



Seasonal dynamics and climatic correlations of major insect pests on tomato (*Lycopersicon esculentum*) in Madhya Pradesh, India

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Abstract

Tomato (*Lycopersicon esculentum*), a member of the Solanaceae family, is a widely cultivated crop in tropical and subtropical regions, particularly in India, where it holds significant economic value. This crop is vulnerable to various insect pests, including Fruit borer (*Helicoverpa armigera*), Whitefly (*Bemisia tabaci*), Jassid (*Amrasca biguttula biguttula*), and aphid (*Aphis gossypii*). These pests contribute to severe losses in both quality and quantity, with fruit borer being particularly destructive, causing yield reductions of up to 70%. The present study examines the seasonal incidence of major insect pests on tomato and their correlation with climatic parameters to devise effective pest management strategies. Conducted during the Kharif season of 2019-2020 in Madhya Pradesh, India, the study involved monitoring pest populations at weekly intervals and analysing correlations with weather variables such as temperature, humidity, wind speed, sunshine, and rainfall. The study found that Whitefly, Jassid, and Fruit borer were the dominant pests, with peak populations occurring in the 4th week of September for whitefly and the 4th week of November for fruit borer. The pest populations exhibited a significant positive correlation with evaporation and sunshine, while relative humidity and rainfall were negatively correlated. The effectiveness of various insecticides was tested, and the results indicated that chemical control remains a primary strategy, although resistance development poses challenges. The study highlights the importance of integrated pest management (IPM), combining biological and climatic factors, and emphasizes the need for timely pest monitoring and targeted interventions. Further research is essential to explore more sustainable pest control methods, particularly to address pest resistance. These findings offer valuable insights into optimizing tomato cultivation practices and reducing pest-related losses.

Keywords: Seasonal incidence, white fly, fruit borer, jassid, tomato, corelation study

Introduction

Tomato (*Lycopersicon esculentum*), a member of the Solanaceae family, is an important vegetable crop widely cultivated in tropical and subtropical regions of the world. It is believed to have originated in tropical America and is recognized as one of the most valuable protective foods due to its high nutritional value. Tomato fruit comprises 93.1% water, 1.9% protein, 0.3% fat, 0.7% fiber, and 3.6% carbohydrates (Rao and Rao, 2007). Globally, India ranks third in tomato cultivation area and second in production after China. During 2016–17, India produced 19.69 million tonnes of tomatoes from an area of 0.8085 million hectares, with an average productivity of 24.4 tonnes per hectare (Anonymous, 2017) [3]. Madhya Pradesh is one of the leading tomato-producing states in India, cultivating the crop year-round during the rainy, winter, and summer seasons. In 2016–17, the state accounted for a tomato production of 3.102 million tonnes from an area of 0.1 million hectares, with a productivity of 31.02 tonnes per hectare. The major tomato-growing districts include Ratlam, Indore, Khargone, Jhabua, Ujjain, Jabalpur, Chhindwara, Satna, Vidisha, and Bhopal (Anonymous, 2017) [3].

Tomato cultivation faces significant economic losses due to insect pests such as fruit borer (*Helicoverpa armigera*), Whitefly (*Bemisia tabaci*), Aphid (*Aphis gossypii*), Jassid (*Amrasca biguttula biguttula*), and Leaf miner (*Liriomyza trifolii*). These polyphagous pests are present throughout the year, causing substantial yield reductions (Sharma *et al.*,

2014). The continuous availability of alternate hosts further supports their population build-up, leading to persistent pest pressure in tomato fields. Among these, the fruit borer (*Helicoverpa armigera*) is considered a key pest, attacking buds, flowers, and fruits, resulting in severe qualitative and quantitative losses. Damage caused by this pest can lead to a yield reduction of up to 70% (Abbas *et al.*, 2015) [1]. Whitefly (*Bemisia tabaci*), jassid (*Amrasca biguttula biguttula*), and aphid (*Myzus persicae*) are major sap-sucking insects that negatively impact tomato production under both field and protected conditions. Heavy infestations can weaken plants, causing chlorosis, stunted growth, uneven ripening, and reduced yields (Hammad *et al.*, 2000) [6].

