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Factors Responsible for Resistance in Okra against Aphid, Aphis Gossiypii Glover (Homoptera: Aphididae)

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FACTORS RESPONSIBLE FOR RESISTANCE IN OKRA AGAINST APHID, A*PHIS GOSSIYPII* GLOVER (HOMOPTERA: APHIDIDAE)

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ABSTRACT

Aphids are herbivores that feed on plant's sap and are widespread throughout the globe. To assess the factors affecting the infestation of *Aphis gossypii* (Glover) and to use antixenosis a trial was conducted using 5 okra genotypes (Sabz Pari, Advanta, Durga, Kaveri, and Shandar) during spring, 2017 at "Agriculture Research Institute" (ARI) Tarnab, under Random Complete Block Design (RCBD) in field and Completely Randomized Design (CRD) in lab with 3 and 8 replications, respectively. Weekly data gathering for mean percent infestation of *A. gossypii* on each genotype to note variation among genotypes. The aphid infestations (2.5 Aphid leaf^{-1}) recorded on Shandar was higher than others and lowest (2.0 Aphids leaf^{-1}) was recorded on Durga. Initially the infestation was lesser (0.5) but with time it reaches to peak (3.62) on 1st May and then gradually declined to least (2.0 aphid leaf^{-1}) in the 10th week. A statistically significant negative relationship existed between aphid abundance and crop yield. In the antixenosis trial, the Durga variety showed significant antixenosis resistance towards aphids after 12, 24, and 48 hours. Furthermore, the maximum yield of Durga variety (8.3 Tons (t)/ha) and the least yield (5.2 tons/ha) Shandar was obtained. Relating to aphid infestation and yield, the Durga variety performed exceptionally well. It is concluded from the results that the varieties showing antixenosis resistance towards insects must be recommended to not only reduce insect attacks but also to enhance yield.

Keywords: Okra, aphid, antixenosis, temperature, correlation.

INTRODUCTION

Okra, also notable as lady's finger or bhindi, is a member of the Malvaceae or mollow family and can be traced back to the African *Abelmoschus esculentus* L. Okra is said to have originated in East Africa, but it is currently cultivated in nearly all tropical and subtropical regions (ECHO, 2003). From there, okra made its way across North Africa, the Middle East, and the Eastern Mediterranean (Ahmed 2000). Okra is a perennial crop that may be harvested at any time of the year in several tropical and subtropical regions (Singh and Verma 1985). In terms of okra cultivation and production, Pakistan ranks first, with an area of 532.64,000 ha, a yield of 6,346,000 tons, and a yield per hectare of 13.14 mt (GOP 2016).

Aphis gossypii (Glover) is a major pest of okra and one of the most significant aphid pests overall. The polyphagous pest *A. gossypii* feeds on plants from around 46 different families. Females typically lay their eggs on the branches of trees and bushes. The thick, black shells of the eggs protect them from freezing or baking. In March, the eggs hatch into featherless female nymphs that look just like the adult, and the entire generation can be finished in about 7 days if the weather is warm enough (Silverstein et al., 2007; Dixon and Mckay 1970).

