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RESEARCH ARTICLE

Influence of meteorological parameters on the seasonal abundance and distribution of major sucking insect pests of okra [*Abelmoschus esculentus* (L.) Moench]

Suraj Soni[1,2], Umesh Chandra[1], Jaydeep Halder[2*], Aman Pratap Singh[1,2], Sameer Kumar Singh[1], Abhisekh Kumar Yadav[3], Harshit Gupta[1], Nikki[1], Priyanshi Kamal[1] & Ankit Kumar[1]

[1]Department of Entomology, College of Agriculture, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya 224 229, Uttar Pradesh, India

[2]ICAR-Indian Institute of Vegetable Research, Varanasi 221 305, Uttar Pradesh, India

[3]Department of Entomology, College of Agriculture, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur 208 002, Uttar Pradesh, India

*Correspondence email - jaydeep.halder@gmail.com

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Abstract

Field experiments were conducted during the *Kharif* seasons of 2023 and 2024 in the Varanasi region to study the population fluctuations of jassid (*Amrasca biguttula biguttula* Ishida) and whitefly (*Bemisia tabaci* Genn.) on okra and their relationship with weather variables. Weekly data on jassid and whitefly populations on okra were taken through simple random sampling, whereas different abiotic parameters were obtained from the meteorological observatory of the institute. The results revealed that the jassid population commenced from 32ndand 31stSMW in 2023 and 2024, respectively. The highest jassid population was observed during the 37th SMW in both years. The maximum temperature, minimum temperature, maximum relative humidity, sunshine hr and minimum relative humidity had significant positive correlations with these two major sucking pests, whereas a negative and non-significant correlation was established between maximum relative humidity, whitefly population, minimum relative humidity, rainfall, evaporation and wind speed in both seasons. In 2024, the wind speed (r = -0.549) had a significant negative correlation with the jassid population. For whitefly, significant negative correlations were found with sunshine hr (r = -0.703), rainfall (r = -0.595) and evaporation (r = -0.622) in 2023.

Keywords: abundance of pest; correlation; okra; sucking insect; weather parameters

Introduction

Okra *Abelmoschus esculentus* (Linn.) Moench (family: Malvaceae), one of the important traditional vegetables in India. It forms a crucial component of the human diet, being a rich source of vitamins (A, B and C), protein, carbohydrates, lipids, iron and iodine. In addition to these, it is a good source of ascorbic acid, folate, dietary fibre and antioxidants (1-3). It is cultivated almost throughout India. India produces the most okra, accounting for 62.12 % of the world's total production. The country has an area of 557 thousand hectares, with 7.305 million tonnes of production and a productivity of 12 t/ha (4, 5).

However, this economically significant crop is ravaged by a number of insect pests throughout its growth period (6-8). More than 72 insect pests have been reported to attack the crop, infesting it from seedling to harvest. The okra shoot and fruit borer (*Earias vitella* Fabricius), (*E. insulana* Boisduval) (Noctuidae: Lepidoptera); fruit borer (*Helicoverpa armigera* Hubner) (Noctuidae: Lepidoptera); jassid (*Amrasca biguttula biguttula* Ishida) (Cicadellidae: Hemiptera) and whitefly (*Bemisia tabaci* Gennadius) (Aleyrodidae: Hemiptera) are considered major pests (7, 9-12). The okra jassid (or leafhopper) and whitefly, are important sucking pests in okra growing region particularly in eastern Uttar Pradesh, causing serious damage and are responsible for lowering the major yield of okra crop. Nymphs and adults feed by sucking cell sap from the underside of leaves and injecting toxic saliva, leading to yellowing, upward curling, poor flowering and fruit set and typical 'hopper burn' symptoms (9, 13). Yield reductions of up to 40 %-50 % have been observed in okra due to leaf hopper infestation (9, 13). Similarly, whiteflies being a polyphagous sucking pest, causes damage through desapping of plants; their nymphs and adults deposits the sugar-rich honeydew on leaves, which provides suitable conditions for the development of black sooty mould, further inhibiting photosynthesis. Apart from this, *B. tabaci* also transmits yellow vein mosaic virus (YVMV) disease in okra (10, 13).

The incidence of insect pests is an outcome of the interaction among plants, sucking pests and weather over a period of time. Weather parameters such as temperature, rainfall, wind speed, evaporation, sunshine and relative humidity strongly influence insect pest populations (6).

