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Population Dynamics of Aphid (*Aphis Gossypii* G.) on Tomato Agro-Ecosystem in Faisalabad Region

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***Abstract* – The occurrence of climate changes is evident from increase in global average temperature, changes in the rainfall pattern and extreme climatic events. These seasonal and long term changes would affect the fauna, flora and population dynamics of insect pests. The abiotic parameters are known to have direct impact on insect population dynamics through modulation of developmental rates, survival, fecundity, voltinism and dispersal. The study was carried out in Vegetable fields of Ghulam Muhammad Abad, Faisalabad using randomized complete block design (RCBD) during Rabi season 2009-10. The observations on aphid incidence were carried out simultaneously on 5 randomly selected plants per plot, taking 3 leaves, that is, each from upper, middle and lower strata. Aphid population showed significant negative correlation with minimum and maximum temperature, whereas significant positive correlation with relative humidity, and non-significant negative correlation with rainfall. The determination of effects of different weather factors on population of aphids in tomato was essential for effective pest management.**

***Keywords* – Tomato, Aphis Gossypii, Weather Parameters, Correlation, Abiotic Factors.**

I. Introduction

In spite of the fact that insect pests have been an issue in agriculture as the centuries progressed, phenomenon of pest outbreaks have expanded with the change of pest complexities, in the most recent four decades. A few insects have increased in seriousness, while others have declined in essentialness [1].

Aphids or plant lice are a standout amongst the most widely recognized polyphagous insect pests [2]. Identification of the field dynamics of tomato aphid population in connection to climatic conditions is acknowledged as a prime imperative for the execution of the subsequent crop protection package in view of modern IPM practices. The pest effects very nearly all the areal parts of the tomato plant from the early development stages till to the fruit maturation stage [3], [4].Feeding frequently brings about stunting, twisting or yellowing of plant green foliage [2]. Extreme infestations may eliminate the plant absolutely [5]. Loss acquired because of sucking to the growing tomato crop is difficult [6].

Pest richness and distribution changes with abiotic elements and thusly meteorological parameters assume an urgent part in the biology of any pest. Temperature is the most pivotal abiotic element affecting the rate of growth and development of insect and is particularly critical for insect as pest control measures must be timed precisely to be viable. Notwithstanding, relative humidity, precipitation, wind rate and temperature are the major climate parameters that generally coordinate the action of a given types of insect. The association between pest movement and abiotic components helps in inferring at prescient models that supports in estimate of pest occurrence.

Hence understanding the late patterns of seasonal abundance of *A.gossypii* is essential to create an integrated management system for this pest. Such time bound perception will help to visualize about the periodicity of the population and the degree of infestation. Perception on population dynamics of *A.gossypii* in light of pest management decision making is in this way discovered essential. The objective of the study was to characterize the fundamental population arrangement of *A. gossypii* and to consider the part of climate parameters on the rate of the *A. gossypii* population in the Rabi crop season at Ghulam Muhammad Abad, Faisalabad, Pakistan.

II. Materials and Methods

Field experiments were conducted at the field site, in Ghulam Muhammad Abad, Faisalabad (31°27′N, 73°04′E; 500 m above sea level). The area was selected because of intensive cultivation of vegetables especially tomato.The field study used a randomized complete block design (RCBD) during the Rabi crop season (2009–2010) in a tomato field. Regular pest scouting was carried out fortnightly after the transplantation of the tomato crop. Parameters selected for sampling included nymph and adult population. The population was determined by manually counting the number of nymphs and adults present on upper, middle, and lower portion of the leaves visible by naked eye. The population of tomato aphid was recorded on three leaves one each from top, middle and bottom canopy of the five plants selected randomly in the tomato field. The influence of climatic factors on the population dynamics of the insect pests of vegetables, the daily temperature and relative humidity were recorded and the data was collected from different sources by portable thermometer, hygrometer installed in the field and official websites of database of Pakistan meteorological data.Analysis of variance was performed for different dates and different insect pest species as suggested by Steel *et al* [7], to evaluate the significance of differences among the mean population at different sampling dates. Statistical significance was assumed at 5% and 1% levels of probability. Pest populations showing significant differences on sampling dates were analyzed to evaluate their correlation with abiotic factors. In addition, regression coefficients for environmental parameters were estimated for pest populations. Differences among means were determined by Duncan's multiple range test [DMRT, 8].

III. Results

Incidence of *Aphis gossypii* in tomato fields was assessed with a randomized complete block design during the Rabi crop season (2009-10) in Ghulam Muhammad Abad, Faisalabad, Pakistan. The results are delineated below.

