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Investigation of Dynamic Whitefly Population *Bemisia tabaci* (Gen.) in Very Narrow Cultivation in The Fields of Cotton Golestan Province of Iran

Darvish Mojeni, Taghi
Agricultural Research, Education and Extension Organization (AREEO), Department Research of Plant Protection Cotton Research Institute of Iran
***E-mail:** tmojeni@gmail.com

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ABSTRACT

This method of planting is developing in the United States and according to the obtained reports, it has saved water consumption, reduced the cost of weeding, increased production and maturity, and reduced the population of pests and damage to cotton. The advantages of this planting method include increasing maturity as well as crop yield. To investigate this issue in Golestan province, some important studies such as the effect of pix material, different fertilizers, pests and diseases and irrigation in planting very narrow row spacing were evaluated over two years .This experiment is to examine and compare the population of cotton whiteflies on 3 cluster cultivars and one control, using the method of narrow planting distance of 20 × 20 and 20 × 80 cm as a factorial design in the form of an RCBD with 3 replications in Hashemabad cotton research station in Gorgan during two years 2018- 2019 was evaluated. Statistics of different stages of cotton whitefly pest were recorded weekly in the tested treatments and recorded in special tables. Based on the studies, the results of the combined analysis of variance showed that the yield in the cultivars tested in the Sajedi cultivar with a distance of 80 cm with an average wash of 1696 gr in the plot and Golestan® cultivar 80 cm with 1622.9 gr in the plot with the highest yield and cultivar T2 with a distance of 20 cm, 847.2 gr had the lowest yield in the plot. Infestation rate of cluster cultivars tested in very narrow cultivation of whitefly population density on Golestan® cultivars with a distance of 80 cm, Sajedi with a distance of 20 cm with 65.50 and 57.75 whitefly in the leaves had the highest infestation, respectively, and on Sajedi cultivars with a distance of 80 cm with a density of 46.75 whitefly on the leaves had the least infestation.

INTRODUCTION

Compared to the more spaced row spacing system, there will be evident changes in the number of bolls per plant and the state of the canopy. In this system, the number of bolls per plant and plant height and length of branches decrease (Galanopoulous, *et al.*,1980). Reducing cotton production costs, especially through early maturity, reducing pesticide use by interrupting the critical cycle of pests, reducing irrigation water consumption are some of the benefits of dense planting and in different ways, including planting narrow and very narrow intervals, plating a clump. Also, with the advent of mechanized, early harvesting of cotton has become very important. Agronomic and environmental factors that have a great effect on the precociousness of the product, can plant density, Plant pest control, nitrogen

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fertilizer management and proper irrigation periods. More densities generally increase aging, but the management of such farms is very important. In this type of farming, due to increased competition, the loss of buds increases, which in each plant leads to a decrease in yields (Kucheki, 1985). In China, various UNR cropping systems are carried out on a large scale in more than 1 million hectares of cotton fields about 10 years are dedicated to this method of cultivation. One of the potential benefits of ultra-narrow cotton row systems is that they reduce production costs under certain conditions and make it possible to increase yields, especially in poor soils or short areas of the season (Bin Mohamad and Sappenfield, 1982). Cotton cultivation is expanding in very high densities under the name of Ultra Narrow Row in cotton-rich and developed countries. In the planting system, very narrow row spacing with spacing of rows between 20 and 40 cm is considered (Kirby *et al.*, 1990). The use of very narrow row spacing in cotton has become very important in developing countries with the aim of reducing production costs and making harvesting easier. Cotton cultivation in very narrow rows was first investigated and introduced in America .Interest in producing narrow-row cotton in Arizona led to the planting of about 7,000 acres of cotton in 1999. (Steve *et al.*, 2003) Cotton farmers are facing farm management problems in order to reduce production costs and increase profitability. An alternative method to balance the profit of cotton planting is narrow row spacing.