In recent years, to control insect pests in vegetable crops, various types of systemic and contact insecticides either as spray, seed treatment or granule formulations, have been widely applied. Indiscriminate and injudicious application of these pesticides often causes problems like resistance to pesticides, resurgence of many sucking pests, widespread killing of non-target organisms and residue accumulation in food and beverages, which further aggravates the problem.

The multiplication of these major okra pests has been found to be governed by environmental factors. Correlation studies between different abiotic factors and insect pest populations are essential tools for developing pest prediction models. This will be useful to take suitable integrated control measures, well in advance, thus reducing dependence on the excessive and sole usage of insecticides and thereby reducing the cost of cultivation as well as environmental hazards. Keeping this in view, the present investigation was aimed at elucidating the effect of different weather parameters on the population build-up of these two nefarious sucking pests of okra.

Materials and Methods

The experiment on the prevalence of sucking insect-pest on okra and their correlation with weather parameters was conducted during two consecutive *Kharif* seasons from July to October in 2023 and 2024, at the research farm of ICAR- Indian Institute of Vegetable Research (25°12' N latitude, 82°52' E longitude), Varanasi, Uttar Pradesh. The experimental site falls under the alluvial zone of Indo-Gangetic plains, having silt loam soils with low organic carbon (0.43 %) and available nitrogen (185 kg ha^{-1}). The site receives an average annual rainfall of about 1110 mm, with the majority concentrated between the first week of July and mid-August.

An experimental area of 60 m^2 was divided into three replicates (each 20 m^2) and was designed according to a complete randomized blocks design (CRBD). The seeds of okra (cv. Kashi Pragati) were sown in plots with a plant-to-plant 45 cm and a row-to-row 60 cm. The line-sowing method was followed. A total of 3-4 seeds were sown in each hill in the rows, at a depth of 2-3 cm during the *Kharif*.

Fertilizers (N:P:K = 120:60:60) were applied at the recommended doses. Half of the nitrogen and full doses of phosphorous and potash were applied at the time of sowing and remaining half of nitrogen was applied in two equal spilts: the first at 30 days after sowing and the second at the initiation of flowering and fruiting. Hand weeding and irrigation were provided as required and all standard crop husbandry practices were followed, except for plant protection measures.

Insect incidence was monitored weekly during morning hr (7:00–8:00 a.m.). The population of sucking pests (jassid and whitefly) was counted on three leaves per plant-one each from top, middle and bottom regions-from six randomly selected plants and expressed as the number of insects per leaf(11, 14, 15). All the stage of nymphs and adults of both pests were taken into account while counting. The jassid and whiteflies on the upper surface of leaves were counted first, followed by those on the lower surface by gentle turning, taking care not to disturb them (14). The data were recorded from germination until crop maturity. The weekly meteorological data of various parameters were collected during the cropping seasons from the meteorological observatory of the institute.

Statistical analysis

To study the correlation among the different abiotic parameters (temperature, relative humidity, etc.) and the populations of jassids and whiteflies on okra during 2023 and 2024, SAS software (version 9.3) was used for statistical analysis, following the standard procedure.

Results and Discussion

Jassid, *Amrasca biguttula biguttula* (Ishida) (Cicadellidae : Hemiptera)

Abundance of jassid on okra

During the *Kharif* season of 2023, jassid nymphs and adults were observed. Incidences of jassids/leaf varied from 1.53 to 6.96, with a mean of 4.09 per leaf. The incidence of jassids on okra started during 32nd SMW (i.e. three week after sowing) and was observed up to 42nd SMW (4th week of October) (Table 1; Fig. 1). The initial mean population of jassid was recorded as 1.53 jassids/leaf during 32nd SMW and there was a gradual increase from the second week of August (33rd SMW) to the second week of September (37th SMW), with a maximum population of 6.96 jassids per leaf. The peak incidence of pest population was observed during the second week of September (37th SMW) with a mean population of 6.69 jassids per leaf. Thereafter, the population gradually decreased from the third week of September (6.26 jassids per leaf). During the next year (i.e. 2024), the incidence of jassids on okra started from 31st SMW and continued up to 43rd SMW. Peak jassid population (5.6 jassids per leaf) was found during the 2nd week of September (37th SMW). Thereafter, the population of jassids declined gradually (Table1; Fig. 2).

