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Management of *Helicoverpa armigera* (Hübner) on Cotton by Host Plant Resistance and Sowing Time

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Abstract: Experiments were conducted to record the larval population and damage caused by *Helicoverpa armigera* on four cotton cultivars viz., NIAB-krishma (V_1), FH-900 (V_2), CIM-446 (V_3) and BH-118 (V_4), sown on four different dates, viz., 25-April (D_1), 10-May (D_2), 25-May (D_3) and 9-June (D_4). Mean population and damage caused by the larvae of first generation of *H. armigera* was non significant for all the cultivars. While, it was found significant, when recorded in relation to sowing dates. Interaction between plant genotype and sowing dates showed that early planting dates supported the high larval population and percent fruit injury by *H. armigera* on each of the cultivar.

Key words: Cotton, *Halicoverpa armigera*, resistance

INTRODUCTION

Cotton (*Gossypium hirsutum* L.) is the main cash crop of Pakistan, which contributes substantially to the national income. It accounts for 11.7% of value added in agriculture and about 2.9% of GDP[1]. Cotton produces the most important textile fiber in the world. In addition to providing raw material to the local textile industry, the lint cotton is a major export item. The oil extracted from cottonseed accounts for 55% of the total edible oil production in the country[2]. Cottonseed cake, an important by product, is a valuable source of feed for cattle and cotton sticks are used for fuel purposes. About 25% of country's population is directly or indirectly engaged in cotton production. It is the main source of employment for millions of people at farms, ginning factories, textile mills, edible oil and ghee industries[3]. Some ninety countries from around the globe produce cotton; USA., China and Pakistan provide over half of the world's cotton[4].

Pakistan is the third largest producer of cotton lint after China and USA.[4]. Pakistan has made progress by increasing yield up to 641 kg ha^{-1} in 1999-2000[3]. Still the yield per hectare is less than other cotton producing countries. Cotton was cultivated on an area of 2.79 million ha with a lint production of 10.2 million bales during 2002-2003[1].

One of the main reasons for lower yield of cotton is insect pests, causing 30-40% yield loss[5]. The importance of cotton as a cash crop in Pakistan is impaired by the problems of low yields. Insect pest attack is the major problem, affecting yield[6]. One of the main reasons for low yield in our country is unawareness of a majority of our small farmers from modern farming practices and pest management techniques[7]. The unawareness of farmers is also due to poor extension services[6].

Cotton insect pest complex is divided into two categories; sucking insect pests and chewing insect pests or bollworms. Important sucking insect pests are *Bemisia tabaci* (Gennadius) (Homoptera:Aleyrodidae), *Amrasca biguttula biguttula* (Ishida) (Homoptera:Cicadellidae) and *Thrips tabaci* Lindeman (Thysonaptera:Thripidae). The Bollworm complex includes *Pectinophora gossypiella* (Saunders) (Lepidoptera:Gelechiidae), *Helicoverpa armigera* (Hübner) (Lepidoptera:Noctuidae), *Earias vitella* (Fabricius) (Lepidoptera:Arctidae) and *E. insulana* (Boisduval) (Lepidoptera:Arctidae)[8].

The bollworms feed on fruiting as well as non fruiting parts of cotton plant resulting in considerable losses both in quality as well as in quantity that caused 30-40% reduction in yield of seed cotton[9]. Bollworms, importantly *P. gossypiella*, *E. vitella*, *E. insulana* and *H. armigera* cause 30-40% loss in yield[9]. *H. armigera* is the most important pest of cotton[10].

H. armigera is a major pest on a wide range of crops in Europe, Africa, Asia and Australia[11]. *Helicoverpa* management relies predominantly on use of insecticides.

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Some progress had been made towards biologically oriented pest management approach, including use of resistant varieties, parasites, predators, pathogens and selective insecticides. Using singly, none of these components is very effective[12].

Helicoverpa armigera is a key pest of agriculture and horticulture in Pakistan[13]. Key factors contributing to the pest status of *H. armigera* are its polyphagy, mobility, diapause and high fecundity. Application of pesticides is an important part in pest management for cotton. However, in response to environmental and public safety concerns, alternative pest management strategies viz., date of sowing, host plant resistance and conservation of bio-control agents are being focused.

In Pakistan, no remarkable work has been reported on the management of *H. armigera* with special reference of new genotypes of cotton and sowing date. Thus the proposed study was carried out to find out the effect of sowing date and plant genotype on the management of population of *H. armigera* (H.) in cotton.

MATERIALS AND METHODS

Four cotton cultivars, NIAB-krishma (V_1), FH-900 (V_2), CIM-446 (V_3) and BH-118 (V_4) were sown on four sowing dates, viz., 25-April (D_1), 10-May (D_2), 25-May (D_3) and 9-June (D_4) in 2003. The experiments were carried out on Khokhar farm, Shujah Abad Road, Multan.

