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Population Dynamics of Whitefly and Thrips under Different Row Spacing and Plant Density Conditions in a Cotton Field of Punjab, Pakistan

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Authors' Contribution
AMA, NI and JI designed the experiment. MS performed the experiment. AMA, NI, JI, KA and WJ analyzed the data. AMA, NI, HAAK and TK wrote the manuscript

Key words
***Bt* cotton, Pest infestation, Plant density, Pest management, Population dynamics**

ABSTRACT

In the current study, populations of whitefly (*Bemisia tabaci*) and thrips (*Thrips tabaci*) were observed in 2016 under three different conditions: 75 cm row to row spacing without mapiquate chloride (growth inhibitor), 30 cm row to row spacing without mapiquate chloride, and 30 cm row to row spacing with mapiquate chloride, using two cotton varieties (BS-15 and BS-70). The results indicated that the population of both sucking pests was more on variety BS-70 as compared to BS-15 cotton variety. Thrips and whitefly populations varied significantly in three row spacings ($P<0.01$) with the maximum population recorded in line spacing of 30 cm without mapiquate chloride (9.12-11.15 thrips/leaf and 9.18-7.83 whitefly/leaf), followed by line spacing of 75 cm without mapiquate chloride (8.65-9.12 thrips/leaf and 5.97-5.06 whitefly/leaf) and 30 cm with mapiquate chloride (4.57-5.41 thrips/leaf and 2.64-2.88 whitefly/leaf). The peak population was observed on June 5, 2016 for thrips (15.46-27.53 nymphs and adults/leaf) and August 29, 2016 for whitefly (11.40-20.80 nymph and adults/leaf).

INTRODUCTION

Agriculture plays an important role in the economy of Pakistan. The majority of the people in Pakistan are linked to agriculture and relevant business directly or indirectly. Among the major crops of Pakistan, cotton (*Gossypium hirsutum* L.) contributes 10% in national GDP, whereas 5.2% in agriculture value addition, and has great importance in the textile industry as a raw material (Economic Survey of Pakistan, 2016-17).

Cotton is an important crop of Pakistan but its yield has been decreased due to a number of factors. Among various factors of the reduction in the cotton yield, the attack of insect pests is the most prominent with significant losses every year (Arshad and Suhail, 2010; Makwana *et al*., 2018). Among insect pests, whiteflies (*Bemisia tabaci* Genn.) and thrips (*Thrips tabaci* Lind.) have been assumed serious sucking insect pests. To overcome the problems caused by such insect pests, the use of synthetic insecticides has become one of the major insect control tactics (Anonymous, 2001). The unjudicial use of chemicals has not only caused the resistance to insect pests, but also the outbreak of many secondary pests and pollution to the environment (Arif *et al*., 2006).

Cotton plants contain a narrow range of ecological flexibility and variety selection of crop in an agro-climatic region has main importance due to difference in behaviors of fruit branches, production of bolls and weight of seed cotton per boll (Qayyum *et al*., 1992; Hussain *et al*., 2000; Khan *et al*., 2007). Commonly farmers adopt traditional

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sowing. The traditional plant to plant distance also results in higher expenditures of crop production at high prices. For increasing the plant population and reducing the yield losses, cotton growers are moving towards ultra-narrow row spacing (UNR) (Trehune, 1998; Hussain *et al*., 2000; Nichols *et al*., 2003, 2004; Vories and Glover, 2006).

In the UNR planting system, the cotton plants are more in number with few numbers of nodes concentrating the production of bolls in the upper positions. Reduction in branches of individual plants may results in the decline of crop production on one end, but this decrease can be compensated by additional plants per unit area on the other end (Nawaz *et al*., 2016). However, a dense plant population will favor insect multiplication and enhance the pest population and make insect scouting more difficult.

Keeping in view the above scenario, a reliable pest management strategy should be developed to cope with pests and increasing environmental problem by maintaining proper line spacing and plant density, and also knowing the correlation between insect pests population and weather factors which not only affect the crop growth (Nawaz *et al*., 2016; Rehmani *et al*., 2016) but also play key role in the development of insect pest population (Isler and Ozgur, 1992; Arif *et al*., 2006). The current study has been carried out to know an overall population situation of two cotton pests i.e. whiteflies and thrips in different plant spacing. The aim of the study was to find out the best cotton sowing practice that discourages sucking pests.

