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Frequency of Aphid (*Aphis Gossypii* G.) on Brinjal (*Solanum Melongena* L.) and Farming Practices in the Agroclimatic Conditions of Faisalabad, Pakistan

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***Abstract* – The size of *Aphis gossypii* population in brinjal (*Solanum melongena* L.) crop field was assessed using a randomised complete block design in the Rabi crop season (2009–10) at Ghulam Muhammad Abad, Faisalabad, Punjab, Pakistan. The maximum aphid population was recorded in February. In this study we observed that aphid population started decreasing with time as the environmental temperature increased. Abiotic conditions played an important role and significantly affected the reduction in the number of aphids. Environmental variables, such as the maximum and minimum temperature, had significant negative effects, whereas relative humidity had a significant positive effect, precipitation had a non-significant negative effect on the *Aphis gossypii* population. Farming practices indicated that different plant protection strategies were adopted, which mainly involved the excessive application of pesticides. Given the frequency of aphids on brinjal crops and farming practices, there is a need to develop a crop protection package based on modern integrated pest management practices**.

***Keywords* – Aphid, Abiotic Factors, Brinjal Aphid, Environment, Meteorological Factors.**

I. Introduction

Brinjal, also known as eggplant or aubergine (*Solanum melongena* L.), belongs to the Solanaceae family and is a popular vegetable grown throughout the world. The Solanaceae family contains more than 2450 species distributed in 95 genera [1]. Brinjal fruits are of a low calorie value and have a mineral composition that is beneficial for human health; these fruits are a rich source of potassium, magnesium, calcium and iron [2].

Brinjal crops are damaged by several insect pests that can cause considerable damage, which renders the fruit unfit for human consumption [3]. Aphids are one of the most harmful non-indigenous threats to agriculture. The direct consequences of aphid infestation include production losses, decline in quality and increased agricultural risks [4]. Aphid population has been increasing in the last few years, and they have attained the status of a common pest in Pakistan [5]. The nymphs and adults suck the sap from the leaves and tender shoots, and plants become weak, pale and stunted, which reduces the fruit size [6].

Meteorological parameters play a pivotal role in the biology of pests. Temperature is the most crucial abiotic factor that affects the life economy of any organism. However, no single climatic factor governs the activity of pests because the effects of weather elements on pests are generally confounded [7]. The level of sunshine, rainfall, relative humidity and wind speed are the other chief weather parameters that largely control the activity of a given insect species. The association between pest activity and abiotic factors can help to derive predictive models that facilitate the forecasting of pest incidence [8].

Given the current situation wherein insect pests affect vegetables, particularly brinjals, there has always been a need to develop a comprehensive control program to overcome this problem. The effects of weather factors, such as temperature and relative humidity play extremely important roles in the multiplication and distribution of insect pests. However, less importance is given to the roles of these factors resulting in less progress in the development of integrated pest management (IPM) strategies.

II. Material and Methods

Geographic location and experimental layout

The experiment was conducted in Ghulam Muhammad Abad, Faisalabad (31°27′N, 73°04′E; 500 m above sea level). The field study used a randomized complete block design (RCBD) during the Rabi crop season (2009–2010) in a brinjal field.

Assessment of the aphid population

Regular pest scouting was fortnightly performed for the brinjal crop. The parameters tested included the nymph and adult populations. The populations of aphids on brinjals were recorded on three leaves, i.e. one each from the top, middle and bottom canopy of five randomly selected plants in brinjal field

Meteorological data

The effects of climatic factors on the population dynamics of aphids were tested by recording the daily temperature and relative humidity, which were collected from different sources using a portable thermometer, a hygrometer installed in the field and official websites containing meteorological data for Pakistan.

Farming practices

A comprehensive study was conducted to evaluate the farming practices for the management of the brinjal crop; a questionnaire was prepared to obtain information on pest management practices used by the farmers in the brinjal field.

Characteristics of irrigation water

The irrigation water applied to the vegetables was tested for the presence of heavy metals. The concentrations of lead (Pb), cadmium (Cd), nickel (Ni), chromium (Cr) and copper (Cu) were determined using an atomic absorption spectrophotometer (Polarized Zeeman AAS, Z-8200; Hitachi, Japan), according to a previously described method [9].

Statistical analysis

Analysis of variance (ANOVA) was used to analyse the aphid populations; [10], the significance of differences among mean populations on different sampling dates was evaluated. The fortnightly aphid populations were correlated with the prevailing climatic factors such as the maximum temperature, minimum temperature, relative humidity and precipitation. In addition, regression coefficients were estimated for pest populations relative to the environmental parameters. Differences among means were determined using Duncan's multiple range test [DMRT, 11].

III. Results

The numbers of aphids on the upper, lower and middle leaves of brinjals were recorded; the mean population data is given in Table 1. The maximum number of aphids was recorded on 15 February, 2010, and no aphids were observed after 30 April, 2010. The overall mean population was highest at the start point, and it tended to decline as the crop matured.

There were significant differences in the pest population on different sampling dates (Table 2). The results of ANOVA showed that the mean number of aphids significantly differed at fortnightly intervals.

