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Ecological impact assessment of transgenic cotton against *Bemisia tabaci* under field conditions

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Abstract
Transgenic cotton was found successful in terms of controlling chewing pests but it can also harm non-target sucking pests including white flies. White flies being most important sucking pest of transgenic cotton and its incidence occurred more due to less sprays and resistance development occurrence in transgenic cotton in current situation. White flies for risk assessment studies are required to be tested in three tiers. These tiers are to test them from laboratory to semi-field till last stage of field studies. In current studies, we observed ecological risk assessment of transgenic cotton against white flies by observing their population dynamics in transgenic cotton as compared to non-transgenic cotton under field conditions. White flies were sampled using random sampling method with three leaves sampled from cotton plant i.e upper leaf, middle leaf and lower leaf in transgenic cotton as compared to non-transgenic cotton. Observations were recorded on weekly basis. Results showed that white flies occurrence was more in transgenic cotton as compared to non-transgenic cotton. These results reveal that some morphological, physiological, biochemical processes might affect white flies incidence in transgenic cotton. However, a more vast study should be carried out to observe white flies risk assessment at molecular level.

Keywords: whitefly, risk assessment, population dynamics, BT cotton

Introduction
Pakistan is an agricultural country. They play an important role in the gross domestic production (GDP) of about 22 % of agriculture sector. *Gossypium hirsutum* L has a key role in the economy. Cotton is a top listed cash crop of Pakistan, which also a earning a considerable foreign exchange from field to factories deliver bread and butter to the millions of peoples (Salman *et al*., 2011) [27]. However through its growing period of time. Bread and butter respectively abut 7 and 10 percent to agricultural value added and GDP of Pakistan (Pakistan Economic Survey, 2012-13) [23]. Cotton crop through its growing season is vulnerable to be attacked of sucking insects in field cause the reduction in yield quantity and quality of cotton crop (Arshad *et al*., 2001) [8].

Climatic condition of indo-Pak- region, American cotton, *G. hirsutum* (L.), is most favourable to the attack of sucking insects as compared to desi cotton *Gossypium arborium* (Nath *et al*., 2000) [22]. In sucking insects of cotton, white fly, aphid, jassid and thrips are important and damaging pest of cotton (Arif *et al*., 2006; Ali and Aheer, 2007; Salman *et al*., 2011) [7, 27, 2]. These sucking pest cause gradual retardation in plant vigor and destroy the cotton lint quality and quantity (Amin *et al*., 2008; Shah, 2014) [4, 28]. White fly consider as a most important pest of cotton (Ali *et al*., 1993; Aheer *et al*., 1999) [1]. White fly not only damage the host plant but also cause the spread of disease cotton leaf curl virus among plants (Gupta *et al*., 1997; Inee-Gogoi *et al*., 2000) [14]. Sucking insects cause the severe damage and cause the reduction in yield (Arif *et al*., 2006; Khan *et al*., 2008) [7, 21].

Over 100 year ago Cotton white fly was described as a pest of tobacco in Greece (Anonymous, 1989) [6]. Then white fly become the one of the most important sucking pest of cotton. White fly ha over 500plant species from Asia, Africa, Europe, Russia, and from the Iceland confirm that, white fly are polyphagous in nature (Anonymous, 1986; Greathead, 1986) [5]. 164 species of White fly has been reported from cotton growing areas of central Punjab (Attique *et al*., 2003) [9]. In 16 out of 27 white fly species are cotton growing countries, white consider as a major sucking and important pest of white fly from mid to late cotton growing season (Ann., 1989). Due to white fly attack, American cotton varities are totally failed during 1919 and 1926 and partially failed in 1921, 1923 and 1927 (Hussain & Trehan, 1933) [17]. Due to Heavy infestation of white fly reduce plant vigor and plant growth; also cause uneven ripening of bolls. White flies due to direct feeding cause physiological disorder. Nymph Producing sugary material on which Sooty mold grows on leaf, as a result reducing the photosynthetic process, As a result stunting plant growth. White fly causes then more than 100 plant viruses, which causes different diseases (Jones, 2003, Atwal and Dhaliwal, 2007) [20, 10].

