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Influence of weather parameters on seasonal incidence of sucking pests and their natural enemies on okra

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Abstract
The goals of current study were to record the variation in sucking pest populations and those of their natural enemies in okra and to evaluate the impact of meteorological factors on the seasonal occurrence of these pests. According to the data, okra crops experienced pest infestations all season long during Kharif-2022. The third week of July (30th MW) noticed the first appearance of *Aphis gossypii*, which peaked in the last week of August (35th MW) with 17.91 individuals per three leaves. Throughout the season, *Amrasca biguttula biguttula* were also present; their population peaked in the final week of October (44th MW) and ranged from 6.56 to 20.45 individuals per three leaves. Populations of *Bemisia tabaci* ranged from 4.52 to 9.67 individuals per three leaves; the second week of September (the 37th MW) noted the highest activity. The last week of July (the 31st MW) noticed the appearance of coccinellids, the pests' natural predators, who peaked in the second week of October (the 41st MW) with a population density of 3.51 individuals per three leaves.

Keywords: Seasonal incidence, okra, *Aphis gossypii*, *Amrasca biguttula biguttula*, *Bemisia tabaci*, weather parameters, correlation

Introduction
Okra (*Abelmoschus esculentus* (L.) Moench) commonly known as bhindi or lady's finger (Family: Malvaceae) is a popular fruit vegetable crop and it is originated from Africa. It is an important *summer* and *kharif* season vegetable crop grown throughout the world (Sapkal *et al.*, 2022) [18]. Okra is grown throughout India on an area of 532.66 thousand hectares, with an annual production of 6513 thousand metric tonnes. It is grown on an area of 8.91 thousand hectares in Maharashtra, with an annual production of 139.28 thousand tonnes. (Anonymous, 2021). It is a significant cash crop with high returns for growers. However, this crop is also known to be susceptible to a variety of insect pests and diseases that must be dealt with in a timely and effective manner. Approximately 72 insect pests attack the crop from germination to harvesting (Rao and Rajendran, 2003) [16]. According to Dangi and Ameta (2005) [4] and Meena and Kanwat (2005) [10], the main insect pests are Aphid, *Aphis gossypii* Glov., whitefly, *B. tabaci* (Genn.) and leaf hoppers, *A. biguttula* biguttula (Ishida), and mites, *Tetranychus cinnabarinus* (Boisd.). Among them, sucking pests like aphids, leafhoppers, and white flies pose a serious risk to okra production. Furthermore, studies examining the effects of meteorological factors on pest populations have yielded important knowledge about the distribution and behaviour of these pests. (Deshmukh *et al.*, 2023) [5]. By performing a thorough analysis of pest populations in okra fields and their relationship to weather, this study adds to the body of knowledge already available. The purpose of this study is to present a thorough analysis of the variations in pest populations and how they relate to okra weather parameters in Kharif 2022-2023.

Materials and Methods
In Kharif 2022–2023, the research field Post Graduate Institute, MPKV, Rahuri conducted a study with the goal of analysing the seasonal incidence of sucking pests and their natural enemies in okra. A 10 x 10 m unprotected plot was used for the experiment, and recommended agronomic practices were followed. The number of nymphs and adults of sucking pests (aphids, leafhoppers, and whiteflies) was counted on three randomly chosen leaves (the bottom, middle, and top leaves) of five different plants. On the other hand, the average population of each plant was calculated by recording the population of natural enemies (coccinellids) on five randomly chosen plants from the net plot.

The MPKV, Rahuri observatory provided meteorological data for the corresponding seasons, which were then correlated with pest dynamics. In order to determine relationships between weather parameters and sucking pests and their natural enemies in okra cultivation, the study used a straightforward correlation analysis.

Results and Discussion

The data on seasonal incidence of *Aphis gossypii*, *Amrasca biguttula biguttula Bemisia tabaci* and in okra during *Kharif*, 2022-23 are presented in Table 1.