Comparison of the aphid populations on different sampling dates using DMRT indicated that maximum population was recorded on 15 February, 2010, while the minimum population was recorded on 30 April, 2010 (Table 3).

Pearson's correlation coefficient indicated that there was a highly significant negative correlation between the maximum temperature and pest population (Table 4 & Fig. 1). Therefore, the pest population significantly decreased as the maximum temperature increased.

The minimum temperature showed a similar correlation with the pest population, i.e. it was negatively and significantly correlated with pest population (Table 4 & Fig. 1).

Pearson's correlation coefficient indicated that the relative humidity had a highly significant correlation with aphid population on brinjal crop (Table 4 & Fig. 1), i.e. a positive value obtained after correlation analysis indicated that pest population increased with humidity.

Further a non-significant negative correlation was identified between pest population and precipitation (Table 4 & Fig. 1).

A simple linear regression was used to determine the effects of abiotic factors on the aphid population. There were highly significant associations ($p < 0.01$) between aphid population, maximum and minimum temperatures and the relative humidity, whereas precipitation had no effects on the aphid population ($p > 0.05$). The coefficient of determination values (R^2 values) indicated that the maximum temperature had 84.39% correlation with the aphid population, while the minimum temperature and relative humidity had 87.82% and 85.16% correlations, respectively (Table 5).

Farming practices

We assessed farming practices and farmers' knowledge and perceptions of pests and pesticide use in vegetable cultivation to analyse pesticide use and determine usage intensity of pesticide during vegetable cultivation. We used a questionnaire to obtain information regarding farming practices from sowing until crop maturity. Farmers reported that the vegetable area was scouted to determine the threat of insect pests. The field was examined daily or twice a week to check crop growth, moisture stress and schedules, which included scouting as part of the process. The crop was treated with an insecticide to control insect pests. The schedule was not based on the economic threshold level because there was a blanket use of insecticides without any concern for health risks. The leading sources of information when selecting insecticides were chemical dealers. Farmers used different plant protection strategies, but the main focus was excessive use of pesticides i.e. repeating pesticide application at three-day intervals.

Concentrations of heavy metals

The analysis indicated that the concentrations of heavy metals (Cd, Pb, Cu, Ni and Cr) were below the permissible limits; Ni concentration, 0.04 mg L^{-1} (permissible limit, 0.2 mg L^{-1}); Pb concentration, 0.01 mg L^{-1} (permissible limit, 5 mg L^{-1}); Cr concentration, 0.03 mg L^{-1} (permissible limit, 10 mg L^{-1}); Cu concentration, 0.02 mg L^{-1} (permissible limit, 0.20 mg L^{-1}); and Cd concentration, 0.02 mg L^{-1} (permissible limit, 0.01 mg L^{-1}).

IV. Discussion

Climatic factors play an important role in fluctuation of the population of insect pests [12]. Physical and biological factors lead to variation in insect pest populations as suggested by [13]. In our study, we observed that climatic factors greatly influenced the population dynamics of insect pests, particularly brinjal aphids. Therefore, aphid population varied on different sampling dates.

The aphid population size had a significant negative correlation with the maximum temperature, minimum temperature and precipitation, whereas relative humidity was positively correlated with the population size. Our results were in accordance with the findings of [8], who reported a significant negative correlation between aphid populations and maximum temperature.

The maximum temperature (20.5–27.5°C) and relative humidity (64–67%) in February promoted an increase in the aphid population. Our results are similar to the findings of Sharma [14], who reported that a maximum temperature of 15.8°C–24.7°C and a relative humidity of 61%–65% during February favoured the multiplication of aphids.

The maximum aphid population recorded in February was in accordance with the findings of [15]. Similarly, [16] reported that aphid population started increasing in February. Our results slightly disagreed with those of other studies [16], [17], and [18] where the maximum aphid activity occurred during March. Our results indicated that the aphid population decreased with increasing temperature, which is in agreement with the results of [19], who reported lowest aphid population at 33°C.

Farming practices

The information gathered from farmers indicated that most of them were illiterate; these farmers did not consider the residual effects of pesticides. In addition, they sprayed the crops after three-day intervals, which showed that they were unaware of the appropriate spraying intervals and harmful effects of these chemicals on human health. We observed that vegetable growers consulted pesticide dealers to identify insect pests. Interviews conducted for farmers indicated that their main sources of information were pesticide dealers, other farmers and their own experience. Our survey revealed that pesticides were applied most frequently to brinjal crops. Most of the farmers sprayed the crops themselves, and did not use protective clothing. They continued spraying pesticides without being concerned about the residual effects of pesticides. Continuous spraying leads to the accumulation of chemical residues in vegetables, which causes serious health problems in humans. Thus, vegetable growers should be appropriately educated during each season about the judicious use of pesticides, making them aware about the hazards of pesticide misuse.