Sixteen treatment combinations, viz., D_1V_1, D_1V_2, D_1V_3, D_1V_4, D_2V_1, D_2V_2, D_2V_3, D_2V_4, D_3V_1, D_3V_2, D_3V_3, D_3V_4, D_4V_1, D_4V_2, D_4V_3 and D_4V_4 were formed. The experiments were laid out, in three replications, in a Randomized Complete Block arrangement. An area of 66x90 m^2 was divided into 48 sub plots of size 8x14 m^2, each. There was a water channel running along south side of the experimental area. Sub channels for water supply were made in center of each block, to irrigate each treatment plot independently.

The cotton seeds were delinted by H_2SO_4. The crop was planted on raised beds by dibbling manually. Planting geometry for each treatment was followed as prescribed by the relative research organization. Other crop management practices were followed as per recommendations of the Department of Agriculture Extension, Government of Punjab, Pakistan.

Population of *H. armigera* larvae on each treatment was observed from 20 plants selected randomly. Upper half of each plant was thoroughly examined for the presence of larvae. The data was tabulated as number of larvae per plant. Damage of the pest to cotton was recorded in terms of injury to cotton fruits. The data for damage was presented as percentage of total fruiting bodies. The data regarding the mean population levels of the pest and the fruit injury were analyzed statistically, for the significance of main effects of sowing time as well as cotton cultivars and for interaction between the two.

RESULTS AND DISCUSSION

Host plant resistance

Population of larvae: The mean numbers of larvae per plant on the various cultivars viz., V_1, V_2, V_3, V_4, were 0.1, 0.08, 0.1 and 0.1167, respectively. Analysis of variance for the mean at ($F = 0.15$, $p = 0.93$) and individual confidence of intervals 95% for means based on pooled standard deviation 0.1074 revealed the non-significant differences among the means. The plot for main effects (Fig. 1) of cotton genotype showed no differences among the mean values.

Percent damage: The means of percent fruit injury caused by first generation of *H. armigera* on cotton, observed on 7-July viz., 9.566, 7.31, 8.49 and 7.19 for V_1, V_2, V_3 and V_4 in a respective order, were found non-significant ($F = 0.29$, $p = 0.832$) for the effects of cotton genotype. All the treatments regarding cotton varieties were statistically similar (CI 95%, Pooled St. Dev. 7.419). The plot for main effects (Fig. 2) showed the mean numbers in a graphical manner.

The four cultivars, such as, NIAB-krishma, FH-900, CIM-446 and BH-118 were found to be statistically non-significant for the mean number of larvae per plant as well as for the mean percent damage of fruiting bodies, at early flowering stage of cotton. A numerical comparison However, showed less population (0.08 larvae/plant) on FH-900, which agrees with the findings of Rehman *et al.*[14], who stated that the infestation of *H. armigera* was high on VH-53 followed with that on NIAB-krishma and FH-900. Similarly,

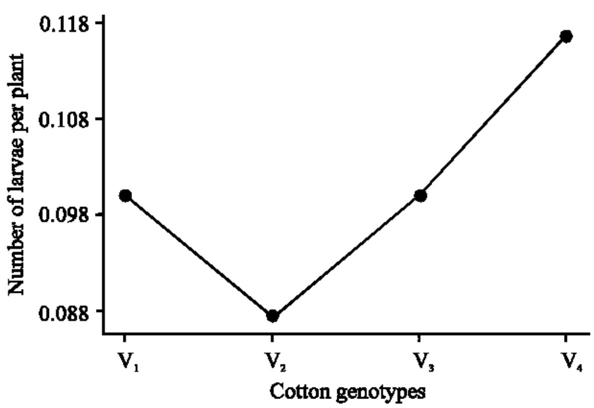

Fig. 1: Plot for main effects of plant genotype (V), on population of first generation of *Helicoverpa armigera* (Hubner) on cotton

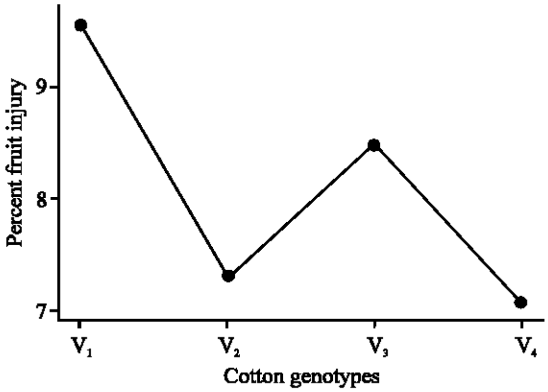

Fig. 2: Plot for main effects of plant genotype (V), on mean percent fruit injury caused by *Helicoverp armigera* (Hubner) on cotton