Aphids typically undergo cyclical parthenogenesis (Crossley et al., 2021), in which numerous parthenogenetic ages occur during the spring and summer as well as a single sexual age occurs in the fall, resulting in diapausing, overwintering eggs (Davies 1939). Parthenogenetic lineages exist within some aphid species year-round, and some aphid species can engage in either sexual or asexual reproduction in the same year (Blackman 1976; Dedryver et al., 2001). Aphids damage plants by sucking cell sap and producing excessive honeydew on leaves, which reduces fruit yield and quality. These aphids secrete honeydews, which provide excellent growth media for sooty mold. The fungus can easily be developed on this honeydew, which affects photosynthesis and resulted in poor yield quality and quantity (Atwal 1994). The attack of aphids resulted in chlorosis in leaves then which turned round and change their shape and become dried, these aphids also play a role in the transmission of the virus to a no. of the plant (Van den Berg et al., 1997). Along with sucking the aphid also inject some of the salivae into the plants, which results in curling and brown spots on the foliage (Rani et al., 2020; Metcalf and Flint 1951). Aphid population dynamics result from favourable factors corresponding to the hatching of aphids and unfavourable factors causing death. The balance between these factors causes an increase or decrease in their numbers. The nature of the plant itself may affect the dynamics of *A. gossypii* by altering its capacity for development or reproduction (Metcalf and Flint 1951). Okra aphids (*A. gossypii*) are controlled by different methods viz, cultural, physical, chemical, biological, and host plant resistance. Aphidophagous predators like *Coccinella septumpunctata* and *Menochilus sexmaculata* are to play a key role in aphid population management. Host plant resistance is also considered one of the safest methods for managing the aphid population (Khan et al., 2009). Keeping the value of the yield loss origin by these insects pest and the production of the excellent crop, it is necessary to adopt suitable measures in managing the pest population. Environmental factors show a central part in the improvement of these pests (Saxena et al., 1987). Conformity in perspective the value of the aphid *A. gossypii,* the experiment was done to find out the almost unsusceptible okra cultivar against aphids in Peshawar and to find out the antixenosis resistance in okra against aphids.

MATERIALS AND METHODS

A research study was conducted during the spring season (2017) on *A. gossypii* in the different variations of okra at the Agricultural Research Institute (ARI) Tarnab, Peshawar. The variations Sabz Pari, Durga, Kaveri, Advanta, and Shandar were examinations for the population trend of aphids in the field and also examinations for the Antixenotic Resistant in the controlled environment.

Field Preparation

A field was selected and divided into three equal blocks. Every block was further separated into five sub-plots with a plot size of 4x3 m^2. Row to row and plant spacing was 25 and 12 cm respectively. The seed was soaked overnight before it is sown in the field and then sown in five rows in each subplot. The crop was transplanted in the 2nd week of March 2017. Irrigation, fertilizer, hoeing, and weeding were all carried out as required by good agronomic practice. The experiment had

three different treatments and was set up in a Randomized Complete Block Design (RCBD). But to have an idea of the potential aphid population on different okra variants, we randomly observed 10 plants in each replication and counted the number of aphids. From March 27th to May 29th, weekly observations of these plants were made.

Population Trend of Aphid Aphis gossypii

The experiment was conducted in the field for the population trend of Aphids *A. gossypii* on five different variations of okra. For population sample was started right from the seedling stage to the termination of the crop. For this purpose, 10 plants were selected from each sub-plots of each treatment. During sampling, the border rows were avoided. From each sub-plots, 10 plant life were chosen indiscriminately. One week apart, remove three leaves from the topmost, mediate, and lowermost of each plant.

Aphid Culture

Aphids were cultured by introducing them from the field to plants that had already been grown under controlled conditions. The collected aphids were raised in a glass house at 20 ± 5 °C and 50-65 % relative humidity using the locally grown sensitive variety of okra under a light cycle of 14:10 hrs (D: L).

Antixenosis Experiment

Each type had one seedling planted evenly spaced around the outside of a 32-cm-diameter, 16-cm-tall pot. At the 2-4 leaf stage, aphids of the species *Aphis gossypii* were released onto a white portion of paper located in the middle of the pot. The level of antixenosis was determined by enclosing plants in a nylon mesh cage and counting the number of aphids on each type 12, 24, and 48 hours after infestation. At least eight copies of each kind were made. The antixenosis study was a randomized, controlled trial.

Yield Data

In this experiment, the fruit was harvested every four days, at 3- to 4-centimeter sizes. All of the okra picked for the season was tallied together at harvest time to get the final harvest amount. To get an accurate measure of the harvest, we transformed the yield into kilograms per hectare.

Data Collection

All the pre-recorded information was analyzed by the statistical package Statistics 8.1 version. Means were examinations by LSD examination using 95 % of probability.