A very narrow row spacing system is agriculture where cotton is planted at a row spacing of 38 cm or less. In this case, the density of the field plants is 173,000 to 297,000 plants per hectare and the crop is harvested by a striper. Planting cotton in a very narrow row spacing requires careful attention to some management factors such as the use of plant growth regulators to control the size of the cotton plant, reducing wood chips and, as a result, fiber quality loss. Planting cotton in a very narrow row spacing is also effective on the density or population of its pests. High vegetative growth of cotton in the system of narrow row cultivation and shading can intensify the problems of pests and diseases and reduce the production efficiency and fiber quality and product yield, reduce the number of nodes and internodes, and increase the height of short and premature plants (Steve *et al.*, 2003) . Planting cotton in very narrow rows can be investigated from various aspects such as pix hormone consumption, irrigation, pests and diseases, cost comparison with the usual method of cotton cultivation, etc. (Keter., 1991)The rate of application of pix is very important in terms of determining the final size of the cotton plant organ and its performance. Its very high consumption or, on the contrary, its lower consumption can have a different effect on growth control. Many of the effects of PIX are obtained as a result of limiting the growth and enlargement of cells. By consuming pix, the leaves are smaller and the leaf area index decreases by 5 to 10%. The leaves treated with Pix are also thicker, which is due to the increase in cell layers. By using pix, the branches become smaller and the dry weight of the stem decreases by almost 20%. Pix does not directly affect the shrinking of the cells, but it limits the growth of the cells and as a final result increases the storage or shelf life of the harvested bolls. In another two-year study in South Carolina, where different amounts of pix hormone were used in three-row spacings (19, 38, 76 cm), there was no effect on the yield, fiber, or fiber percentage due to the use of the mentioned hormone (Jones, 2001) .Wright et al. (2000) stated that the internode length of the cotton plant should always be checked in the field, and if this length was 5 cm, the use of Pix hormone should be taken .Zhao *et al.*, (2017) reported that an increase in fiber yield was observed as a result of the application of plant growth regulators in the early stages of cotton growth. However, these results were highly dependent on weather conditions and cultivar type. Since the climatic conditions are more variable than in the past in recent years, the management of the use of the pix hormone has become problematic (Ferreira, 2014). The issue of fertilizer consumption in the method of planting very narrow rows of cotton is also one of the most important issues in this topic.

McConnell *et al.,* (2008) reported that the effect of different levels of nitrogen fertilizer on plant height was significant and by increasing the amount of fertilizer to 56 kg/ha, plant height also increased significantly. Also, the yield of cotton was significantly affected by different levels of nitrogen fertilizer. The appropriate fertilizer recommendation was found between 56 and 84 kg/ha, which was lower than the fertilizer recommendation for conventional cotton cultivation (112 kg/ha).

In studies on the amount of infection of the population of sucking pests in Golestan province, the Skt-134, Tbl-80 and N2G80 hybrids have the least infection with the major suckling pests such as thrips, aphids, white fly and cotton grasshoppers (Darvish, Mojeni, 2012, 2013). The aim of this study was to investigate the effects of very low-distance farming (UNR) on the populations of sucking pests in arable crops in Golestan province for the first time.

Infestation of the tested varieties in cultivation is very narrow thrips populations on Sahel and Golestan® cultivar with 25cm respectively, 3.52 and 3.11 thrips per leaf has the highest infestation and number density on Sahel with distance 80cm 1.24 thrips per leaf have shown minimal infection. Therefore, the Golestan® cultivar with an average yield of important sucking pests such as thrips population infestation, the lowest cotton cultivation in agriculture ultra-narrow rows of 80 and 25 centimeters had in the cotton fields (Mojeni, 2019).Infestation levels of cultivars of cotton aphid population, Golestan and Sepid with a distance of 80cm, respectively, with a density of 53.42,49.18 and 41.35 aphids per leaf has the highest infestation, Sepid and Sahel varieties 25cm, respectively, with a density of 9.26 and 7.11 aphids per leaf had the lowest infestation. Population Bemisia levels of cotton cultivars in Golestan, Sahel and Sepid 25cm respectively with densities of 27.63,24.31 and 20.86 Bemisia on leaf number, maximum infestation and Sepid Variety with a distance of 80cm with a density of 6.15 Bemisia number of leaves have the least infestation. Therefore, the Golestan cultivar with an average yield of important sucking pests such as population infestation, aphids and whitefly the lowest cotton cultivation in agriculture ultra-narrow rows of 80 and 25 centimeters in the cotton fields (Mojeni,2019).Infestation rate of cluster cultivars tested in very narrow cultivation of *Aphis gossypii* population density on sajedi cultivars with a distance of 80cm and the Khorshid with a distance of 20 cm with densities of 41.39 and 40.36 aphids per leaf, respectively, with the highest aphid per leaf and cultivar T2 and Khorshid with a distance of 20cm 23.59 and 29.04 aphid respectively (Mojeni, 2021). The cultivar Saiokra 324 had more yield and yield than the number of bolls per plant. This figure is more than 400 to 600 kilograms in comparison to the Sahel variety and produces more than 200-500 kilograms from the Zeta-2 variety. In all cultivars, the highest yield was obtained at high plant densities, so the highest yield in the Sahel cultivar was observed at plant densities of 125,000 plants per hectare, In the cultivar Saiokra 324 at a plant density of 125000 and 62500 plants and In Zeta-2 cultivar, 125000 plants were also reported. There are different opinions about the effect of row spacing on performance in different studies. Cotton farming is expanding in ultra-narrow Row in cotton-growing countries (Ghajari and Ghadrei, 2006).