The present results corroborate with observations of whom, revealed that jassid incidence started from first week of August, three weeks after sowing (16). The present result are also similar with findings of whom, also reported that jassid populations on *Kharif* crop started from the first 31st - 32nd SMW of August (6, 17). Similar

Table 1. Correlation coefficient (r) between sucking pest of okra and weather parameters during *Kharif*, 2023 and 2024

Weather parameters	Sucking pest			
	Jassid		Whitefly	
	2023	2024	2023	2024
Maximum temperature	0.133	0.435	0.484	0.249
Minimum temperature	0.339	0.111	0.049	0.094
Relative humidity maximum	0.490*	-0.020	-0.373	-0.045
Relative humidity minimum	0.323	0.160	-0.072	0.155
Sunshine hr	0.252	-0.060	-0.703**	-0.043
Rainfall	-0.133	-0.026	-0.595 *	-0.093
Evaporation	-0.068	-0.008	-0.622 **	-0.049
Wind speed	-0.295	-0.549**	-0.093	-0.190

*Significant at 0.2 level; **significant at 0.1 level.

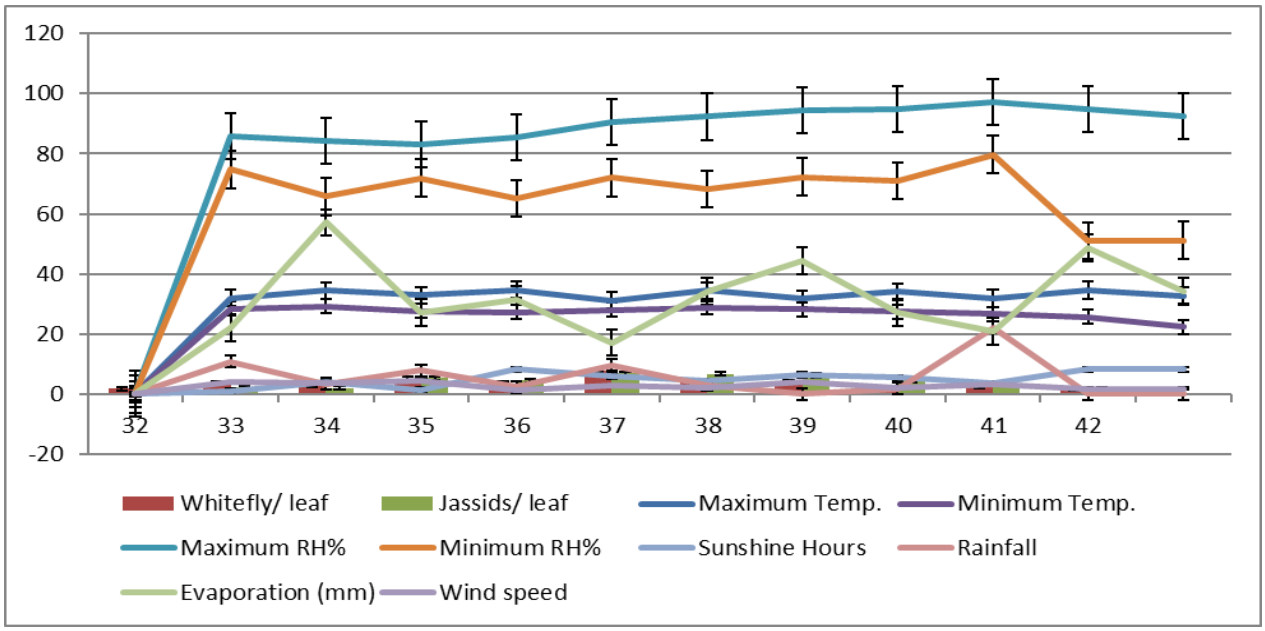

Fig. 1. Seasonal abundance of sucking pests on okra during *Kharif* 2023.

results reported that the peak jassid population from last week of August to September on okra crop (18). The infestation of jassid was noticed during the first week of August and reached its peak during the second and third weeks of September (19). The result finding also got supported from the other findings, that peak leafhopper population on okra was during the second week and third week of September and then declined gradually (20, 21).