RESULTS

Population Trends of Aphis gossypii on Different Okra Variations

The effect of different okra variations on the population of *Aphis gossypii* leaf^{-1} (Table-1) shows that the aphids population started in the past days of March. The mean no. of aphid's leaf^{-1} on various okra variations display important differences at ($P < 0.05$). The lowest (2.0 Aphids leaf^{-1}) mean of several aphids was registered in the Durga variety, preceded by Sabz Pari, Kuveri, and Advanta variety with 2.1, 2.2, and 2.3 Aphids leaf^{-1}respectively. The highest (2.5 Aphids leaf^{-1}) mean the number was recorded on the Shandar variety. Comparing the global mean aphid population across multiple periods reveals striking differences. The maximum (3.6 aphid leaf^{-1}) infestation of aphids was recorded in the 6th week (1st May), followed by week 5th and week 7th (24th April and 8th May) with (3.3 and 3.2 aphid leaf^{-1}), correspondingly. While the minimum number (0.5 aphids leaf^{-1}) was recorded on the 10th week (29th May). At the start the infestation of the aphids was low (0.7 aphid leaf^{-1}), boosted with the transition of period and extend to the limit (3.6 aphid leaf^{-1}).

Table 1: Population trends of aphids on different okra cultivars at Agricultural Research Institute Tarnab, Peshawar, during spring, 2017

	Number of Aphid leaf^{-1}										
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	Mean
variations	27-Mar	3-Apr	10-Apr	17-Apr	24-Apr	1-May	8-May	15-May	22-May	29 May	
SabzPari	0.61xy	1.20t	2.20op	2.77k	3.33ef	3.58bc	3.21fg	2.50n	1.95rs	0.28z	2.1d
Advanta	0.90vw	1.29t	2.29o	2.90ij	3.50cd	3.68b	3.33ef	2.92hi	2.10pq	0.49y	2.3b
Shandar	0.99uv	1.85s	2.90ij	3.20g	3.60bc	3.90a	3.38de	2.80jh	2.00qr	0.80w	2.5a
Durga	0.55xy	1.05u	2.14p	2.52mn	3.19g	3.35e	3.05h	2.6lm	1.86s	0.35z	2.0e
Kuveri	0.84w	1.19t	2.20op	2.85ijk	3.30efg	3.16bc	3.21fg	2.74kl	1.95rs	0.65x	2.2c
Mean	0.7i	1.3h	2.3f	2.8d	3.3b	3.6a	3.2c	2.7e	1.9g	0.5j	

Means followed by a different letter(s) are significantly different from each other ($p \leq 0.05$)
LSD for variant at $p \leq 0.05 = 0.0378$, LSD for Weeks at $p \leq 0.05 = 0.1001$, LSD for interaction of variations × Weeks at $p \leq 0.05 = 0.0448$