Numbers of aphids on upper, lower and middle strata were recorded. Population data means are presented in Table 1. Initially, a high aphid population was recorded in the first week of February, and then the population diminished and a low number was recorded in the month of April. The overall mean population was highest at the start point and tended to decline as the crop matured. There were significant differences in the pest population on different samplingdates (Table 2). The results of ANOVA showed that the mean number of aphids significantly differed at fortnightly intervals. Comparison of aphid populations on different sampling days using Duncan's multiple range test indicated that the maximum population was recorded on February 15, 2010 and the minimum population on April 30, 2010 (Table 3). There was a highly significant negative Pearson's correlation between the maximum temperature and pest population (Table 4). Therefore, the pest population decreased as the maximum temperature increased. The minimum temperature showed a similar significant negative correlation with pest population (Table 4). Relative humidity had a highly significant correlation with aphid population on the brinjal crop (Table 4), meaning that pest population increased with humidity. A non-significant negative correlation was observed between pest population and precipitation (Table 4). Simple linear regression was used to evaluate the effects of abiotic factors on the aphid population. There were highly significant associations ($p < 0.01$) between aphid populations, maximum and minimum temperature, and relative humidity, whereas precipitation had no effect on the aphid population ($p > 0.05$). Maximum temperature had an 86.82% coefficient of determination (R^2) with aphid population and minimum temperature and relative humidity had R^2 values of 87.6% and 88.89%, respectively (Table 5).

IV. Discussion

Aphids are very serious insect pests of vegetables. Most aphids are extremely host specific, feeding on one or a few plant species that are usually closely related. These aphid species can cause serious problems on vegetable crops even at low densities, since they can transmit plant viruses among phylogenetically divergent host plants [9].

Climatic factors exert a great influence on the growth, development, distribution, and population dynamics of insect pest [10]. Both the physical and biological factors are much vital causing the variations in the densities of aphid population [11]. The results of [12] revealed that pest population varied due to temperature.

The incidence of aphid showed significantly negative correlation with maximum temperature, minimum temperature and precipitation, whereas relative humidity is positively correlated with the population. Our results were confirmatory with the findings of [13], who found significant negative correlation of the aphid population with maximum temperature. In present study maximum activity of aphid was observed in February which was confirmatory with the findings of [14], who concluded that population of aphids was maximum in the month of February during the 2001–2002 crop seasons. Although our findings are in contradiction with [15] and [16], who found the activity of aphid from 3rd week of August. Similarly [17], [18] and [19], found the highest aphid population during March. The findings of [18] reported that aphid count was low in January due to low temperature but it started increasing in February. In the present study the population of aphid increased with decrease in temperature, lowest population was found on tomato (mean value 10) at temperature of 32.5°C and the highest population was recorded (mean value 16) at temperature of 27.5°C. These results are in collaboration with the findings of [20], who found the lowest population (mean value 2.273) at temperature of 33°C and the highest population (mean value 2.40) at temperature 32.5°.

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: Average Population of Tomato Aphid (*Aphis gossypii* Glov.)

Date	Mean ± S.E.	Minimum No.	Maximum No.
15/2/2010	19.01 ± 0.44	8	34
28/2/2010	16.13 ± 0.40	6	29
15/3/2010	10.77 ± 0.31	4	17
30/3/2010	3.42 ± 0.82	0	10
15/4/2010	0.93 ± 1.01	0	3
30/4/2010	0.51 ± 1.15	0	2

Table II: Analysis of Variance for Tomato Aphid (*Aphis gossypii* Glov.) on Different Sampling Dates

Source of Variation	DF	SS	MS	F-ratio
Replication	2	1.325	0.663	2.42^{ns}
Sampling Dates	5	962.301	192.460	702.58**
Error	10	2.739	0.274	-
Total	17	966.366	-	-

ns: Non-significant; * : Significant; **: Highly significant

Table III: Mean Comparison of Tomato Aphid (*Aphis gossypii* Glov.) Population by Duncan's Multiple Range Test on Various Sampling Dates

Date	Mean ± S.E.	DMRT lettering
15/2/2010	19.01 ± 0.44	A
28/2/2010	16.13 ± 0.40	AB
15/3/2010	10.77 ± 0.31	C
30/3/2010	3.42 ± 0.82	D
15/4/2010	0.93 ± 1.01	E
30/4/2010	0.51 ± 1.15	E

Mean comparison by DMRT at 5% level of significance. Means followed by similar letters are not significantly different from each other.

Table IV: Correlation Values between Population of Tomato Aphid (*Aphis gossypii* Glov.) and Abiotic Factors.

Abiotic Factors	Pest Population	Max. Temp.	Min. Temp.	R. Humidity	Precipitation
Max. Temp.	-0.932	-	-	-	-
Min. Temp.	-0.936	0.842	-	-	-
R. Humidity	0.943	-0.897	-0.846	-	-
Precipitation	-0.486 ^{ns}	0.240 ^{ns}	0.708 ^{ns}	-0.377 ^{ns}	-
Wind Speed	0.006 ^{ns}	-0.321 ^{ns}	0.171 ^{ns}	0.045^{ns}	0.785^{ns}

Table V: Simple Regression Equation between Tomato Aphid (*Aphis gossypii* Glov.) and Abiotic Factors.

Weather Parameter	Regression Equation	R^2 value
Max. Temperature	y = -0.9967x + 40.691	0.8682**
Min. Temperature	y = -1.4125x + 31.535	0.876**
Relative Humidity	y = 0.5287x - 18.5	0.8889**
Wind Speed	y = 0.0148x + 8.3861	0.00004ns
Precipitation	y = -38.173x + 10.054	0.2366ns

****** Significant at $p<0.01$; ns: non-significant $p>0.05$