Analysis of irrigation water from the brinjal field

Our results demonstrated that heavy metal concentrations (Cd, Cr, Pb, Ni and Cu) in the irrigation water were below the permissible limit [20]. Our results were similar to those obtained in a previous water analysis [21], which showed that the canal water used for irrigation purposes was free of heavy metals, except Mn (0.1 mg L^{-1}) and Cd (0.001 mg L^{-1}), although the concentrations of these metals were within the permissible limits. Our results disagreed with those of [22], who found that irrigation water had highly variable heavy metal concentrations.

V. Conclusion

The results concluded that peak aphid population was recorded during the beginning of the third week of February in 2009–2010. Aphid dynamics were largely dependent on temperature and relative humidity, however, aphid population was not significantly correlated with rainfall.

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Table I. Mean aphid (*Aphis gossypii* Glov.) population on brinjal

Date	Mean ± S.E.	Minimum No.	Maximum No.
15/2/2010	26.67 ± 0.44	12	48
28/2/2010	23.20 ± 0.38	12	41
15/3/2010	14.62 ± 0.26	7	23
30/3/2010	5.89 ± 0.59	1	13
15/4/2010	3.89 ± 0.55	1	8
30/4/2010	1.49 ± 0.78	0	4

Table II. Analysis of variance for aphid (*Aphis gossypii* Glov.) population on brinjal on different sampling dates

Source of Variation	DF	SS	MS	F-ratio
Replication	2	22.497	11.248	12.36**
Sampling Dates	5	1676.087	335.217	368.48**
Error	10	9.097	0.910	-
Total	17	1707.681	-	-

** Significant

Table III: Comparison of the mean aphid (*Aphis gossypii* Glov.) population on various sampling dates using Duncan's multiple range test

Date	Mean ± S.E.	DMRT lettering
15/2/2010	26.67 ± 0.44	A
28/2/2010	23.20 ± 0.38	A
15/3/2010	14.62 ± 0.26	B
30/3/2010	5.89 ± 0.59	C
15/4/2010	3.89 ± 0.55	CD
30/4/2010	1.49 ± 0.78	E

Mean comparison at 5% level of significance. Means followed by the same letters were not significantly different

Table IV. Correlations between aphid (*Aphis gossypii* Glov.) population and abiotic factors

Abiotic Factors	Pest Population	Max. Temp.	Min. Temp.	R. Humidity	Precipitation
Max. Temp.	-0.919	-	-	-	-
Min. Temp.	-0.937	0.842	-	-	-
R. Humidity	0.923	-.0897	-0.846	-	-
Precipitation	-0.516^{ns}	0.240^{ns}	0.708^{ns}	-0.377^{ns}	-
Wind Speed	-0.034^{ns}	-0.321^{ns}	0.171^{ns}	0.045^{ns}	0.785^{ns}

ns: Non-significant

Table V. Linear regression analyses of aphid (*Aphis* gossypii Glov.) population and abiotic factors

Weather Parameter	Regression Equation	R^2 value
Max. Temperature	y = -1.2969x + 54.558	0.8439**
Min. Temperature	y = -1.8665x + 43.112	0.8782**
Relative Humidity	y = 0.683x - 22.205	0.8516**
Wind Speed	y = -0.1065x + 13.187	0.0011ns
Precipitation	y = -53.458x + 14.853	0.2664ns

** Significant, ns: Non-significant

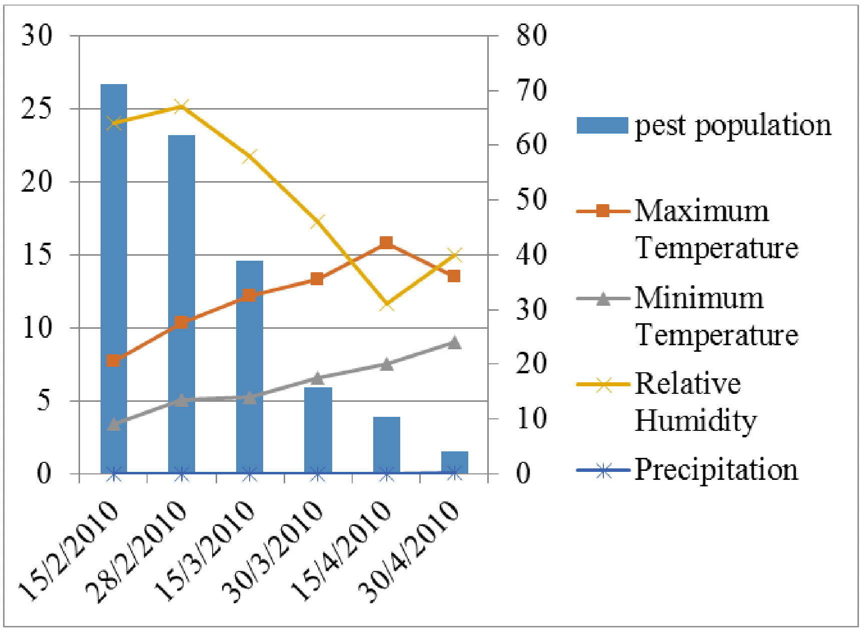

Fig.I. Aphid population relative to abiotic factors