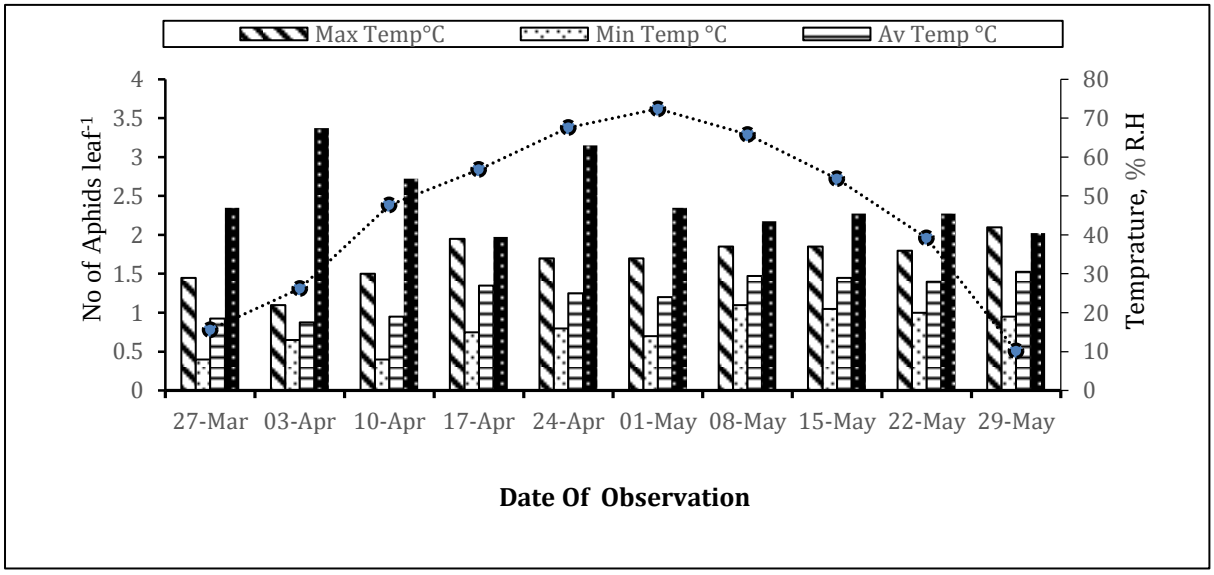

Figure 1: *Aphid gossypii* population calculated with weather factors

Table 2: Correlation of *A. gossypii* with yield

Correlation variable	R	P-Value
Aphids Density vs Okra yield	-0.9668	0.0072

Significant at a 5 % level of probability

Table 3: Antixenosis examination of the mean number of aphids *A.gossypii* at different time intervals.

variations	12hr	24 hr	48 hr
Sabz Pari	6.35 c	6.00 d	6.50 d
Advanta	12.05 a	11.50 b	12.17 b
Shandar	12.95 a	12.50 a	13.00 a
Durga	5.95 c	5.50 d	6.17 d
Kaveri	9.13 b	8.90 c	9.00 c
LSD	0.7518	0.5582	0.6167

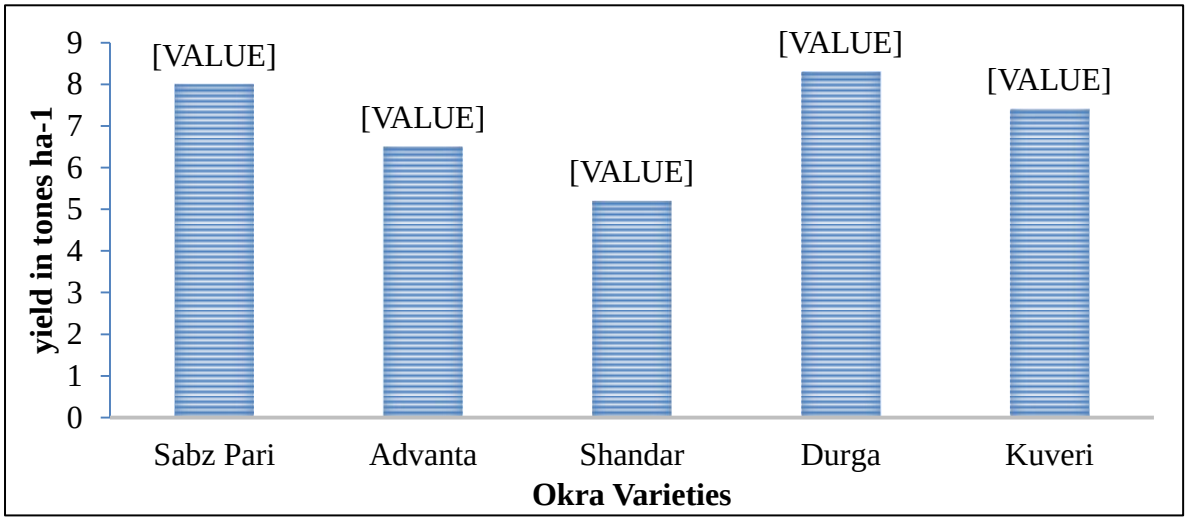

Figure 2: Yield of Okra variations in tons/ hectare.