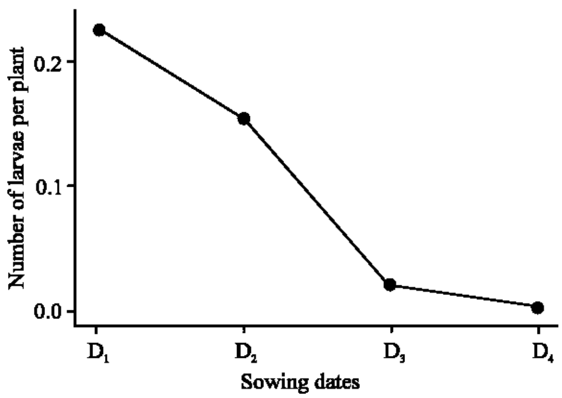

Fig. 3: Plot for main effects of sowing time (D) on population of first generation of *Helicoverpa armigera* (Hubner) on cotton

Ahmed *et al.*[15] inferred from the results of their studies that FH-901 was more susceptible to bollworm complex and that FH-900, emerged as, however, comparatively resistant variety to the bollworms.

A numerical comparison of the population of larvae per plant with the resultant injury to the respective cultivars showed that the highest population of larvae (0.12 larvae/plant) was observed on V_4 (BH-118), where fruit injury (7.19%) found was the lowest. The population of larvae on V_1 (NIAB-krishma) and on V_3 (CIM-446), was at same level (0.1 larvae per plant), whereas the injury observed was highest in V_1, i.e., 9.56%. The highest results can be attributed to the bearing behavior of the cultivars and the spatial distribution of fruiting bodies on the plant. V_4 started bearing late, whereas, V_1 was early bearing cultivar. The cotton plants which had more fruiting bodies, suffered more injury.

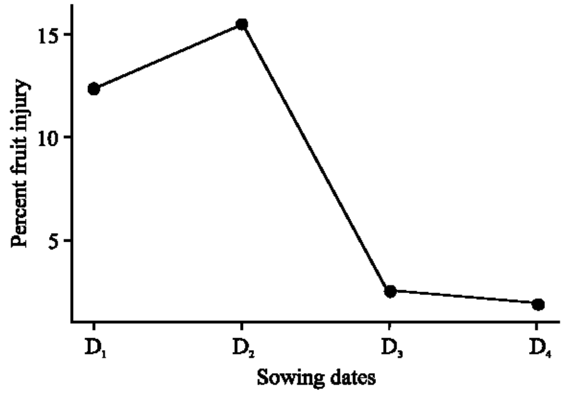

Fig. 4: Plot for main effects of sowing time (D) on mean percent fruit injury caused by *Helicoverpa armigera* (Hubner) on cotton

Alteration of sowing time

Population of larvae: The mean populations of larvae in relation to sowing dates D_1, D_2, D_3 and D_4 were 0.23, 0.15, 0.021 and 0.0042, respectively. These mean values were plotted in Fig. 3, showing main effects of the treatments. The highest number of larvae (0.225 larvae/plant) was recorded in D_1, followed by D_2 (0.15 larvae/plant), then the lowest D_3 (0.021 larvae/plant)and D_4 (0.0042 larvae per plant). The differences among the treatment means were significant at $F=57.34$ and $p = 0.000$. Analysis of variance showed that D_4 and D_3 were statistically similar and received the lowest population (0.0042 and 0.021, respectively) of the pest, whereas D_2 (0.15417) and D_1 (0.225) were relatively high and significantly different at CI 95% and pooled SD 0.0487.

Percent damage: The means of percent fruit injury recorded in the various sowing date in treatments viz., D_1, D_2, D_3 and D_4, were 12.40, 15.52, 2.57 and 1.94, respectively. Plots for main effects of the sowing times (Fig. 4) represented the highest mean level of percent fruit injury (15.52%) achieved in D_2 and the lowest were D_3 (2.47%) and D_4 (1.94). Analysis of variance for the means at $F= 34.65$ and $p = 0.00$, revealed the significant difference among the treatment effects. Individual 95% confidence of intervals for the means based on pooled St. Dev. 4.171, stated that with the highest percent fruit injury (12.4 and 2.57%), D_1 and D_2 were statistically similar, while the percent damages recorded in D_3 and D_4, were low and non-significant. It was noted that the percent injury due to the pest was high in the cotton crops sown on 25-April and 10-May.