The results of studies by Wright *et al*., (2011) showed that fiber yield decreased by 9 plants per row compared to 1 and 5 plants. The yield of fiber of early cultivar and limited growth was not influenced by density, but in the case of complete clay and unlimited growth, with increasing density, the yield decreased.

Increasing the yield of the product by increasing the density in the above-mentioned method, regardless of weather conditions, is also reported in some reports (Jesus Rossi, *et al.,* 2004). In the closure of a faster or shadow surface, the area of life for weeds is severely reduced (Phlip, 2001). On the other hand, this reduces water evaporation after irrigation and saves it (Jesus Rossi, *et al.,* 2004). The study of the increase in the number of cotton plants ranging from 50,000 per hectare to 125 thousand. The population of important sucking pests such as aphids and white fly were easily controlled due to the increase of their natural enemies in the cotton field (Wright, *et al.,* 2015).

MATERIALS AND METHODS

In this research (UNR), planting is used instead of the distance of open rows at distances below 40 cm. This research was carried out at Hashemabad cotton research station in Gorgan in 2018-2019. The treatments included 3 cluster cotton cultivars (Khorshid, T2 and Sajedi and Golestan® cultivar) with two narrow planting distances of 20 × 20 and 20 × 80 cm as a factorial design. Random complete blocks (RCBD) were evaluated in three replications. Each plot consisted of 10 planting lines of 12 m with planting patterns of 20 × 20 and 20 × 80 cm. Two sidelines and half meters from the beginning and end of each row are considered as margins and all statistics were performed from the middle rows. After the emergence of pests in the field, to study population changes *Bemisia tabaci* regular weekly sampling was performed on plants on 15 leaves per plot.

Performance was also yielding variety measured in the experiment. The obtained data were analyzed as a factorial experiment in a randomized complete block design using SAS software and the mean data were compared by LSD test.

RESULTS AND DISCUSSION

Based on the analysis of the research results obtained in two years of testing and also comparing the averages of obtained data, cultivar treatments have significant differences in very narrow cultivars. In terms of average yield, the amount of washes obtained in cluster cultivars tested in very narrow crops by performing combined analysis of variance in Sajedi cultivar with cultivation distance of 80 cm with 1696gr/plot and Golestan 80 cm with 1622.9gr/plot had the highest yield in Group **a** and Golestan® and T2 cultivars with a distance of 20 cm with 867.4gr/plot and 847.2gr/plot, respectively, in group **c** with the lowest yield at the level of 5% showed a significant difference (Tables 1 and 2).

Table 1: Analysis of variance related to cotton yield (gr/plot) in cluster cultivars in very narrow agriculture at Hashemabad station 2018-2019.

Sources of changes	df	S. S	MS	F
Rep.	2	0.226	0.113	0.71ns
Treat.	7	0.307	0.044	0.28**
Year	1	7.821	7.821	49.10**
Erro.	37	5.894	0.159	
CV	14.17 %			

Table 2: Comparison of mean LSD and grouping of performance-related treatments.

Treat. (Variety)	Average yield(gr/plot)	5 %
Sajedi 80 cm	1696	a
Golestan® 80 cm	1622.9	a
Khorshid 80 cm	1295	ab
T2 80 cm	1196.1	ab
Sajedi 20 cm	1039.7	b
Khorshid 20cm	913.3	b
Golestan® 20 cm	867.4	bc
T2 20 cm	847.2	c

In terms of the average infection rate of the cotton whitefly population in the cluster cultivars tested by performing a combined analysis of variance in very narrow crops Golestan® cultivars with a distance of 80 cm Sajedi with a distance of 20 cm, with a density of 65.50 and 57.75 pieces of whitefly per leaf in group a and Sajedi with a distance of 80 cm and T2 80 cm with a density of 55.94 and 46.75 pieces of whitefly per leaf, respectively in group b, they showed a significant difference at the 5% level compared to the control (Tables 3, 4 and Fig. 1).

Table 3: Analysis of variance related to the effect of very narrow agriculture on the population of whitefly *Bemisia tabaci* on cluster cultivars in Hashemabad station 2018-2019.

Sources of changes	df	S. S	MS	F
Rep.	2	99.875	49.937	0.20ns
Treat.	7	1074.667	153.523	0.61**
Year	1	35769.006	35769.006	142.25**
Erro.	37	9303.616	251.449	
CV	21.91 %			

Table 4: Comparison of mean Lsd and grouping related to population density of cotton whitefly in treatments.