MATERIALS AND METHODS

The current study was carried out at the research farm of Ghazi University, Dera Ghazi Khan (30.0489° N, 70.6455° E). Two cotton varieties were used for experimentation: BS-70 and BS-15. Land preparation was done during the month of May using standard protocols and cotton varieties were sown in two row spacings: Ultra Narrow Row Spacing (30 cm) and Conventional Row Spacing (75 cm).

Population dynamics of whitefly and thrips

The population dynamics of both pests were studied under three different conditions: 75 cm row to row spacing without mapiquate chloride (growth inhibitor), 30 cm row to row spacing without mapiquate chloride, and 30 cm row to row spacing with mapiquate chloride. The experiment was laid out in split-plot design with each treatment having three replications. The plot size for each treatment was 300 cm × 600 cm. In UNR spacing, application of growth inhibitor was repeated after every 20 days interval. Data on sucking pests were recorded at weekly intervals starting from May, 2016. The numbers of insects were counted from upper leaf of the 1st plant, middle leaf of the 2nd plant, lower leaf the 3rd plant and so on with a total of nine plants from each replication.

Data of environmental variables such as temperature and relative humidity were also recorded with the help of a digital thermo-hygrometer on the day of population sampling.

Data analyses

At the end of experiment, the data of the weekly population in each treatment were analyzed by the analysis of variance (ANOVA) and means were compared by LSD test using Statistix 8.1v. Correlation analyses were also done between populations of whitefly and thrips and environmental variables with the help of Statistix 8.1v.

RESULTS

Effect of line spacing on thrips population

Thrips population differed significantly between two varieties ($F_{1,14}$ = 8.41; P=0.01) with maximum population recorded on variety BS-70 (8.41 thrips/leaf) followed by variety BS-15 (6.97 thrips/ leaf). The population of thrips was also significantly different among three line spacing ($F_{2,28}$ = 23.63; $P < 0.01$) on variety BS-70. The population was maximum in line space of 30 cm without mapiquate chloride (11.15 A), followed by line space of 75 cm (8.65 B) and line of 30 cm treated with mapiquate chloride (5.41 C). Maximum thrips population was recorded on June 5, 2016 in all row spaces i.e. 21.26 adults and nymph/leaf, 27.06 adults and nymph/leaf and 16.06 adults and nymph/ leaf in line space of 75 cm, line space of 30 cm without mapiquate chloride and line space of 30 cm treated with mapiquate chloride respectively (Fig. 1A).

Almost similar pattern of thrips population was observed on variety BS-15. The numbers of thrips were significantly different in three row spacings ($F_{2,28}$ = 11.68; $P < 0.01$). The population was maximum in line space of 30 cm without mapiquate chloride (9.12 A), followed by line space of 75 cm (7.21 A) and line of 30 cm treated with mapiquate chloride (4.57 B). First peak in thrips population was recorded on June 5, 2016 in three row spaces ranging from 15.46-27.53 nymphs/leaf. The second peak (24.46 nymphs/leaf) was recorded on June 26, 2016 in 30 cm line space where mapiquate chloride was not sprayed from canopy control (Fig. 1B).

Correlation analysis showed that the mean numbers of thrips per leaf had significant and negative association with maximum and minimum relative humidity in both varieties (Table I).

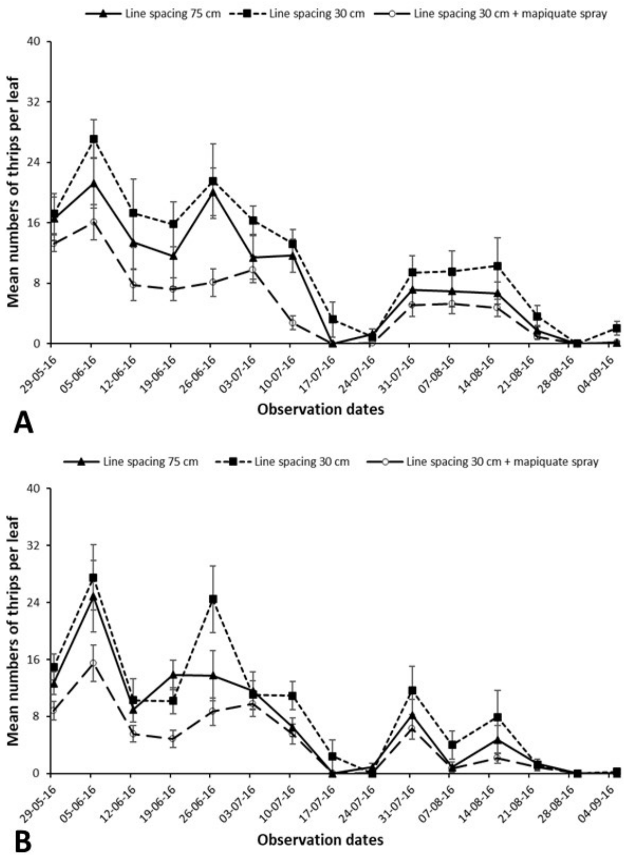

Fig. 1. Mean population of thrips per leaf in three types of row spacing on variety BS-70 (A) and BS-15 (B).

