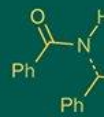


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Anushree Salam
Department of Entomology,
Anand Agricultural
University, Anand, Gujarat,
India

Dr. HC Patel
Department of Entomology,
Anand Agricultural
University, Anand, Gujarat,
India

Dr. MD Suthar
Directorate of Extension
Education, Anand Agricultural
University, Anand, Gujarat,
India

Corresponding Author:
Dr. HC Patel
Department of Entomology,
Anand Agricultural
University, Anand, Gujarat,
India

Seasonal abundance of whitefly, *Bemisia tabaci* (Gennadius) vis-à-vis tomato leaf curl disease in relation to weather parameters

Anushree Salam, HC Patel and MD Suthar

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Abstract

The present study was undertaken to investigate the seasonal abundance of whitefly, *Bemisia tabaci* (Gennadius) vis-à-vis tomato leaf curl disease (ToLCD) and their relationship with prevailing weather parameters at the Entomology Farm, B. A. College of Agriculture, Anand Agricultural University, Anand during *khariif-rabi* 2025-26. The whitefly population appeared during the fourth week of September and remained active throughout the crop season with its population varying from 0.47 to 5.50 whiteflies per leaf. The highest population of whitefly was recorded during the fourth week of December. Tomato leaf curl disease incidence was first observed during the first week of October (0.87%) and increased gradually to a maximum of 23.06 percent during the first week of February. Correlation analysis revealed a highly significant positive association between whitefly population and disease incidence ($r = 0.576^{**}$). Whitefly population exhibited a significant positive correlation with bright sunshine hours ($r = 0.533^{*}$), whereas significant to highly significant negative correlations were observed with wind speed ($r = -0.504^{*}$), evening relative humidity ($r = -0.456^{*}$), maximum temperature ($r = -0.600^{**}$), minimum temperature ($r = -0.844^{**}$), morning vapour pressure ($r = -0.843^{**}$) and evening vapour pressure ($r = -0.675^{**}$). Tomato leaf curl disease incidence showed highly significant negative correlations with maximum temperature ($r = -0.828^{**}$), minimum temperature ($r = -0.730^{**}$) and morning vapour pressure ($r = -0.728^{**}$), while evening vapour pressure ($r = -0.471^{**}$) exhibited a significant negative correlation. The remaining weather parameters showed non-significant associations with disease incidence. The findings suggest that weather factors play a crucial role in regulating whitefly population dynamics and that increased whitefly abundance contributes significantly to the development and spread of tomato leaf curl disease.

Keywords: *Bemisia tabaci*, tomato leaf curl disease, seasonal abundance, weather parameters, correlation, tomato

Introduction

Tomato (*Solanum lycopersicum* L.) is one of the most widely cultivated and economically important vegetable crops grown under diverse agro-climatic conditions. Its productivity is constrained by several insect pests, among which whitefly, *Bemisia tabaci* (Gennadius) (Hemiptera: Aleyrodidae) is considered a major sucking pest (De Barro *et al.*, 2011) [7]. Whitefly causes direct damage by extracting plant sap and indirect damage through the transmission of several plant viruses (Bugti, 2016; Pal *et al.*, 2021) [3, 12]. Among these, *tomato leaf curl virus* (ToLCV), the causal agent of tomato leaf curl disease is one of the most destructive viral pathogens affecting tomato production in tropical and subtropical regions. *B. tabaci* serves as the principal vector of ToLCV and transmits the virus from infected to healthy plants in a persistent-circulative manner (Uchibori *et al.*, 2013) [18]. The incidence and severity of tomato leaf curl disease are closely associated with the abundance of the whitefly vector and higher vector populations often result in greater disease spread and crop losses (Cohen and Berlinger, 1986) [6]. The population dynamics of whitefly and the development of leaf curl disease are greatly influenced by prevailing weather conditions, including temperature, relative humidity, rainfall, bright sunshine hours and wind speed (Khandare *et al.*, 2019) [9]. Knowledge of the seasonal occurrence of whitefly and its relationship with environmental factors is therefore essential for forecasting pest outbreaks and implementing timely management interventions. Considering the economic importance of tomato leaf curl disease and the role of whitefly as its vector, the present investigation was

undertaken to study the seasonal abundance of *B. tabaci* vis-à-vis tomato leaf curl disease and their relationship with prevailing weather parameters under field conditions at Anand, Gujarat.