The results were in accordance with the findings of Zhen Wang *et al.*[16] who found significant effects of

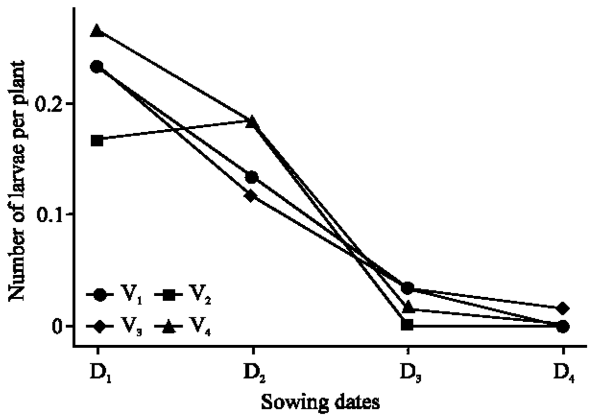

Fig. 5: Plot for interaction between plant genotypes and the sowing time for mean population of 1st generation of *Helicoverpa armigera* on cotton

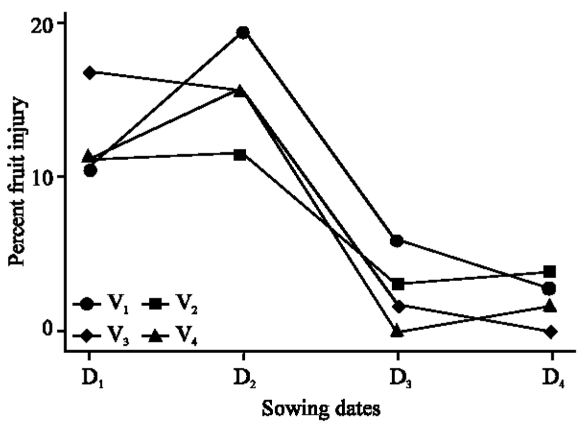

Fig. 6: Plot for interaction between plant genotypes and the sowing time for mean percent fruit injury caused by the 1st generation of *Helicoverpa armigera* on cotton

sowing dates on the infestation of *H. armigera,* at early crop stage. The higher infestation and injury to the crops, sown early, may be attributed to the higher number of total fruiting bodies per plant, which made cotton plants more attractive. The well-developed plant canopy provided more shelter to the pest from predation and desiccation. The availability of good quality food in abundance on an early sown plant, gave a better support to the pest population that may had reduced the natural mortality of the young larvae.

Interaction between plant genotype and planting time

Population of larvae: Interaction between plant genotype and the planting date were studied. The level of interaction viz., D_1V_1, D_1V_2, D_1V_3, D_1V_4, D_2V_1, D_2V_2, D_2V_3, D_2V_4, D_3V_1, D_3V_2, D_3V_3, D_3V_4, D_4V_1, D_4V_2, D_4V_3 and D_4V_4 gave rise the mean numbers of the pest per plant presented graphically (Fig. 5). It showed that all cultivars at some earlier planting date were supporting the high population. Pest population per plant on the D_3 and D_4 remained the lowest having 2.57 and 1.94 larvae per plant. The mean pest population for the earlier planting dates (D_1 and D_2) was found varying from cultivar to cultivar, that tended to be at same level for the later sowing dates 25-May and 9-June. Analysis of variance for the means, revealed the interaction between plant genotype and planting time was significant with F = 12.44 at p = 0.00. It further stated that individual 95% confidence intervals based on pooled St. Dev. 0.048, the treatment combinations with D_3 and D_4 for all cultivars under test were non-significantly different from each other. The treatment combination D_1V_4 received the highest population (0.25), followed by D_1V_1 and D_1V_3 having mean population 0.23 larvae per plant.

Percent damage: Interaction between plant genotype and the planting date were studied. The level of interaction viz., D_1V_1, D_1V_2, D_1V_3, D_1V_4, D_2V_1, D_2V_2, D_2V_3, D_2V_4, D_3V_1, D_3V_2, D_3V_3, D_3V_4, D_4V_1, D_4V_2, D_4V_3 and D_4V_4 gave rise the mean percent injury caused by the pest, which presented graphically (Fig. 6). It showed that the level of damage to the different cultivars was found varying largely on 2nd sowing date D_2. All the cultivars, on D_3 and D_4 received minimum percent fruit loss. Analysis of variance for the means revealed that the interaction between plant genotypes and planting times was significant with F = 7.92 at p = 0.000. It further stated that individual 95% confidence intervals based on pooled St. Dev. 4.048, the treatment combinations with D_3 and D_4 for all cultivars under test were non-significantly different from each other. The treatment combination D_2V_1 received the highest level of the percent fruit injury (19.35%), followed by D_1V_3, D_2V_3 and D_2V_4. Present results were in conformity to the results of Rasool *et al.*[17], who found a significant interaction of sowing times and the genotypes, regarding pest infestation.

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