Effect of line spacing on whitefly population

The two varieties did not differ significantly in term of whitefly infestation ($F_{1,14} = 0.41$; $P = 0.53$). The cotton variety BS-70 had a comparatively higher infestation of whitefly (5.93 whiteflies/leaf) as compared to BS-15 variety (5.26 whitefly/leaf). There was significant difference in various line spacing in term of population of whiteflies ($F_{2,28} = 13.18$; $P < 0.01$) on variety BS-70. Maximum population was recorded in line space of 30 cm without mapiquate chloride (9.18 A), followed by line space of 75 cm (5.97 B) and line of 30 cm treated with mapiquate chloride (2.64 C). Ups and downs were observed in trend of white fly population in all line spaces. After August 7, 2016, whitefly population rose rapidly, until its infestation reached at peak at August 22, 2016 in all line spaces which were 23.4 adults and nymph/leaf, 31.2 adults and nymph/leaf and 6.4 adults and nymph/leaf in line spaces of 75 cm, line space of 30 cm without mapiquate chloride and line space of 30 cm treated with mapiquate chloride respectively. After August 28, 2016, decreasing trend of white fly infestation was observed (Fig. 2A).

Similarly, population of whiteflies differed significantly in three line spaces ($F_{2,28} = 22.36$; $P < 0.01$) on variety BS-15 with the highest population recorded in line space of 30 cm without mapiquate chloride (7.83 A), followed by line space of 75 cm (5.06 B) and line of 30 cm treated with mapiquate chloride (2.88 C). Maximum infestation of whiteflies was observed on August 29, 2016 in all line spaces i.e. 14.53 adults and nymph/leaf, 20.80 adults and nymph/leaf and 11.40 adults and nymph/leaf in line space of 75 cm, 30 cm without mapiquate chloride and 30 cm treated with mapiquate chloride, respectively (Fig. 2B).

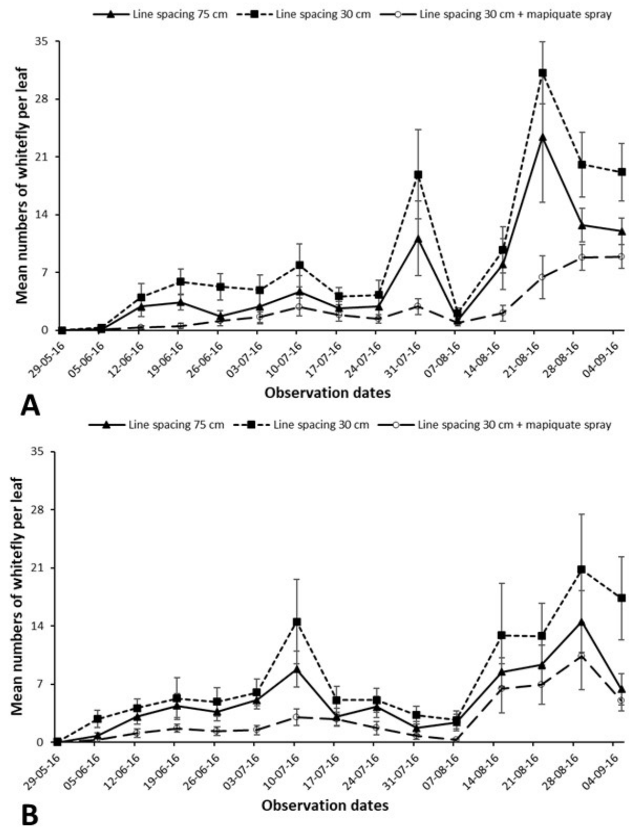

Fig. 2. Mean population of whitefly per leaf in three types of row spacing on variety BS-70 (A) and BS-15 (B).

Correlation analysis showed that mean numbers of thrips per leaf had a significant and negative association with maximum and minimum relative humidity in both varieties (Table I). However, in the case of whitefly, a negative association was observed between whitefly and maximum air temperature for BS-15. Whereas, a positive association between whitefly and minimum and maximum humidity were observed in most of the cases for BS-15 and BS-70 (Table II).