Materials and Methods

The study was conducted at the Entomology Farm, B. A. College of Agriculture, Anand Agricultural University, Anand, Gujarat during *kharif-rabi* 2025-26. Seedlings of tomato variety GAT 5 (Gujarat Anand Tomato 5) was transplanted in second week of September, 2025 at a spacing of 90 cm × 45 cm in a 7.2 m × 13.5 m plot. The crop was raised following recommended agronomic practices without adopting plant protection measures. The experimental area was divided into six equal quadrates (3.6 m × 4.5 m) and observations were recorded weekly from one week after transplanting until crop termination. For recording whitefly population, five plants were randomly selected and tagged in each quadrate. Three leaves (upper, middle and lower) were examined from each selected plant and the mean whitefly population was expressed as number of whiteflies per leaf. Tomato leaf curl disease incidence was assessed by recording the number of infected and total plants in each quadrate and expressed as percent disease incidence using the formula:

$$\text{Disease Incidence (\%)} = \frac{\text{Number of infected plants}}{\text{Total number of plants observed}} \times 100$$

Weekly meteorological data on maximum and minimum temperature, morning and evening relative humidity, bright sunshine hours, rainfall, wind speed, and morning and evening vapour pressure were collected from the Department of Meteorology, B. A. College of Agriculture, Anand Agricultural University, Anand. To determine the relationship between whitefly population, tomato leaf curl disease incidence and prevailing weather parameters, Pearson's correlation coefficients were computed following the procedure described by Steel and Torrie (1980) [16]. Correlation analyses were performed between whitefly population and tomato leaf curl disease incidence as well as between each of these variables and the corresponding meteorological parameters.

Results and Discussion

The week-wise observations on whitefly population and tomato leaf curl disease incidence are presented in Table 1. Whitefly activity commenced from the second week after transplanting (WAT), corresponding to the fourth week of September (40th Standard Meteorological Week; SMW), with a population of 0.47 whitefly per leaf and persisted throughout the crop season. The population gradually increased and attained an initial peak of 1.70 whiteflies per leaf during the third week of October (5 WAT and 43rd SMW), followed by a slight decline to 1.43 whiteflies per leaf during the 44th SMW. Thereafter, it increased and attained a maximum population of 5.50 whiteflies per leaf during the fourth week of December (14 WAT and 52nd SMW). Subsequently, the population declined gradually and reached 1.90 whiteflies per leaf during the first week of February (5th SMW). The present findings are in close agreement with Patel *et al.* (2021) [13], who reported the onset of whitefly incidence during the 38th and 39th SMW with its peak population during the 48th and 49th SMW,

respectively, in tomato during *kharif*, 2017-18 and 2018-19. Similarly, Chakraborty (2012) [4] and Pavan *et al.* (2020) [14] observed a gradual increase in whitefly population after its initial appearance, with peak populations during the 6th and 7th SMW, respectively. Chavan *et al.* (2013) [5] noted higher whitefly infestation at 11 WAT, whereas Koshale (2018) [10] reported whitefly activity at 7 WAT in tomato. Hence, the seasonal trend observed in the present study broadly corroborates earlier findings, with variations in peak activity likely due to differences in agro-climatic conditions, geographical location, transplanting time, cropping season, tomato cultivar and prevailing weather parameters.

Tomato leaf curl disease incidence was first observed during the first week of October (41st SMW) at 0.87% (Table 1) and increased progressively reaching a maximum of 23.06% during the first week of February (5th SMW). Although whitefly population declined after its peak in late December, disease incidence continued to increase until crop termination. The progressive increase in tomato leaf curl disease incidence observed in the present investigation is in accordance with the findings of Lakshmi *et al.* (2015) [11], Koshale (2018) [10] and Anco *et al.* (2020) [1], who also reported a gradual increase in tomato leaf curl disease incidence as the crop progressed, with maximum disease incidence recorded during the later stages of crop growth.

Relationship between whitefly population and tomato leaf curl disease incidence

Correlation analysis showed in Table 1 revealed a highly significant positive correlation ($r = 0.576^{**}$) between whitefly population and tomato leaf curl disease incidence, indicating that an increase in whitefly population was associated with a corresponding increase in disease incidence. The finding is in agreement with Khandare *et al.* (2019) [9], Bansode (2020) [2] and Koshale (2018) [10], who reported significant positive associations between whitefly population and leaf curl disease incidence in tomato.

Relationship of whitefly population and tomato leaf curl disease incidence with weather parameters

The correlation coefficients of whitefly population and tomato leaf curl disease incidence with different weather parameters are presented in Table 2. Whitefly population showed a significant positive correlation with bright sunshine hours ($r = 0.533^*$). In contrast, highly significant negative correlations were recorded with maximum temperature ($r = -0.600^{**}$), minimum temperature ($r = -0.844^{**}$), morning vapour pressure ($r = -0.843^{**}$) and evening vapour pressure ($r = -0.675^{**}$). Wind speed ($r = -0.504^*$) and evening relative humidity ($r = -0.456^*$) also showed significant negative correlations. However, morning relative humidity ($r = 0.151$) and rainfall ($r = -0.388$) exhibited non-significant associations.