White fly population is different in different season of the year. Atmospheric temperature rain fall, humidity effect the white fly population (Horowitz *et al*., 1984; Horowitz, 1986) [15, 16]. Host plant and different natural enemies such as predator and parasitoid control the population of insect in field. The population of natural enemies and insects depend on environmental factor (Rafiq *et al*., 2008) [25]. White fly population can develop rapidly in warm condition. When natural enemies population decreased and weather is favorable then white fly population rapidly increases. Due to heavy rain population of adult white flies decrease. Morphological

character of a plant cans also decrease the white fly population.

Materials and Methods

Experimental Design

Study was carried out at Entomological Research Area, Department of Entomology, and University of Agriculture Faisalabad from May to December 2017 by using the Completely Randomized design (CRD) consisting of four varieties having three replications. The climatic condition of Faisalabad very hot summer. The average rain fall less than 350 mm. The following four cotton varieties are growing FH-142, FH-942, Lala Zar and Control.

Land Preparation and Sowing

Land can prepare with the help of 2-3 ploughing. Plot size was kept as 100*134 sqft.Plot can be further sub divided into four sub plots. Row to rowdistance as 75 cm and plant to plant distance as 45 cm. The cotton was sow mid-May with the help of choopa method. All agronomic practices such as seed bed preparation, irrigation, hoeing and fertilization were carried out as recommended. Data regarding white fly was recorded on per leaf middle upper and lower side of leaf following the Mario method. Data was taken on Weekly basis, taking Twenty five leaf from top of first plant, twenty five leaf from the middle portion and twenty five leaf from Bottom portion per variety.

Statistical Analysis

Statistical analysis of transgenic cotton and of control was conducted using two way ANOVA.

Results

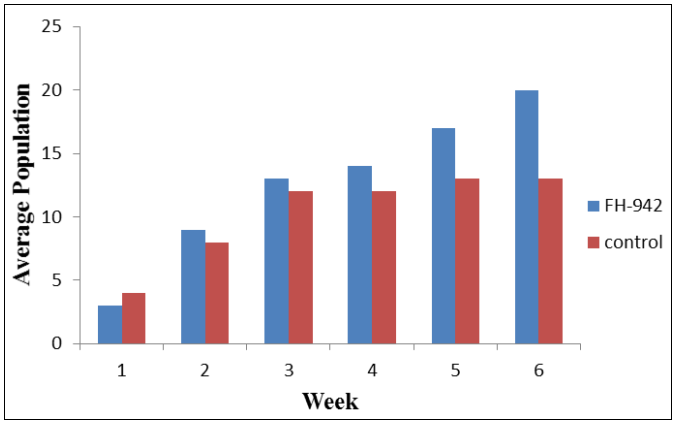

Fig 1: Average population of *Bemisia tabaci* per week basis in FH-942

In Transgenic cotton variety FH-942 Population of cotton white fly maximum was 20 per leaf at 6th weak, while minimum was 4 white fly per leaf at 1st weak. While in case of control variety maximum population of cotton white fly was 13 per leaf at 5th and 6th weak while minimum was 4 white fly per leaf at 1st weak. Overall results showed that there is significant difference in population dynamics of cotton white fly on transgenic cotton as compared to control. As (df) = 1, (F) = 4.152542, (P-value) = 0.097143

