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Potential Impact of Climatic Factors on Whiteflies and Aphids Infesting Chilli (*Capsicum annum* L.)

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ABSTRACT

A field experiment was conducted during the *rabi* seasons of 2020-21, to investigate the impact of climatic factors on the population dynamics of whiteflies and aphids in chili crops under unprotected conditions. Result revealed that the initiation of white fly (2.53 whitefly/3 leaves) and aphid incidence (3.66 aphids/3 leaves) was started in 44th SMW. After that white fly and aphid population was gradually increased and reached its peak with 6.20 whitefly/3 leaves and 8.27 aphids/3 leaves in 49th SMW. Correlation of whitefly and aphids population with climatic factors showed negative correlation with maximum temperature (r= -0.1407, -0.0502) and rainfall (r= -0.0783, -0.0552) while, positive correlation with morning relative humidity(r=0.3847, 0.3327) and evening relative humidity (r= 0.1890, 0.1948), respectively. Whitefly population showed negative correlation with minimum temperature (r= -0.0632) while, aphid population showed positive correlation with minimum temperature (r= 0.0488).

Key words: *Climatic factors, Whitefly, Aphid, Correlation, Chilli.*

Introduction

Chilli (*Capsicum annuum* L.), a member of the Solanaceae family, holds a significant dual role as both a vital spice and a vegetable crop in India. Chilli, also known as the "Wonder spice" or "Universal spice," has its origins in South Central America. Notably, India holds the distinction of contributing 40% to the global chilli production. Being recognized as the "home of spices," India benefits from favorable climate conditions, suitable soil properties, irrigation facilities, andadvanced agricultural practices, enabling year-round chilli cultivation. In India prominent states responsible for chilli production are Andhra Pradesh, Karnataka, West Bengal, Madhya Pradesh, Maharashtra, and Tamil Nadu. Chillies find their primary consumption in various forms like chutneys, pickles, and curries (Singh and Joshi, 2020). The primary factor impeding higher chilli yields is the infestation of insect pests, both during the nursery stage and even after the transplantation of chilli into the field. Among these challenges, more than 35 species of insects and mites have been identified as pests of pepper. This group includes thrips, aphids, whiteflies, fruit borers, cutworms, plant bugs, mites, and other minor pests (Sorensen, 2005). Nymphs and adults of aphids and whitefly suck the cell sap from the under surface of the leaves and growing shoots causing leaf curling and plant stunting. They secrete honey-dew on which black sooty mould develops. Of particular concern within the spectrum of insect pests affecting chillies is the whitefly known as *Bemisia tabaci* Genn. (Aleyrodidae: Hemiptera). This pest has emerged as a significant menace to crop production in recent times. It not only causes direct damage through

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feeding but also serves as a vector for transmitting Begomoviruses and Criniviruses, which are responsible for serious plant health issues (Morales, 2007). Notably, the occurrence of chilli leaf curl disease, caused by Chilli leaf curl virus and transmitted by *B. tabaci*, has become a major challenge to chilli yields in South India due to its potential to trigger epidemics (Raj *et al*., 2005; Kumar *et al*., 2006; Chattopadhyay *et al*., 2008). Insects exhibit diverse patterns of occurrence, behavior, and impact on crops due to the variations in agro-climatic conditions across different regions. The prevalence and expansion of chilli's sucking pests are influenced by various non-living factors such as temperature, relative humidity, and rainfall. Among these, high-temperature thresholds predominantly govern the dynamics of insect populations (Regniere *et al*., 2012). Given that environmental factors strongly influence the seasonal abundance and resulting damage caused by these insect pests, it becomes crucial to comprehensively examine the population dynamics of these pests throughout the crop's growth cycle. This knowledge serves as a foundation that can benefit farmers, crop producers, ecologists, agricultural economists, researchers, and consultants in devising systematic and efficient pest control strategies. As a result, an investigation into the population dynamics of whiteflies and aphids on chilli plants was undertaken. This study aims to shed light on the peak periods of their activity, offering valuable insights for the development of sustainable and effective pest management approaches.

Materials and Methods

In the *Rabi* season of the year 2020-21, a field experiment was conducted to investigate the population dynamics of whitefly (*Bemisia tabaci* Gennadius) and aphids (*Aphis gossypii* Glover) in chilli crops, and to analyse their correlation with climatic factors. This experiment took place at the experimental farm of the Agriculture Research Station in Ummedganj-Kota, Rajasthan. The chilli variety used was "US 611," and its seedlings were initially grown in nursery trays. Transplantation of 43-day-old chilli seedlings occurred during the second week of October 2020. The experimental design employed was a Randomized Block Design (RBD), with a planting arrangement of 60 x 45 cm and plot dimensions of 3.0 x 5.0 m^2. Throughout the entire growth season of the chilli crop, continuous monitoring was conducted to observe the fluctuations in the populations of whitefly and aphids. The observations were carried out during the morning hours, specifically from 7:00 to 8:30 am. This time frame was chosen due to the relatively sluggish activity of winged insects during these hours, making counting easier. These observations were recorded at weekly intervals. For the investigation of whitefly and aphid populations, five plants were randomly selected from each plot and marked. Both nymphs and adults, was recorded on three leaves from different parts of the plant: upper, middle, and lower. This data collection continued until the final harvest of chilli fruits. Subsequently, the data gathered over the course of the study was correlated with various weather parameters. The weather data used was obtained from the meteorological observatory situated at the Agriculture Research Station in Kota. The collected data underwent further statistical analysis, including the calculation of correlation coefficients, to discern potential relationships between the collected variables.