The present findings are in close agreement with Chavan *et al.* (2013) [5] and Patel *et al.* (2021) [13], who reported significant negative correlations of whitefly population with both maximum and minimum temperatures. Likewise, Patel *et al.* (2021) [13] observed a significant negative correlation with wind speed. Koshale (2018) [10] also reported a highly significant positive association between whitefly population and bright sunshine hours, while Jahanzaib *et al.* (2017) [8] observed a non-significant negative association with rainfall. However, Patel *et al.* (2021) [13] reported a significant positive correlation with relative humidity,

differing from the present findings. Such variations may be attributed to differences in agro-climatic conditions, geographical location, crop season, tomato cultivar and prevailing weather conditions.

Tomato leaf curl disease incidence exhibited highly significant negative correlations with maximum temperature ($r = -0.828^{**}$), minimum temperature ($r = -0.730^{**}$) and morning vapour pressure ($r = -0.728^{**}$), while evening vapour pressure ($r = -0.471^{*}$) showed a significant negative correlation. Morning relative humidity ($r = 0.228$) and bright sunshine hours ($r = 0.168$) showed non-significant positive correlations, whereas evening relative humidity ($r = -0.140$), rainfall ($r = -0.406$) and wind speed ($r = -0.167$)

showed non-significant negative correlations with disease incidence (Table 2). The present results are in agreement with Koshale (2018) ^[10], who reported a positive association between bright sunshine hours and tomato leaf curl disease incidence. Likewise, Jahanzaib *et al.* (2017) ^[8] observed non-significant negative correlations of disease incidence with rainfall and wind speed. However, Lakshmi *et al.* (2015) ^[11], Singh *et al.* (2015) ^[15], Koshale (2018) ^[10], Khandare *et al.* (2019) ^[9] and Sujatha *et al.* (2025) ^[17] reported positive associations between temperature and disease incidence. These findings differed from the present research. It might be due to different locations, seasonal pattern, cropping period and tomato cultivars.

Table 1: Seasonal abundance of whitefly *vis-à-vis* leaf curl disease in tomato (*Kharif-rabi* 2025-26)

Month and week		SMW	WAT	No. of whiteflies/leaf	Disease incidence (%)
September, 2025	III	39	1	0.00	0.00
	IV	40	2	0.47	0.00
October, 2025	I	41	3	0.90	0.87
	II	42	4	1.30	1.32
	III	43	5	1.70	1.74
	IV	44	6	1.43	2.18
November, 2025	I	45	7	2.07	3.04
	II	46	8	3.40	5.23
	III	47	9	3.70	6.07
	IV	48	10	4.13	7.39
December, 2025	I	49	11	3.53	10.00
	II	50	12	4.63	11.30
	III	51	13	5.03	13.05
	IV	52	14	5.50	14.36
January, 2026	I	1	15	4.53	16.97
	II	2	16	4.30	18.28
	III	3	17	3.90	20.02
	IV	4	18	2.30	22.17
February, 2025	I	5	19	1.90	23.06
Correlation coefficient (r)				0.576**	
Note: ** Significant at 0.01 level of significance					

Table 2: Correlation coefficients (r) of weather parameters with whitefly population and leaf curl disease incidence in tomato (n = 19)

Weather parameters	Whitefly population	Leaf curl disease incidence
Maximum temperature, °C (MaxT)	-0.600**	-0.828**
Minimum temperature, °C (MinT)	-0.844**	-0.730**
Morning relative humidity, % (RH ₁)	0.151	0.228
Evening relative humidity, % (RH ₂)	-0.456*	-0.140
Bright sunshine hours, hrs/day (BSS)	0.533*	0.168
Rainfall, mm (RF)	-0.388	-0.406
Wind Speed, km/hr (WS)	-0.504*	-0.167
Morning vapour pressure, mm (VP ₁)	-0.843**	-0.728**
Evening vapour pressure, mm (VP ₂)	-0.675**	-0.471*
Note: ** Significant at 0.01 level of significance; * Significant at 0.05 level of significance		

Conclusion

The present study revealed distinct seasonal variation in the population of whitefly and tomato leaf curl disease incidence during *kharif-rabi* 2025-26. Whitefly population peaked during the fourth week of December, while disease incidence increased progressively and reached its maximum during the first week of February. A highly significant positive relationship between whitefly population and disease incidence indicated the important role of vector abundance in disease development. Whitefly population and disease incidence showed significant associations with several weather parameters, highlighting the importance of seasonal weather conditions and vector abundance in the progression of tomato leaf curl disease.

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