(*LSD for yield at ≤ 0.05 = 0.2136)*

After that, a decline occurs in the infestation of aphids, and the lowest (0.5 aphid leaf^{-1}) infestations were recorded in the last week of data observation 10th week (29th May).

The interaction between the response of different okra variations to the aphids and time intervals showed significant differences. The highest (3.9 Aphid leaf^{-1}) population of aphids was recorded on the Shandar variety in the 6th week (1st May). It was followed by the Advanta variety with (3.68 Aphid leaf^{-1}) in the 6th week (1st May), Kuveri with 3.61 Aphid leaf^{-1} in the 6th week (1st May), and Shandar with 3.60 (Aphids leaf^{-1}) in 5th week (24th April). The lower (0.2 Aphids leaf^{-1}) was prerecorded on the Sabz pari variety in the 10th week (29th May).

The Population of Aphis gossypii Vs Weather Factors

The results (Figure 1) show that the population of *Aphis gossypii* first started on March 27, an increasing trend was recorded continuously and reached to highest (3.62 Aphids leaf^{-1}) on 1st May with a minimum temperature of (14 °C) maximum temperature (34 °C) and with average temperature (24 °C) along with 47 % RH. Thus this weather condition favored the maximum for the development of *Aphis gossypii* at "Agriculture Research Institute" Tarnab.

Correlation of Population Abundance of Aphis gossypii with Okra Yield

The results (Table 2) show a negative significant correlation (r = -

0.9668) between aphids and the yield of different okra variations.

Antixenosis

The results of the Antixenosis (preference and non-preference) examination presented in Table 4.3 shows statistically significant antixenotic resistance among the examinations okra variations after 12, 24 and 48 hrs were maximum (12.95, 12.50, and 13.00) mean several aphids were attracted towards Shandar variety followed by Advanta (12.05, 11.50 and 12.17), Kaveri (9.13, 8.90 and 9.00), Sabz Pari (6.35, 6.00 and 6.50) and minimum (5.95, 5.50 and 6.17) mean several aphids to Durga variety after 12, 24 and 48hr post infestation, respectively.

Yield Data (Tons/Ha)

The yield of okra variations discovered an importantly higher P-value ($p < 0.05$) for okra production among the examination's variations. Figure 2 demonstrates that advanced yield (8.3 tons/ha) was recorded for Durga followed by Sabz Pari (8.0 tons/ha), Kuveri (7.4 tons/ha), Advanta (6.5 tons/ha), and Shandar (5.2 tons/ha). The lowest yield was found on the variety Shandar

DISCUSSION

In the current experiment, the aphid population on a single leaf was calculated by dividing the total no. of aphids on 3 leaves by three. This was done to avoid including any unnecessary rows around the margins. This particular species can only support 21 aphids on its upper leaves. Equally, the ability of aphids to produce offspring often depends on the concentration of soluble nitrogen in the plants that serve as their hosts. Overall, nevertheless, this technique allows for a highly precise estimate of the average aphid population per leaf. There are other options, such as beating plants over a cloth to collect aphids, randomly selecting lower leaves and expressing the population as aphids per 100 leaves (Davies 1939), measuring all leaflets of plant samples (Adams 1946), beating individual plants over a cloth for accumulation of aphids (Moericke 1941). Aphid distribution within a plant is thought to be linked to plant nutrients, plant life, and temperatures (Van den Berg et al., 1997). Aphid density on upper leaves was found to be positively related to nitrogen levels by Hu et al., (1992). Aphid reproduction, likewise, may be reliant on the quantity of soluble nitrogen present in the plants that serve as their hosts (Dixon and Mckay 1970). Nitrogen as well as other nutrients are taken up by actively growing leaves in many plants. The current technique has been utilized before by other researchers for estimating aphid numbers in various trials of insecticides on crops grown (Saljoqi and VanEdem 2003a; Saljoqi and VanEdem 2003b; Singh and Verma 1985).

