malvaecae [17, 18] is an important fiber and cash crop of Pakistan and has an essential role towards country's economy [19].
Many entomologists [6, 7] have stated that weather factors play an important role towards variations in sucking insect pests population like whitefly, thrips and jassid and aphids. Approximately 80% pesticides used on cotton in Pakistan [20], the injudicious uses of pesticide causes many health and environmental problems as well as insects resistance which is the major fault towards the better crop production [4]. Whitefly *B. tabaci* spread all over the world and become as a pest [21]. Whitefly has about host range of 600 plants [22].

By 1996 world recognized that transgenic cotton is the ultimate solution to overcome the resistance issues against chewing insect pests. A great resistance has been formed in chewing insect pests like *Helicoverpa armigera, Pectinophora gossypiella, Earias vittella* and *Earias insulana* against transgenic cotton both under laboratory and field condition [23]. Transgenic cotton has great ability to control chewing insect pests but resistance against sucking insect pest is less [24, 25]. With the Bt cotton in the market, the usage of insecticides become less so the sucking insect pests population attack increases [26].

The present field studies were conducted to assess the population dynamics of Whitefly (*Bemisia tabaci),* Thrips *(Thrips tabaci),* Jassid *(Amrasca bigutulla)* and aphid (*Aphis gossypii*) on transgenic varieties as compared to non-transgenic cotton varieties in Pakistan.

2. Materials and Methods

Cotton varieties

In order to evaluate the resistance in various Bt cotton varieties against population dynamics of whitefly, thrips, aphid and jassids. The present experiment was conducted at Entomological Research Area at University of Agriculture, Faisalabad. The following *Gossypium hirsutum* L. Varieties were included in this research

1) FH-LALAZAR
2) FH-142
3) FH-118
4) NIAB-2008

Cotton sowing and field preparation

Following the recommendations regarding the land preparation, the experimental land was ploughed up by cross-wise disc plough. After soaking dose, when the land came in condition, the seedbed was prepared by using cross-wise cultivator followed by rotavator. The clods were crushed completely by clod crusher followed by planking. Sowing of experimental crop will be done by manual method. All the four varieties were sown in three replicates and channels and bunds were prepared to facilitate the irrigation process and further monitoring of the crop against any pest problem.

The Randomized Complete Block Design (RCBD) with three replications was applied. The plot size was maintained at 100 x 28 square feet by keeping the recommended row to row and plant to plant distance. The first two irrigations were provided after 20 days of seed emergence. No pesticides were sprayed in and around the experimental field.

Data collection of sucking insect complex

Whitefly, thrips, aphids and jassids population dynamics were recorded on transgenic cotton varieties as compared with non-transgenic varieties. Moreover, variety with higher infestation was known to be under higher insect preference. Data was recorded after every 7 days interval or 4 times in a month. For recording infestation, 9 plants from each treatment (variety) or 3 plants from each replication of single treatment were randomly selected. From each plant lower, middle and upper leaf was selected and population on each leaf was counted.

Data analysis

Population means of sucking insect complex was calculated and significance level was observed with LSD at 5% interval using two way ANOVA with replication.

3. Results

From Fig. 1, mean population of whitefly was more on FH-Lalazar as compared to the non-Bt variety. No significant difference was observed between these varieties (*df*=9, *p*=0.66). Population of whitefly was observed less on FH-142 as compared to Non-Bt variety. No significant difference was observed (*df*=8, *p*=0.56). Mean population of whitefly on FH-118 was more as compared to non-Bt. No significant difference was observed (*df*=9, *p*=0.77).

Results show that (Fig. 2) mean population of thrips was less on Bt variety FH-LALAZAR as compared to the Non-bt cotton variety. But no significant difference was observed between these two variety (*df*=6, *p*=0.36). Similarly thrips population was less on Bt variety FH-142 as compared to the non-bt variety. No significant difference was observed (*df*=6, p=0.42). But the mean population of thrips on Bt variety FH-118 was more as compared to the Non-Bt variety. No significance difference was observed (*df*=6, *p*=0.46).