Continuous pest monitoring is essential to prevent sudden outbreaks. Various pest management approaches including cultural, mechanical, physical, biological, and chemical methods are employed to control sucking and borer pests. However, chemical control remains the most widely used approach due to its quick effectiveness. Unfortunately, the indiscriminate use of insecticides has led to the development of resistance among insect pests, diminishing the efficacy of conventional chemical treatments (Palumbo *et al.*, 2001) [15]. Given the economic importance of tomato and the challenges posed by insect pests, the present study aims to evaluate the seasonal incidence of major pests and analyse their correlation with climatic parameters to develop effective management strategies.

Material Methods

The experiment was conducted during the *Kharif* season of 2019-2020 to study the seasonal incidence of major insect pests on tomato and their correlation with climatic parameters. The tomato crop (variety: *Lakshmi*) was sown on 5th July 2019 and transplanted on 3rd August 2019, with a spacing of 60 cm × 60 cm in a plot size of 15 m × 6 m, consisting of 10 rows. The crop was cultivated following standard agronomic practices in Madhya Pradesh, India.

Observations on pest populations were recorded at weekly intervals on randomly selected ten plants per plot. The population of sucking pests, such as Jassids (*Amrasca biguttula biguttula*) and Whiteflies (*Bemisia tabaci*), was assessed by counting individuals present on three leaves (upper, middle, and lower) of each plant. The incidence of Fruit borer (*Helicoverpa armigera*) was monitored from the vegetative stage onward, and during the fruiting stage, the number of healthy and damaged fruits was counted at each picking. The correlation between major pest populations and weather parameters, including temperature, relative humidity, wind speed, sunshine hours, evaporation, and rainfall, was analysed statistically.

To evaluate the efficacy of insecticides against major pests, a randomized block design (RBD) was employed with three replications and eight treatments. The insecticides tested

were Chlorantraniliprole 18.5% SC (162 ml/ha), Flubendiamide 39.5% SC (152 ml/ha), Emamectin Benzoate 5% SG (200 g/ha), Spinosad 45% SC (278 ml/ha), Indoxacarb 14.5% SC (276 ml/ha), Abamectin 1.9% EC (158 ml/ha), and Lambda Cyhalothrin 5% EC (400 ml/ha), along with an untreated control. The experimental plots measured 4.2 m × 3 m, with a spacing of 60 cm × 60 cm between plants, 1 m between replications, and 0.5 m between plots. Fertilizer application was done in two stages: half of the nitrogen and full doses of phosphorus and potassium as basal application (100:80:60 NPK kg/ha), while the remaining nitrogen was applied as a top dressing at 45 days after sowing (DAS).

Pest observations were taken before and after insecticide application. The population of sucking pests was recorded 1 day before spraying and then at 1, 3, 7, and 10 days after spraying. Fruit borer larval counts were also recorded at each picking, and the percentage of fruit damage was calculated. The first insecticide spray was applied when pest populations reached the economic threshold level (ETL), followed by a second spray 15 days after the first application using a knapsack sprayer at 500 L/ha. for statistical analysis, method used to suggest by Pradhan (1969). The obtained results were analysed to identify the most effective and economically viable insecticide for controlling major tomato pests.

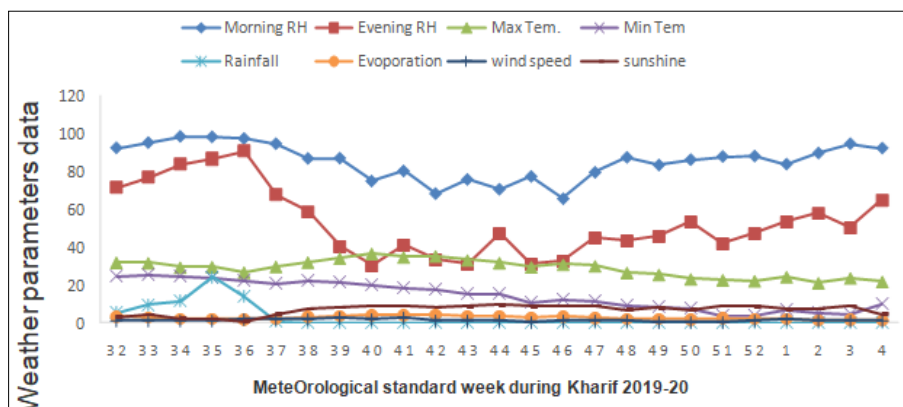


Fig 1: Weekly meteorological data during the experimentation period *i.e.* (2nd week of August 2019 to 4th week of January 2020) at Tikamgarh