Effect of weather parameters on abundance of jassid on okra

Taking into account the data, it is evident that jassid infestation on okra crops showed a positive correlation with maximum temperature (r = 0.133), minimum temperature (r = 0.339), minimum relative humidity (r = 0.323) and bright sunshine hr (r = 0.252). In contrast, rainfall (r = -0.133), wind speed (r = -0.295) and evaporation (r = -0.068) showed negative and non-significant correlations. The maximum relative humidity was significantly correlated with weather conditions during 2023 (r = 0.490, p ≤ 0.01) (Table 1; Fig. 1). Similarly, during the successive year, the correlation analysis for *Kharif* 2024 revealed that the jassid population had a positive correlation with maximum temperature (r = 0.435), minimum temperature (r = 0.111), minimum relative humidity (r = 0.160) and negative correlation with maximum relative humidity (r = -0.020), sunshine hr (r = -0.060), rainfall (r = -0.026) and evaporation (r = -0.008) (Table 1; Fig. 2).

Looking to the past findings there was impact of all the weather parameters on the infestation of leafhopper population viz. sunshine hr (r = -0.140), rainfall (r = -0.120), wind speed (r = -0.100), maximum temperature (r = 0.550) and minimum temperature (r = 0.370) (21). In another study, a non-significant association of different abiotic factors with jassid activity was highlighted (22). These present findings are in accordance with the other researchers, who reported that jassid population showed positive non-significant correlation with maximum relative humidity and minimum relative humidity (r = 0.545), whereas wind speed (r = -0.109) and rainfall showed negative, non-significant correlations with leafhopper (23-25). However, a negative and non- significant correlation of jassid population with rainfall was also observed (26). The present findings are also in close agreement with the findings of (27).

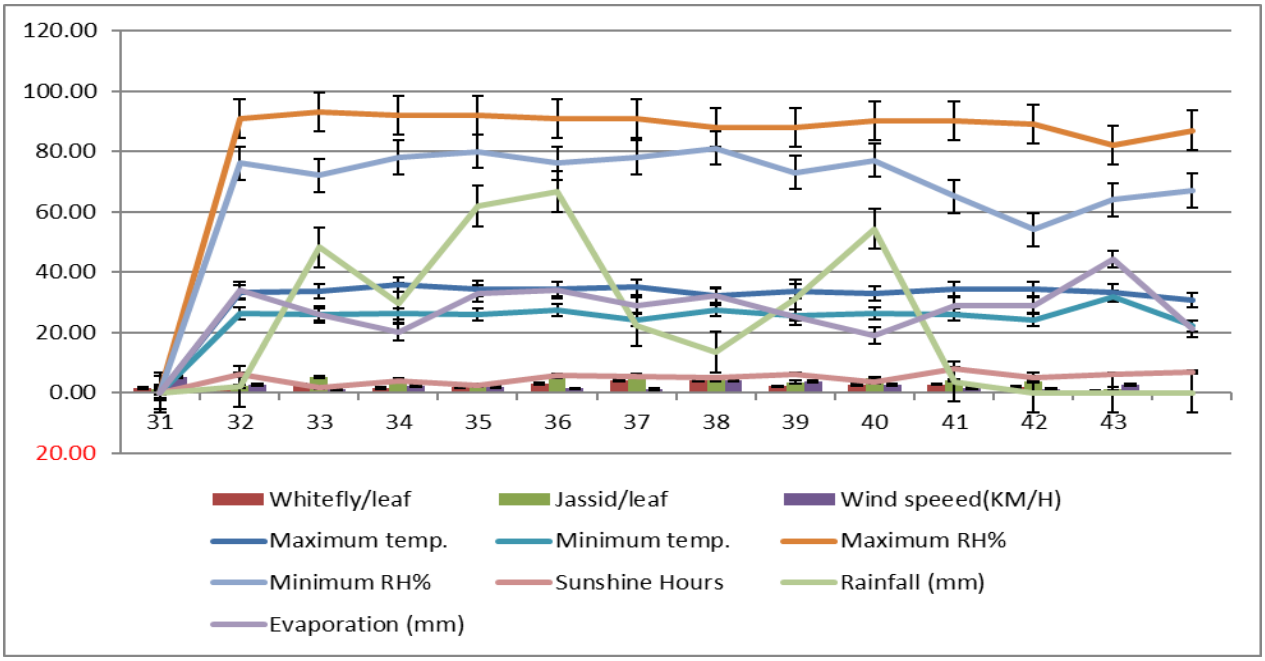

Fig. 2. Seasonal incidence of sucking pest on okra during *Kharif* 2024.