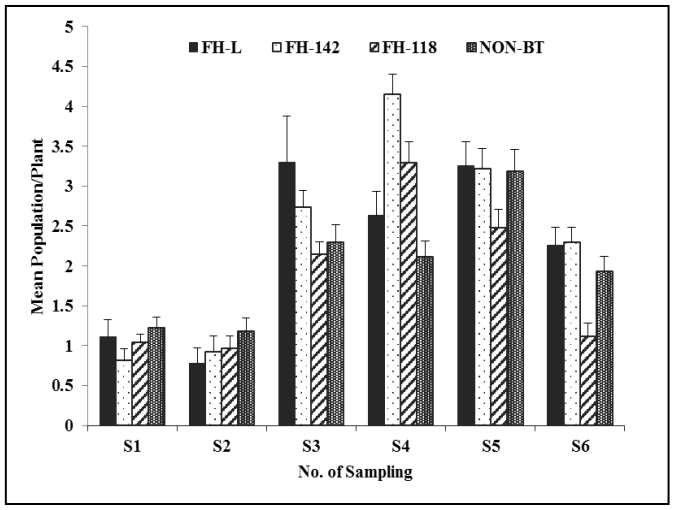

Fig 1: Population dynamics of white flies on Bt and non-Bt cotton varieties in Pakistan

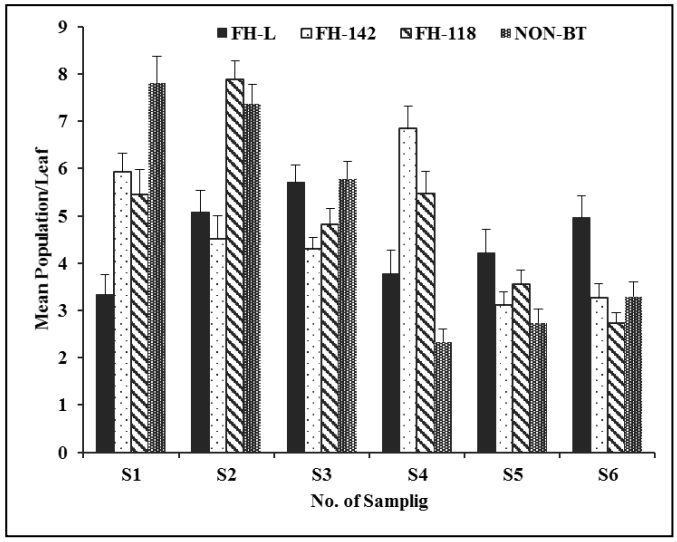

Fig 2: Population dynamics of thrips on Bt and non-Bt cotton varieties in Pakistan

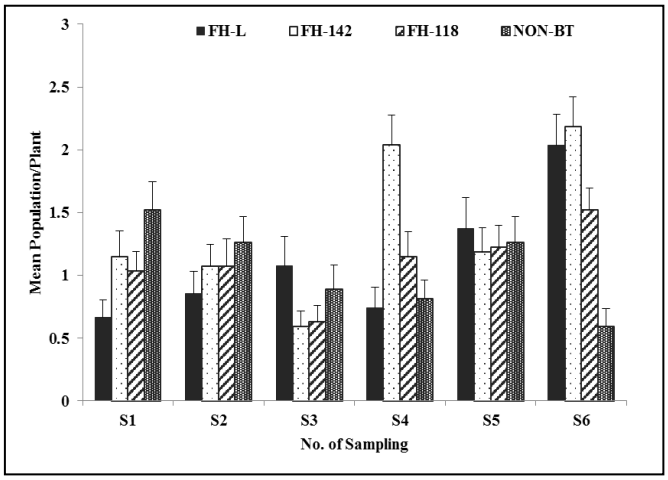

Fig 3: Population dynamics of jassids on Bt and non-Bt cotton varieties in Pakistan