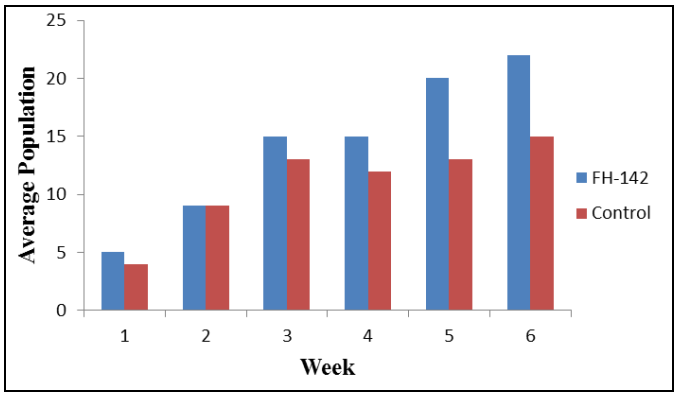

Fig 2: Average population of *Bemisia tabaci* per week basis in FH-142

In Transgenic cotton variety FH-142 Population of cotton white fly maximum was 22 per leaf at 6th weak, while minimum was 5 white fly per leaf at 1st weak. While in case of control variety maximum population of cotton white fly were 15 per leaf at 6th weak, while minimum was 4 white fly per leaf at 1st weak. Overall results showed that there is significant difference in population dynamics of cotton white fly on transgenic cotton as compared to control. As (df) = 1, (F) = 7.352941, (P-value) = 0.042194.

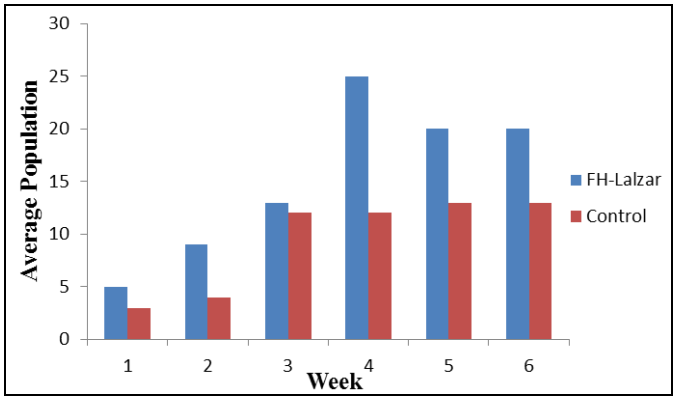

Fig 3: Average population of *Bemisia tabaci* per week basis in FH-Lalazar

In Transgenic cotton variety Lala-Zar Population of cotton white fly maximum was 20 per leaf at 5th and 6th weak, while minimum was 5 white fly per leaf at 1st weak. While in case of control variety maximum population of cotton white fly were 13 per leaf at 5th and6th weak, while minimum was 3 white fly per leaf at 1st weak. Overall results showed that there is significant difference in population dynamics of cotton white fly on transgenic cotton as compared to control. As (df) = 1, (F) = 10.99641, (P-value) = 0.021099

Discussion

Our results directed that frequency of whitefly was more on Bt genotypes than non-Bt as supported by Jeyakumar *et al.* (2008) [19] who noticed higher incidence of whitefly in Bt cotton. This was possibly due to limited or no feeding by bollworms and not because of higher whitefly susceptibility (Wilson *et al*., 1992) [29]. The most important abiotic factor is temperature which has overriding role in pest population

variation (Bale *et al*., 2002) [12]. The above held parameter traces egg laying, increases rate of feeding, metabolism, herbivory and development (Pedigo, 2002) [24].

In our findings relative humidity and seasonal rainfall also exerted their effect on the immature and adult stages of whitefly. The population abundance of all stages of *B. tabaci* was fluctuating during the following season. These results match with Luo *et al*. (1989) who studied the population dynamic of *B. tabaci* in cotton fields in Shanghai, China.

In this study we observed population dynamics *B. tabaci* on three varieties of transgenic cotton while in one variety of conventional cotton which showed the more attack of *B. tabaci* on transgenic cotton rather than conventional cotton. These conclusion was corresponds to the results of B. Atta *et al*. (2015) [11] *who* concluded that Maximum population of *B. tabaci* was recorded on transgenic varities of cotton as compare to non-transgenic.

According to Zhang Xiao-ming *et al.* 2013 [30] the occurrence of weeds were positively correlated with the population of the white fly. These results are aslo match with our conclusion that we also found high infestation of white fly in those cotton plants where weed were in abundance.

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