Result and Discussion

Studies on the seasonal incidence of major insect pests revealed that Whitefly, Jassid, and Fruit borer were the major pests which damaged the crop.

Whitefly (*Bemisia tabaci* Genn.) The population of whiteflies (*Bemisia tabaci*) ranged from 0.80 to 18.20 per plant during the months of August to January. The initial incidence was observed in the 34th Standard Meteorological Week (SMW) (4th week of August), after which the population gradually increased, reaching its peak of 17.3 whiteflies per three leaves per plant in the 39th SMW (4th week of September). During this period, the maximum temperature was 30°C, and the minimum was 23°C, with a morning and evening relative humidity (RH) of 87% and 40%, respectively. Additionally, rainfall was 0 mm, wind speed was 0.8 km/hr, and evaporation was 3.4 mm. Following this peak, a declining trend was observed, with the lowest population recorded at 0.8 whiteflies per three leaves per plant in the 4th SMW (4th week of January).

Correlation analysis between whitefly population and weather parameters revealed that whitefly population exhibited a highly significant positive correlation with evaporation ($r=0.601$) and a significant positive correlation

with minimum temperature ($r=0.403$). A positive but non-significant correlation was found between whiteflies and maximum temperature ($r=0.380$) and sunshine ($r=0.323$). In contrast, the relationship between whiteflies and morning RH ($r=-0.402$) was significantly negative, while evening RH ($r=-0.373$), wind speed ($r=-0.025$), and rainfall ($r=-0.266$) were also negatively correlated but non-significant. This indicates that weather parameters, especially evaporation and minimum temperature, play a crucial role in influencing whitefly populations on tomato crops.

The present study aligns with previous findings on whitefly (*Bemisia tabaci*) incidence. Mishra *et al.* (2017) [11] observed that whitefly infestation began in the fourth week of August (1.80/plant) and peaked at 21.10 whiteflies/plant in late September (39th SMW). Meena *et al.* (2010) [7] reported a similar trend, with infestation starting in early September and peaking in the fourth week. Abhishek *et al.* (2016) [2] recorded an increase from 37th to 41st SMW, followed by a decline. Prasad *et al.* (2008) [17] noted peak populations in early November, while Naik *et al.* (2009) [12] found no significant correlation with abiotic factors. Patra *et al.* (2015) [16] reported negative, non-significant correlations with RH and rainfall.



Plate 1: Whitefly population on tomato crop



Plate 2: Whitefly attack symptoms on tomato

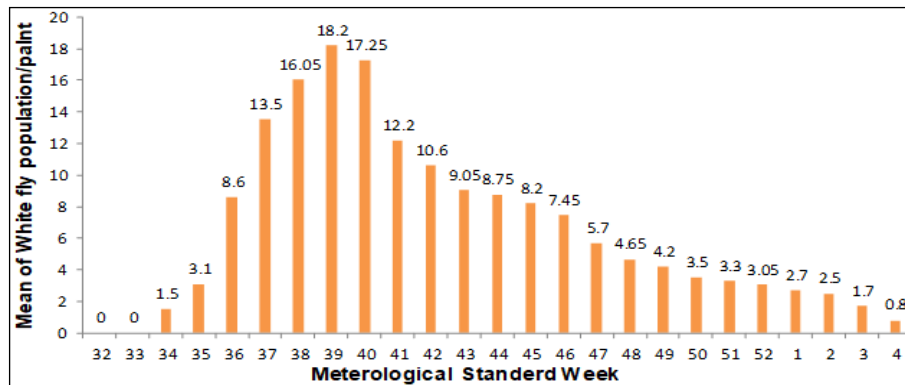


Fig 2: Seasonal incidence of white fly on tomato and their correlation with wheather parameters during kharif season 2019-20