Whitefly, *Bemisia tabaci* (Gennadius) (Aleyrodidae: Hemiptera)

Abundance of whitefly on okra

The adult whitefly population ranged from 1.73 to 7.76 whitefly per leaf) between the 32nd and 43rd SMWs of *Kharif* 2023 (Table 1; Fig. 1). Incidence of whiteflies began in the 32nd SMW (third week after sowing) when the temperature was 32 °C (Tmax), 28.4 °C (Tmin) and the relative humidity was 85.7 % in the morning and 74.7 % in the evening. The population gradually increased during the successive weeks, but fluctuated during 36th SMW. The peak population of whitefly (7.76 whitefly per leaf) was observed at the 37th SMW at 34.4 ° C maximum, 28.7 °C minimum temperature and 92.28 % and 68.28 % maximum and minimum relative humidity, respectively. After the peak population, the whitefly population suddenly decreased to 3.86 per leaf. After 39th SMW, the whitefly population declined gradually and reached mean population of 1.83 per leaf during the 42nd SMW.

During 2024, the incidence of whitefly was in the range of 0.58 to 4.11 per leaf, from 31st SMW (i.e. 1st week of August) to 43rd SMW (last week of October). The initial incidence was observed in the 3rd week after sowing i.e. starting of August month (31st SMW), with a mean population of 1.57 whiteflies per leaf. The population was gradually increased during successive weeks, but fluctuated during 34th SMW due to rainfall. The pest population reached its peak during the 37th SMW (2nd week of September), with a population of 4.11 per leaf.

The present observations are corroborated with the findings of whom, reported the incidence of whitefly started during 32nd SMW and gradually increased and reached maximum population during 37th SMW and from 40th SMW onwards its population started declining (6). It also stated that the whitefly incidence started from the 34th SMW and lasted up to 44th SMW, with the peak occurring in the 38th SMW (7.4 whiteflies per leaf) (12, 14).

Effect of weather parameters on abundance of whiteflies on okra

Study on the effect of various weather parameters on the fluctuation of whitefly population on okra during *Kharif* 2023 indicated that maximum temperature showed a positive correlation (r = 0.484), while rainfall (r = -0.595) and sunshine hr (r = -0.703) were significantly negative (Table 1; Fig. 1). Similarly, during 2024, the correlation co-efficient between the whiteflies and different weather parameters revealed that the whitefly population exhibited positive but non-significant interactions with maximum temperature (r = 0.249), minimum temperature (r = 0.094) and minimum relative humidity (r = 0.155). In contrast, the relationships between the whitefly and maximum relative humidity (r = -0.045), bright sunshine hr (r = -0.043), evaporation (r = -0.049) and wind speed (r = -0.190) were negative but non-significant correlation (Table 1; Fig. 2).

The present finding on occurrence of whitefly are consistent with the findings, who observed positive, non-significant correlation with maximum and minimum temperatures, while negative, non-significant correlation with minimum relative humidity, rainfall and wind speed (24). The correlation of whitefly with existing weather factors also exhibited negative, significant correlation with rainfall and wind speed (6). A positive, non-significant correlation with maximum and minimum temperatures and negative, non-significant correlation with maximum relative humidity, rainfall and wind speed were also reported by (28, 29).

Conclusion

Jassids and whiteflies are the major sucking pests infesting okra throughout the cropping season. However, their population dynamics vary with prevailing weather conditions. Correlation analysis indicated that maximum temperature, minimum temperature, relative humidity maximum, sunshine hr and minimum relative humidity had significant positive correlations with these two major sucking pests. In contrast maximum relative humidity, rainfall, evaporation, wind speed showed negative or non-significant correlations with pest incidence in both seasons. Keeping this in view, the present investigation was aimed to elucidate the effect of different weather parameters on the population buildup of these two nefarious sucking pests of okra and also to predict pest incidence to alerts farmers about pest attack and develop weather-based pest management strategies. This will be useful to initiate suitable integrated control measures well in advance, thus reducing the excessive and sole usage of insecticides and thereby reducing the pest incidence and overall cost of cultivation.

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Authors' contributions

SS was responsible for the conceptualization of the study, conducting the experiments, data analysis and data curation. UC and JH provided supervision, contributed to the development of the methodology and were involved in reviewing and editing the manuscript. SKS, SS, APS, AKY, HG, N, PK and AK contributed to the preparation of the final draft and participated in its revision. All authors read and approved the final manuscript.

Compliance with ethical standards

Conflict of interest: The authors declare that there is no conflict of interest regarding the publication of this research.

Ethical issues: This study did not involve any experiments on human participants or animal that required ethical approval. All procedures were conducted following standard scientific guidelines and institutional policies.

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