Results and Discussion

Data on population dynamics of whitefly, *Bemisia tabaci* Gennadius and aphids, *Aphis gossypii* Glover on chilli is presented in Table 1 and Figure 1.

Whitefly, ***Bemisia tabaci*** **Gennadius**

The population of whitefly (2.53 whitefly/3 leaves) was recorded initially after 2^{nd}week of transplanting of chilli seedling (44^{th} SMW). Whitefly population was gradually increased and reached it's peak (6.20 whitefly/3 leaves) after 7^{th} week of transplanting (49^{th} SMW) and there after whitefly population decrease and remained active up to 22^{nd} weeks after transplanting (12^{th} SMW) with average population 1.86 whitefly/3 leaves. Moderate population of 1.86 to 3.40 whitefly/3 leaves was recorded for a period of 13 weeks, *i.e.* 52^{th} to 12^{th} SMW (10 to 22 weeks after transplanting). The peak whitefly population (6.20 whitefly/3 leaves) was found when, maximum temperature, minimum temperature, morning relative humidity, evening relative humidity and rainfall (29.24 ^{o}C, 12.00 ^{o}C, 89.00 per cent, 76.14 per cent and 0.00 mm, respectively). Correlation of whitefly population with weather parameters revealed that maximum temperature, minimum temperature and rainfall showed negative correlation (r= -0.1407, -0.0632 and -0.078344, respectively) while, morning relative humidity and evening relative humiditywas

Table 1. Population dynamics of whitefly and aphid infesting chilli variety "US 611" during *Rabi* 2020-21

SMW (Duration)	Week after transplanting (Date of observation)	Temperature (°C)		Relative humidity (%)		Rainfall (mm)	Mean population on 3 leaves/plant	
		Max.	Min.	Morning	Evening		Aphids	White fly
43rd (22 Oct – 28 Oct)	1st (23-Oct 2020)	34.74	18.64	67.57	78.71	0.00	0.00	0.00
44th (29 Oct – 04 Nov)	2nd (30-Oct 2020)	32.93	15.75	75.50	76.83	0.00	3.66	2.53
45th (05 Nov – 11 Nov)	3rd (6-Nov 2020)	31.96	15.30	89.57	67.29	0.00	6.60	4.13
46th (12 Nov – 18 Nov)	4th (13-Nov 2020)	31.39	14.86	86.43	66.71	0.00	7.60	4.93
47th (19 Nov – 25 Nov)	5th (20-Nov 2020)	30.81	14.00	89.71	70.00	0.00	8.00	5.60
48th (26 Nov – 02 Dec)	6th (27-Nov 2020)	30.46	13.71	89.00	70.29	0.00	8.13	6.00
49th (03 Dec – 09 Dec)	7th (4-Dec 2020)	29.24	12.00	89.00	76.14	0.00	8.27	6.20
50th (10 Dec – 16 Dec)	8th (11-Dec 2020)	26.67	10.86	88.29	70.43	17.00	7.67	5.33
51th (17 Dec – 23 Dec)	9th (18-Dec 2020)	25.60	8.71	87.43	59.14	0.00	6.07	4.67
52th (24 Dec – 31 Dec)	10th (25-Dec 2020)	25.10	8.63	77.38	60.00	0.00	4.53	3.27
1st (01 Jan – 07 Jan)	11th (1-Jan 2021)	24.60	9.00	76.00	66.00	57.00	3.13	2.33
2nd (08 Jan – 14 Jan)	12th (8-Jan 2021)	23.39	10.14	99.86	80.14	0.00	2.40	2.06
3rd (15 Jan – 21 Jan)	13th (15-Jan 2021)	23.89	6.36	99.71	78.00	0.00	3.07	2.53
4th (22 Jan – 28 Jan)	14th (22-Jan 2021)	24.24	6.64	99.57	68.14	0.00	3.20	2.67
5th (29 Jan – 04 Feb)	15th (29-Jan 2021)	22.60	6.50	87.70	65.30	0.00	3.53	3.00
6th (05 Feb – 11 Feb)	16th (5-Feb 2021)	24.70	9.00	86.00	69.60	0.00	3.67	3.13
7th (12 Feb – 18 Feb)	17th (12-Feb 2021)	26.80	10.30	85.00	63.00	0.00	3.80	3.40
8th (19 Feb – 25 Feb)	18th (19-Feb 2021)	29.40	12.00	79.40	70.70	0.00	3.60	2.86
9th (26 Feb – 04 Mar)	19th (26-Feb 2021)	32.40	13.00	74.70	44.30	0.00	3.13	2.53
10th (05 Mar – 11 Mar)	20th (5-Mar 2021)	34.00	13.10	72.00	37.40	0.00	2.93	2.26
11th (12 Mar – 18 Mar)	21st (12-Mar 2021)	34.70	14.00	86.60	37.00	7.00	2.66	2.13
12th (19 Mar – 25 Mar)	22th (19-Mar 2021)	35.50	14.00	82.00	48.60	0.00	2.40	1.86
Total							98.05	73.42
Correlation								
Max. Temp. (°C)							-0.05027	-0.1407
Min. Temp. (°C)							0.04886	-0.0632
Morning R.H. (%)							0.3327	0.3847
Evening R.H. (%)							0.1948	0.1890
Rainfall (mm)							-0.0552	-0.0783