Jassid (*Amrasca biguttula biguttula*)

The initial population of *Amrasca biguttula biguttula* was observed in the 34th SMW (4th week of August), with 0.2 jassids per three leaves per plant. The population gradually increased, reaching its peak at 9.3 jassids per three leaves per plant in the 40th SMW (1st week of October). During this period, the average maximum temperature was 36.5°C, and relative humidity was 74.71% (morning) and 30.30% (evening). Other recorded weather parameters included 0 mm rainfall, 0.4 km/hr wind speed, 8.65 hours of sunshine per day, and 3.9 mm evaporation. After reaching its peak, the jassid population declined significantly.

The correlation studies between jassid population and weather parameters revealed that jassid population was highly significantly positively correlated with evaporation (r=0.705) and sunshine hours (r=0.703). A positive but non-significant correlation was found with maximum temperature (r=0.298). A negative and highly significant correlation was observed with morning RH (r= -0.743),

evening RH (r= -0.802), and rainfall (r= -0.524). Additionally, wind speed (r= -0.478) and minimum temperature (r= -0.068) showed a negative but non-significant correlation.

In summary, the population of jassids started in late August, peaked in early October, and then declined. The population dynamics were largely influenced by environmental factors, with temperature, evaporation, and sunshine playing a crucial role in jassid activity. Relative humidity, wind speed, and rainfall negatively impacted the population, suggesting their role in suppressing jassid infestations.

The findings align with Vishwanathrao (2002) [19], who reported a significant negative correlation between jassid activity and wind velocity and a positive correlation with sunshine hours. Studies by Noutiyal *et al.* (2016) [13], Meena *et al.* (2014) [8], and Prasad (2008) [17] also observed similar jassid population trends, peaking in October and declining afterward.

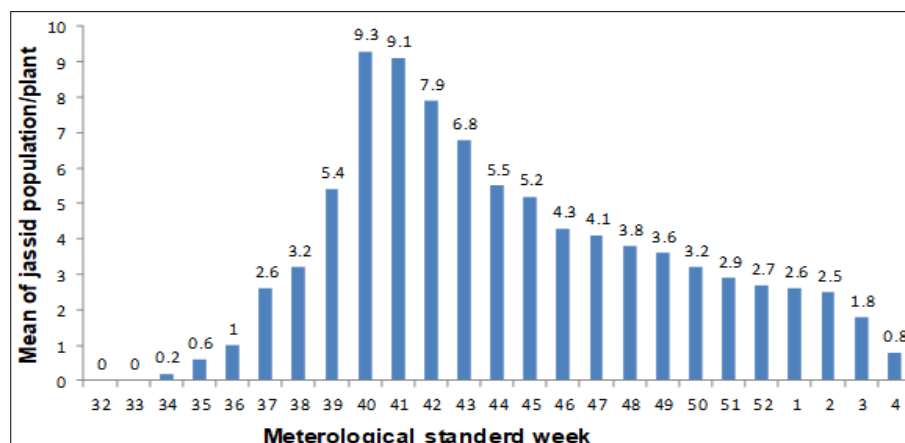


Fig 3: Seasonal incidence of jassid on tomato and their correlation with wheather parameters during kharif season 2019-20



Plate 3: Damage symptoms of jassid on tomato plants

Fruit borer (*Helicoverpa armigera* Hubner)

The seasonal incidence of *Helicoverpa armigera* on tomato was studied during the kharif seasons of 2019-20. The population of the fruit borer was monitored from 15th September to 28th January, spanning the 36th to 4th Standard Meteorological Weeks (SMW) in both years. In 2018-19, the population ranged from 0.05 larvae per plant initially to 6.2 larvae per plant at the peak infestation level. The incidence began in the 36th SMW with 0.5 larvae per plant, peaked at 6.2 larvae per plant in the 47th SMW (4th week of November), and then declined to 0.05 larvae per plant by the 4th SMW (4th week of January).