Treat. (Variety)	Whitefly (Num/leaf) average.	5 %
Golestan®80 cm	65.50	a
Sajedi 20cm	57.75	ab
Golestan® 20 cm	57.42	ab
Khorshid 80 cm	57.34	ab
Khorshid 20 cm	57.14	ab
T2 20 cm	56.72	ab
T2 80 cm	55.94	ab
Sajedi 80 cm	46.75	b

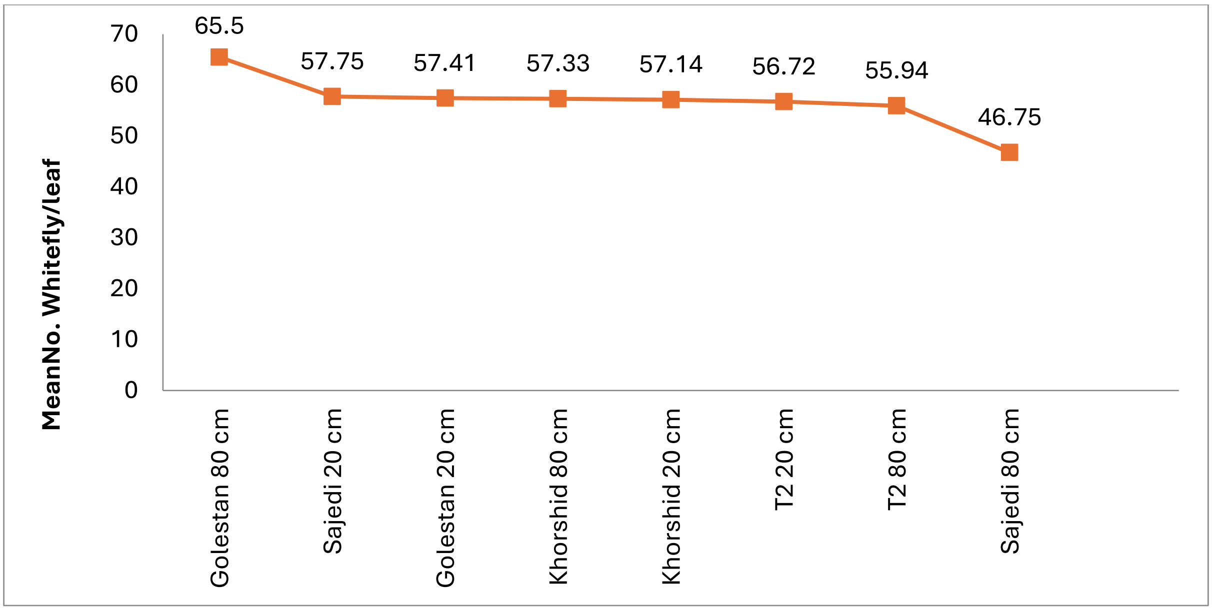

Fig. 1: Mean population of dynamic *Bemisia tabaci* on cotton cluster cultivars in the field's cotton of Golestan province 2018-2019.

Whitefly cotton is active in the cotton fields of Golestan province from the end of July to the middle of October. Sahel cultivar 25 cm with 24.31 white flies had the highest density and Golestan® cultivar 80 cm with 19.81 whitefly had the lowest density (Darvish, Mojeni, 2012,2013). In the studied cluster cultivars, Golestan® and Sajedi cultivars with a density of 65.50 and 57.75(whitefly per leaf) had the highest infection and the Sajedi cultivar with a density of 46.75 whiteflies on the leaf had the least infection (Mojeni, 2019). The results were the same as studies in other countries. Narrow row cultivation of cotton production can have a significant impact on the management of these insects, but little information is available to make appropriate adaptations to insect control strategies. Important cotton pest populations such as aphids, whiteflies, and spider mites are reduced. Almost all cotton pests can be controlled indirectly with a very narrow culture system (Wright, *et al.*, 2011). Study increasing the number of cotton plants from 50,000 plants per hectare to 125,000 plants per hectare the population of important sucking pests such as Thrips, aphids and whitefly were easily controlled due to the increase of their natural enemies in the cotton field (Wright, *et al.*, 2015).

In this study, it was clarified that the final yield in a very narrow row spacing, with a significant difference, was more than the usual planting row spacing of 80 cm. In this way, it was concluded that the cultivation of very narrow row spacing compared to 80 cm spacing generally did not increase the density of important cotton pests, and it also decreased it in many pests and in certain cultivars.

Declarations:

Ethics Statement: The researcher conducted the study in compliance with all applicable ethical standards and regulations. The study went through an ethical review by a research and ethics team. No human participants or vertebrate animals were involved in this study.

Authors Contributions: All authors contributed equally, and have read and agreed to the published version of the manuscript.

Conflict of Interest: The authors declare no conflict of interest**.**

Availability of Data and Materials: The datasets generated and analysed during the current study are available from the corresponding author upon reasonable request.

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