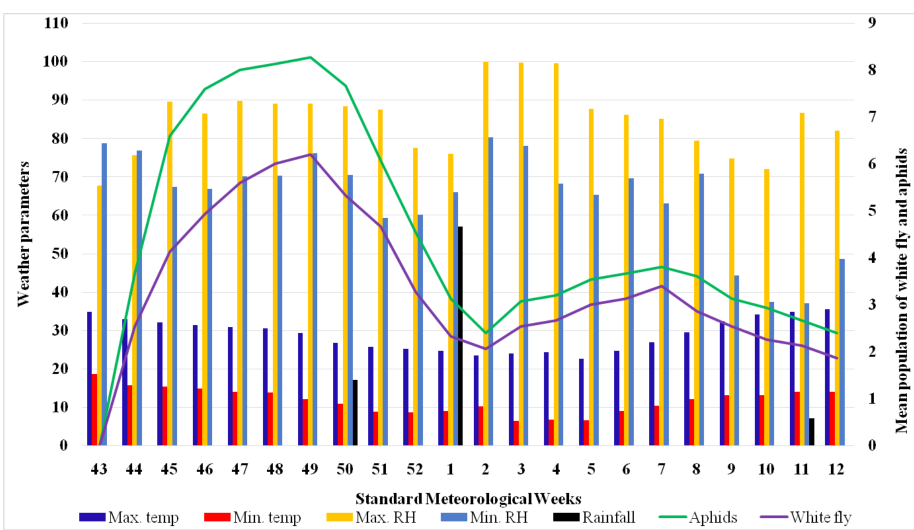

Fig. 1. Population dynamics of whitefly and aphid infesting chilli variety "US 611" during *Rabi* 2020-21

positively correlated (r=0.3847 and 0.1890, respectively). The present results of correlation study supported with the findings of Bhatt and Karnatak (2020) reported that the whitefly population exhibited negative correlation with maximum temperature, whereas positive correlation with morning and evening relative humidity. Moanaro and Jaipal Singh Choudhary (2008) reported that the whitefly population showed positive correlation with relative humidity and negative correlated with rainfall. Kumawat *et al.* (2015) they reported that relative humidity exhibited positive correlation with whitefly population. Yadav *et al*. (2014) found that the whitefly population showed negative correlation with rainfall.

Aphid, *Aphis gossypii* Glover

The initiation of aphid incidence (3.66 aphids/3 leaves) was started after 2nd week of transplanting of chilli seedling (44th SMW). After that population was gradually increased and reached it's peak (8.27 aphids/3 leaves) after 7th week of transplanting (49th SMW) and their after population decrease and remained active up to 22nd weeks after transplanting (12th SMW) with an average population of 2.40 aphids/3 leaves. Moderate population ranged from 2.40 to 3.80 aphids/3 leaves remained for a period of 12 weeks, *i.e.* 1st to 12th SMW (11 to 22 weeks after transplanting). The peak aphid population (8.27 aphids/3 leaves)was observed when maximum temperature, minimum temperature, morning relative humidity, evening relative humidity and rainfall was 29.24 °C, 12.00 °C, 89.00 per cent, 76.14 per cent and 0.00 mm, respectively. Correlation of aphid population with weather parameters revealed that maximum temperature and rainfall showed negative correlation (r= -0.0502 and -0.0552, respectively) while, minimum temperature, morning relative humidity, evening relative humidity showed positive correlation (r=0.0488, 0.3327, 0.1948, respectively). The present results of correlation study supported with the findings of Bhatt and Karnatak (2020) reported that the aphid population exhibited positive correlation with minimum temperature and evening relative humidity. The present results of correlation study supported with the findings of Pathipati *et al.* (2020) they reported that the morning relative humidity, evening relative humidity and minimum temperature exhibit significant positive correlation with aphid population, whereas negative significant correlation was observed with maximum temperature and rainy fall for aphid population. Jayewar *et al.* (2019) and Kumar *et al*. (2019) reported that the aphid population showed negative correlation with rainfall. Priyadarshini *et al*. (2018) reported that the aphid population showed negative correlation with rainfall. Hadiya and Kalariya (2017) also found that the aphid population showed negative correlation with maximum temperature. Kumawat *et al.* (2015) who reported that the aphid population showed positive correlation with relative humidity.

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Declaration of Conflicting Interests

The author(s) declared no conflicts of interest concerning this article's research, authorship, and publication.

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