Mean percentage population data for *A. gossypii* showed that okra variants were importantly diverse from one another. According to the results, Durga okra demonstrated much higher resistance to *A. gossypii* infestation than other okra cultivars. Initially, the infestation of the aphids was found low but with time intervals, its infestation reached to peak, and then a reduction was recorded in the infestation of aphids till the last week of date observation where the lowest number of aphids was recorded. The corresponding finding was founded by (Akbar and Khan 2015) who according to important deviation in the population of aphids among different examinations contrary variations and also found the population of aphids in the same pattern.

In the present research study, the abiotic factor (temperature and humidity) was also recorded and presented with the population of aphids which shows that the

population of *Aphis gossypii* first started on March 27, an increasing trend was recorded continuously and reached to highest (3.62 aphids leaf^{-1}) on 1st May with daily minimal temperatures 14 °C, maximum temperature 34 °C and average temperature 24 °C along with 47 % RH. These findings agreed with (Hu et al., 1992) who estimated a lower threshold for *Aphis gossypii* at 7.34 °C, 6.9 °C, and 10.47 °C respectively, in various crops. The results also agree with (Aldrvhim and Khalil 1993) who reported the upper limit for the survival of *Aphis gossipii* at 35 °C on Cucurbitaceae in Saudi Arabia and 45 °C in the okra field.

In the research, the correlation between the aphid population and their yield shows a negative significant correlation (r = -0.9668) between aphids and the yield of different okra variations. The results demonstrated that the overall yield of okra was struck by differences in the *A. gossypii* population. When compared to other varieties, Shandar was discovered to have the best yield and was also noted as being relatively more resistant to *A. gossypii* attack. Those areas with the largest *A. gossypii* population also had the lowest yield from the Durga variety. These findings corroborate those of (Shannag *et al*., 2007), who found that *A. gossypii* infestation on okra variants decreased total production.

In antixenosis examination, significant antixenotic resistance was found in examinations of okra variations after 12, 24, and 48hr under laboratory conditions. The lower number of aphids were attracted to the Durga variety followed by Sabz Pari, Kaveri, and Advanta while, the maximum number of aphids were attracted to the Shandar variety. These determinations are in line with the finding of (Abang et al., 2015) that examined different okra variations and found a significant resistant variety against okra aphids in Taiwan. Similar findings were also reported from research (Khan et al., 2009) who demonstrated antixenotic resistance against aphids in our crops.

The results demonstrated that the overall yield of okra was struck by differences in the *A. gossypii* population. Durga, in comparison to all other varieties, was determined to be the most susceptible to *A. gossypii* onrush, resulting in the maximum yield. Wherever the most *A. gossypii* was found to be growing, the Shandar variety had the lowest yield. These findings corroborate those of (Shannag et al., 2007), who found that *A. gossypii* infestation on okra variants decreased total production.

CONCLUSION

The preceding study concludes that aphid population densities were constant across all okra varieties. The highest concentration of *A. gossypii* was seen throughout April and May when the crop was actively increasing. On Shandar, where the average frequency of *A. gossypii* was 3.1 aphid leaf-1, the pest was far more abundant. At 14 degrees Celsius, 34 degrees Celsius, and 24 degrees Celsius with an average of 47 % relative humidity, the highest densities of *A. gossypii* were recorded. Aphid infection was significantly correlated with lower crop yields. The Durga variety performs better than other varieties in antixenosis tests. The Durga variety had the maximum yield in terms of kg per hectare. The Durga variety of okra outperformed the others in terms of resistance to aphids and yield. To increase okra growers' productivity, income, and sustainability, it is advised that they adopt IPM tactics that include the Durga variety.

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AUTHORS CONTRIBUTION

All authors equally contribute to carry out the present study; review and write the manuscript. All authors have read and agreed to the published version of the manuscript.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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