Seasonal incidence of *Aphis gossypii*

The data revealed that during *Kharif*-2022, the incidence of aphid populations during the third week of July 2022 ranging from 3.42 to 17.91 aphids per three leaves throughout the *kharif* season. Initial aphid presence was observed on the 30th Meteorological Week (MW), roughly 15 days after sowing, with a population of 3.42 aphids per three leaves. This population steadily increased, reaching a peak of 17.91 aphids per three leaves on the 35th MW, which falls within the last week of August. Interestingly, the aphid population remained relatively stable at 17.51 aphids per three leaves until the end of the cropping season. Present findings are in line with those reported by Parasai and Shastry (2009) [12] who recorded maximum incidence of aphid population during 1st week of September *i.e.*, 37th MW. Thara *et al.,* (2019) [19] who reported that the population of aphid gradually increased and reached the peak level during second week of October.

Seasonal incidence of *Amrasca biguttula biguttula*

During *kharif* 2022 season, the leafhopper population appeared from 30th MW (6.56 leafhoppers/3 leaves). The population of leafhoppers gradually decreased from 35th MW (17.10 leafhoppers/3 leaves) and again increased reached its peak in the last week of October *i.e.,* 44th MW (20.45 leafhoppers/3 leaves). During *kharif* 2022 okra crop experienced leafhopper populations ranging from 6.56 to 20.45 leafhoppers/3 leaves. Similar observations were also observed by Mahmood *et al.,* (1990) [21] who revealed that leafhoppers started emerging from month of June and remained active till the end of crop season. The findings are also in accordance with Hedge *et al.,* (2004) [9] who reported maximum population during August to September.

Seasonal incidence of *Bemisia tabaci*

During *kharif* 2022, the population of whitefly on okra crop was recorded throughout the season. The infestation first started from second week of July *i.e.,* 29th MW with initial mean population of 4.52 whitefly/3 leaves. The infestation ranged from 4.52 to 9.67 whitefly/3 leaves. The highest population was recorded in 37th MW (9.67 whitefly/3 leaves). Thereafter gradual decrease in population was observed. The present findings are more or less similar to those reported by earlier researchers, Potai and Chandrakar (2018) [13] who reported appearance of pest during second week of August and the population reached at its peak in third week of September (38th Standard MW). Aarwe *et al.,* (2016) [1] who revealed that population of whitefly reached its peak in August (34th Standard MW).

Table 1: Seasonal incidence of sucking pests on okra and their natural enemies during *Kharif*-2022

Month	MW	Mean no of sucking pests / 3 leaves / plant			No. of natural enemies / plant
		Aphids	Leafhoppers	Whiteflies	Coccinellids (Grubs / Adults)
July-2022	28	0.00	0.00	0.00	0.00
	29	0.00	0.00	4.52	0.00
	30	3.42	6.56	5.17	0.00
	31	4.65	7.89	4.87	0.82
August-2022	32	4.26	9.47	5.07	1.56
	33	5.30	11.96	4.83	1.79
	34	14.63	15.30	4.23	3.23
	35	17.91	17.10	6.62	1.47
September-2022	36	15.24	16.36	7.33	2.14
	37	8.58	14.85	9.67	1.86
	38	9.17	13.67	8.30	1.25
	39	10.42	13.21	7.74	2.64
October-2022	40	13.61	12.78	7.89	2.49
	41	12.01	16.96	4.45	3.51
	42	14.47	17.61	6.82	2.45
	43	16.96	17.46	6.37	2.98
	44	17.51	20.45	7.00	1.37

Seasonal incidence of Coccinellids

In the *kharif* season of 2022, it was observed the presence of predatory coccinellids throughout the cropping cycle, alongside various pest species. The initial coccinellid population, recorded during the 31st meteorological week (last week of July), was 0.82 coccinellids per 3 leaves. Throughout the season, the population fluctuated between 0.82 and 3.51 coccinellids per 3 leaves. The peak coccinellid activity, with a population of 3.51 coccinellids/3 leaves, occurred during the 41st meteorological week. The results are in line with the Gaikwad *et al.,* (2020) [8] who revealed that the population of coccinellids were first noticed during 31st MW with gradual increase in following weeks. The reports of the Singh *et al.,* (2013) [18] also recorded the peak coccinellid incidence in the first week of September and second week of October, respectively.