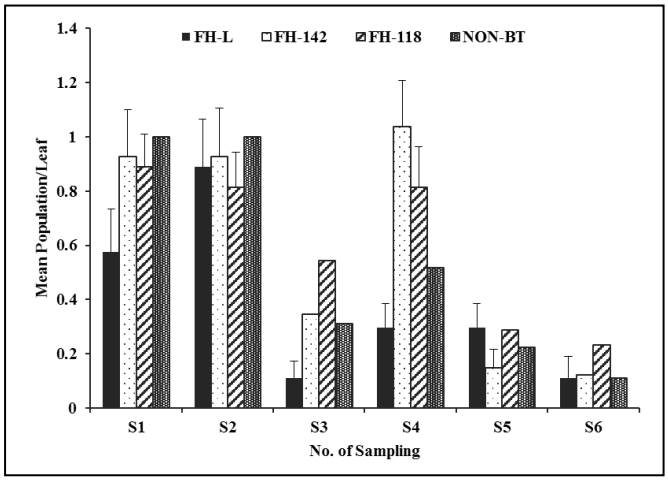

Fig 4: Population dynamics of aphids on Bt and non-Bt cotton varieties in Pakistan

From Fig. 3, it is more evident that, FH-Lalazar was more attractive to the jassid population as compared to the non-Bt variety. No significant difference was observed (*df*=9, *p*=0.79). In similarity to FH-Lalazar, mean population of jassid was more on FH-142 as compared to the non-bt variety. No significant difference was observed as (*df*=8, *p*=0.30). Jassid population was maximum on FH-118 as compared to the non-bt variety. No significant difference was observed (*df*=10, *p*=0.79).

From Fig. 4, mean population of aphids on FH-Lalazar Bt variety was less as compared to the non-Bt variety. No significant difference was observed between these two varieties (*df*=9, *p*=0.48). But FH-142 attracts the more population of aphid in comparison with non-bt variety. Where there were slightly more population of aphid observed during sampling. But no significant difference was observed (*df*=10, *p*=0.81). Similarly FH-118 was more attractive to aphid population as compared to Non-transgenic variety. No significant difference was observed as (*df*=9, *p*=0.73).

Overall results comparison between Bt and non-Bt cotton shows that Bt cotton has no impacts on the sucking insect pest. Bt cotton varieties also attract some extent more population in comparison with the non-Bt cotton varieties.

4. Discussion

Field experiment result shows that population of sucking insect pest on Bt cotton varieties and non-Bt cotton varieties was almost similar. Transgenic cotton varieties have no effect on the performance and density of sucking insect pests thrips, whitefly and jassid. Field experiments also showed that transgenic cotton varieties have effective against the lepidopteron pest but not posing the harmful effects on sucking insect pests.

Our result was in agreement with reports who reported that Bt rice has no impact on thrips population in field condition, it was also reported that transgenic rice varieties have no considerable impact in the suppression of thrips different species population [27]. Some shows more attraction for the thrips population. Our results were in the similar to the above studies. [28] reported that Transgenic Bt cotton varieties have no significant effect on the population of different sucking insect pest. Almost similar population was recorded on Bt and non-Bt cotton varieties. Our results were similar to the above studies. Our results were in agreement to the [29] who worked on impact of Bt cotton variety to the sucking insect pest. Results show that transgenic variety has not considerable effect on the population dynamics of the sucking insect pest. Our results were in agreement with [30] who reported that Bt eggplant has no significant impacts on the community and population dynamics of non-target organism including *Bemacia tabaci* and *Amrasca bigutulla*. Similarly non-Bt eggplant has no effect on these pests. However seasonal significant difference was observed between the non-target arthropods.

According to [31] there was no significant difference between transgenic and non-transgenic cotton on population of aphid, jassid, whitefly and thrips and for control of these pests suitable pesticides are required on transgenic cotton and these results are in agreement with our result which shows the same trends. According to [32] whitefly population was more on transgenic cotton as compared to non-transgenic cotton while our results are not similar due to difference of transgenic cotton varieties. The current and earlier studies show that Bt cotton has no impact on non-target insect pests population and regular integrated pest management practices are required stated by [28, 29].

[33] indicated that whitefly and thrips population was maximum on transgenic cotton varieties as compared to non-transgenic cotton varieties and this is due to less feeding by chewing insects and less whitefly liability [34] and these results are not similar with our current study because due to difference of locality and different cotton cultivars.

5. Conclusions

As conclusion it can be asserted that white flie, thrips, jassids, aphids being more destructive sucking pest complex can be less on Bt cotton varieties as compared to control. So in future Bt cotton combined with two sprays will also be helpful in reducing the pest population under ETL level.

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