Table I. Correlation of thrips population with environmental factors during different months of 2016.

Variety	Treatment	Minimum air temperature	Maximum air temperature	Minimum relative humidity	Maximum relative humidity
BS-15	Line spacing 75 cm	R = -0.04 P = 0.88	R = 0.20 P = 0.46	R = -0.76 P < 0.01	R = -0.75 P < 0.01
	Line spacing 30 cm	R = 0.05 P = 0.85	R = 0.21 P = 0.44	R = -0.78 P < 0.01	R = -0.73 P < 0.01
	Line spacing 30 cm + mapiquate spray	R = -0.09 P = 0.73	R = 0.15 P = 0.58	R = -0.79 P < 0.01	R = -0.75 P < 0.01
BS-70	Line spacing 75 cm	R = 0.08 P = 0.76	R = 0.28 P = 0.30	R = -0.78 P < 0.01	R = -0.81 P < 0.01
	Line spacing 30 cm	R = 0.11 P = 0.68	R = 0.30 P = 0.26	R = -0.78 P < 0.01	R = -0.82 P < 0.01
	Line spacing 30 cm + mapiquate spray	R = -0.12 P = 0.66	R = 0.24 P = 0.74	R = -0.73 P < 0.01	R = -0.76 P < 0.01

Table II. Correlation of whitefly population with environmental factors during different months of 2016.

Variety	Treatment	Minimum air temperature	Maximum air temperature	Minimum relative humidity	Maximum relative humidity
BS-15	Line spacing 75 cm	R = -0.21 P = 0.45	R = -0.54 P = 0.03	R = 0.71 P < 0.01	R = 0.61 P = 0.01
	Line spacing 30 cm	R = -0.35 P = 0.19	R = -0.63 P = 0.01	R = -0.65 P < 0.01	R = 0.62 P = 0.01
	Line spacing 30 cm + mapiquate spray	R = -0.32 P = 0.23	R = -0.52 P = 0.04	R = -0.71 P < 0.01	R = 0.64 P = 0.01
BS-70	Line spacing 75 cm	R = -0.05 P = 0.84	R = -0.36 P = 0.16	R = 0.65 P < 0.01	R = 0.61 P = 0.01
	Line spacing 30 cm	R = -0.03 P = 0.88	R = -0.34 P = 0.18	R = 0.67 P < 0.01	R = 0.62 P = < 0.01
	Line spacing 30 cm + mapiquate spray	R = -0.17 P = 0.51	R = -0.43 P = 0.09	R = 0.72 P < 0.01	R = 0.68 P < 0.01

DISCUSSION

The current study was carried out to check the effect of plant density on the population dynamics of two sucking insect pests of cotton under the UNR spacing system in two genotypes viz., BS-70 and BS-15, by controlling the crop height by using PGRs. There was a significant difference in both pest populations in three different line spacing. The maximum population was observed in dense plant population where canopy was not controlled by mapiquate chloride application (conventional spacing) while less population was recorded in plants where mapiquate chloride was sprayed to control plant canopy and height (UNR). The population also differed on different dates and was significantly affected by environmental factors in both varieties.

Significant differences were found to exist among treatments regarding thrips population on cotton. The maximum population was observed in those plots where plant spacing was maintained as 30 cm without mapiquate chloride application and did not differ significantly from those plots where the plant spacing was maintained as 75 cm. The plots where plant spacing was maintained as 30 cm with mapiquate chloride application showed the lowest population of thrips. The highest peaks of whitefly and thrips population were observed on September 5, 2016 and June 26, 2016, respectively, which suggested that these months were the most favorable for both pests. The trend was totally different regarding thrips population i.e., second week of June favored the thrips population to develop. The results in the present study are in accordance with the study of Al-Faisal and Kardu (1986) who reported highest population of the pests at end of June or early July.

In June and July, the temperature is usually higher which favors the pests. In some other studies, Seif (1980), Isler and Ozgur (1992), Majeed *et al*. (1998) and Sohi *et al*. (1995) reported positive correlation between insects and environmental factors. However, current findings are not comparable with those of Enkegard (1993) and Wagner and Willers (1995) due to differences in their experimental procedures.

CONCLUSION

The current study revealed that ultra-narrow row spacing (30 cm) in which plant height is controlled using plant growth inhibitor discouraged the development of pests as compared to conventional row spacings.

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Conflict of interest

The authors have declare no conflict of interests regarding the publication of this article.

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