Plate 4: Damage tomato fruit due to *Helicoverpa armigera*

Similarly, in 2019-20, the population started at 0.05 larvae per plant in the second week of October reached its peak at 6.2 larvae per plant in the 4th week of November, and declined to 0.05 larvae per plant in the last week of January. Correlation studies indicated that the fruit borer population was highly significantly positively correlated with evaporation and sunshine ($r = 0.510$ and $r = 0.652$). A positive but non-significant correlation was observed with maximum temperature ($r = 0.412$). Conversely, negative correlations were found with morning and evening relative humidity ($r = -0.749$ and $r = -0.748$) and wind speed ($r = -0.597$), all highly significant. Rainfall and minimum temperature showed significant but non-significant negative correlations ($r = -0.491$ and $r = -0.170$).

The findings align with previous studies, such as Chavan *et al.* (2016) [4], who observed higher *Helicoverpa armigera* populations during the 42nd SMW at Parbhani. Meena *et al.* (2014) [8] reported fruit borer incidence from mid-November to January, with the population peaking at 4.2 larvae per plant during the fruiting stage. Kumar *et al.* (2017) [14] found a significant negative correlation with maximum and minimum relative humidity and a positive correlation with sun hours. Chula *et al.* (2017) [5] also observed negative correlations between relative humidity and pest population, with significant negative correlations between rainfall and fruit borer population.

Table 1: Activity of major Insect pests of tomato during kharif 2019-20

Name of insect	Scientific name	Population range /plant	Active period	Peak activity period
Whitefly	<i>Bemisia tabaci</i>	0.80-18.20	21 st Aug to 22 nd Jan	Fourth week of Sep.
Jassid	<i>Amrasca biguttula</i>	0.80-9.30	21 st Aug to 22 nd Jan	First week of Oct.
fruit borer	<i>Helicoverpa armigera</i>	0.05 – 6.20	4 th Sep to 22 nd Feb	Fourth week of Nov.

Table 2: Correlation coefficient among major insect pests of tomato with weather parameters

Weather parameter	Insect pests		
	Whitefly	Jassid	Fruit borer
Maximum Temperature (°C)	0.505*	0.298	0.412*
Minimum Temperature (°C)	0.403*	-0.068	-0.170
Morning Relative humidity (%)	-0.402*	-0.743**	-0.749**
Evening Relative humidity (%)	-0.373	-0.802**	-0.748**
Evaporation (mm)	0.601**	0.705**	0.510**
Rainfall (mm)	-0.266	-0.524**	-0.491*
Wind velocity (km/hr)	-0.025	-0.478*	-0.597**
Sun shine (hr/day)	0.323	0.703**	0.652**

* Correlation is significant at 5% level (t value is 2.06)

** Correlation is significant at 1% level (t value is 2.80)

Conclusion

The study on the seasonal incidence of major insect pests on tomato crops during the Kharif season of 2019-2020 highlighted the significant impact of whitefly, jassid, and fruit borer on crop yield. The pest populations of *Bemisia tabaci* (whitefly), *Amrasca biguttula biguttula* (jassid), and *Helicoverpa armigera* (fruit borer) followed distinct patterns, with peak infestations occurring during specific periods, such as the 4th week of September for whitefly and the 4th week of November for fruit borer. The correlation between pest populations and weather parameters revealed that evaporation and sunshine had highly significant positive correlations with pest populations, while relative humidity and rainfall showed negative correlations, highlighting the importance of climatic factors in pest dynamics.

These findings underscore the need for integrated pest management strategies that consider both biological and climatic factors to effectively manage pest outbreaks and minimize crop loss. Timely pest monitoring and targeted interventions, including the judicious use of insecticides, are critical to mitigate the damage caused by these pests. Additionally, the study emphasizes the necessity of continued research to explore more sustainable pest management approaches, particularly in light of increasing pest resistance to chemical controls. This research provides valuable insights for improving tomato cultivation practices and safeguarding yields against major insect pests.

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