Simple correlation of sucking pests and natural enemies with weather parameters during *Kharif*-2022

Correlation coefficients between various weather parameters with the population of sucking pests *viz.,* aphids, leafhoppers and whitefly and their natural enemies *i.e.,* coccinellids presented in Table 2.

Table 2: Correlation of population of aphids, leafhopper, whitefly and natural enemies with weather parameters during *Kharif*-2022

Weather parameters	Correlation coefficient value			
	Aphid	Leafhopper	Whitefly	Coccinellid
Max. Temperature	0.417*	0.271	0.405	0.153
Min. Temperature	-0.560**	-0.532*	-0.252	-0.200
Morning RH	-0.003	0.035	0.235	0.075
Evening RH	-0.609**	-0.472*	-0.286	-0.185
Rainfall (mm)	-0.105	-0.005	0.225	-0.109

*5% level of significance DF 15=0.412
**1% level of significance DF 15=0.558

Correlation study investigated the relationship between maximum temperature and various insect populations. Results found positive correlations between maximum temperature and leafhopper, whitefly, and coccinellid. However, these correlations were not statistically significant, with correlation coefficients of 0.271, 0.405, and 0.153 respectively. In contrast, a significant positive correlation (coefficient 0.417*) was observed between maximum temperature and aphid populations. Minimum temperature showed negative significant correlation with the whitefly (-0.252) and coccinellid (-0.200). Whereas, aphid and leafhopper population was negatively significant with the minimum temperature with correlation coefficient -0.560** and -0.532*, respectively.

The leafhopper, whitefly and coccinellid population correlated positively and non- significantly with the morning relative humidity with correlation coefficient value 0.035, 0.235, and 0.075 respectively. Whereas, morning relative humidity showed negative non- significant correlation (-0.003) with the aphid. The evening relative humidity was negative and non-significant with the whitefly and coccinellid with correlation coefficient value -0.286 and -0.185 respectively. However, aphid and leafhopper population showed negative significant correlation with evening relative humidity with correlation coefficient value (- 0.609**) and (-0.472*), respectively. Rainfall showed positive non-significant correlation with the whitefly with correlation coefficient value 0.225. Whereas, aphid, leafhopper and coccinellid with correlation coefficient value -0.105, -0.005 and -0.109 respectively showed negative non-significant correlation with rainfall.

The present findings are in close agreement with Dhandge *et al.,* (2018) [7] revealed that aphid population showed positive correlation with maximum temperature while, negative correlation with morning and evening relative humidity. Ratanpara *et al.,* (1994) reported that minimum temperature showed negative correlation with leafhoppers. Anita (2007) reported positive correlation between leafhopper and morning relative humidity. Purohit *et al.,* (2006) [14] stated positive correlation of whitefly with all the abiotic factors. These results are in confirmation with the findings of Yadav and Singh (2013) [18] who revealed positive correlation between whitefly and maximum temperature. Another findings by Dhandge *et al.,* (2018) [7] revealed that pest population showed negative correlation with evening relative humidity.

The present study revealed that there was a negative correlation between coccinellid and minimum temperature, evening relative humidity and rainfall, while positive correlation of maximum temperature and morning relative humidity with natural enemies *i.e.*, coccinellid. Reports of Purohit *et al.,* (2006) [14] stated correlation between coccinellid and minimum temperature and rainfall in confirmation to present findings. These findings are similar with reports by Dhaka and Pareek (2007) [6] who revealed correlation between coccinellid and evening relative humidity. Potai and Chandrakar (2018) [13] reported positive correlation between aphid and morning relative humidity in confirmation with the present finding.

Conclusion

The most common threat to okra is the presence of sucking pests. Its frequency is closely associated with environmental factors, specifically minimum temperature, precipitation, and humidity. The results of the current study confirm that the population of sucking pests and their natural enemies in okra is significantly impacted by these weather conditions. This highlights the fact that the weather is the primary determinant of the seasonal occurrence of pests. With this knowledge, farmers and extension agents can create focused pest management strategies that will increase okra yields.

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