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Seasonal incidence of leafhopper, *Amrasca biguttula biguttula* (Ishida) infesting summer okra

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Abstract
An investigation to study the population dynamics of leafhopper, *Amrasca biguttula biguttula* (Ishida) (Cicadellidae) in okra was carried out at CPCA Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Gujarat during summer 2023. The incidence of leafhopper commenced after one week after germination (10th SMW) and continued up to removal of crop in the 21th SMW. A higher incidence of leafhopper was observed during the 17th to 20th SMW. Leafhopper population exhibited significant positive correlation with maximum temperature, whereas it showed highly significant positive correlation with minimum temperature, bright sunshine hours and evaporation. Population of coccinellids and spider had highly significant positive correlation with leafhopper population.

Keywords: Okra, leafhopper, coccinellids, spider and weather parameters

Introduction
Okra (*Abelmoschus esculentus* L. Moench) is the only vegetable crop of significance in the Malvaceae family (Eagri, 2023) [4]. One of the major constraints for okra production is heavy infestation caused by several insect pests. Okra crop attacked with eleven insect pest species have been recorded in Gujarat and among these, leafhopper is the destructive pest of okra which occurred in early seedling stage (Dabhi and Koshiya, 2014) [2]. Among the sucking pest, leafhopper is the major pest, which cause a yield loss of about 40-56 per cent in okra. Okra crop was attacked by beet armyworm (*Spodoptera exigua* Hubner) at the early stage of crop in middle Gujarat (Pathan *et al*, 2018) [9]. Pathan *et al*. (2016^a) [10] recorded coccinellids, *Scymnus* sp. and predating on red spider mite (*Tetranychus urticae*) infesting okra. Seed beetle, *Spermophagus* sp. recorded in okra under storage condition. (Pathan *et al*., 2016^b) [11]. Leafhopper nymph and adult are very active with a characteristic way of moving diagonally in relation to their body, but quick to hopping (Singh *et al*. 2018) [12]. The nymphs and adults suck the plant sap mainly from the lower surface of leaves and cause phytotoxic symptoms known as "hopper burn" which results in complete dessication and has become one of the limiting factors in economic productivity of okra. In addition, there may be some relationship between or among the insect pests in nature. The management strategies for insect pests can become sound and economically viable when information on pest seasonal incidence is integrated in to it. Therefore, present experiment was carried out at Centre for Vegetable Research, C.P. College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar during summer, 2023.

Materials and Methods
Okra variety GAO 5 was sown with row to row spacing of 45 cm and plant to plant spacing of 30 cm at Centre for Vegetable Research, C. P. College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar during summer season of 2023. The plot size was 12 m X 9 m. Standard agronomical practices was followed to raise okra crop. The whole experimental plot was kept free from the application of any insecticides. The plot was divided into six quadrate. From each quadrate, ten plants were randomly selected. From each selected plant, one leaf from top, middle and lower canopy was observed and a number of leafhoppers was counted. Number of natural enemies per plant were also recorded. The observation were recorded at weekly interval starting from one week after germination and continued till the harvest of the crop.

Finally, the mean population per plant at weekly interval was worked out.

In order to study the effect of weather parameters on the population fluctuation of leafhopper, the weekly data on physical factors of environment *viz.*, bright sunshine (BSS), rainfall (RF), evaporation, maximum temperature (MaxT) and minimum temperature (MinT), morning relative humidity (RH_1) and evening relative humidity (RH_2) were correlated. Simple correlation was worked out between weather parameters and population of leafhopper by adopting a standard statistical procedure (Steel and Torrie, 1980) [13].

Results and Discussion

Population dynamics of leafhopper in okra

The data on weekly population of leafhopper and natural enemies are presented in Table 1 and depicted in Fig.1. The incidence of leafhopper in okra crop commenced in the first week after germination *i.e.* first week of March (10th SMW) and persisted up to the harvest of crop *i.e.* 4th week of May (21st SMW). The leafhopper population per leaf ranged from 1.23 to 14.56 leafhopper per leaf. Initially, the population was low (1.23 leafhopper/leaf) which gradually increased and attained a peak (14.56 leafhopper/leaf) during the first week of May *i.e.* 9 weeks after germination (18th SMW). The population was in decreased gradually and it was recorded up to harvest in the fourth week of May (21th SMW).

In past, Das *et al.* (2011) [3] reported that the leafhopper first appeared in the third week after sowing, its population gradually increased and the maximum population was observed during 5 to 7 weeks after sowing of okra. Jadhav *et al.* (2015) [5] also reported that the leafhopper infestation in okra commenced from 10th SMW and the maximum population was recorded during the 18th SMW. According to Pathan and Bharpoda (2016) [10, 11], leafhopper infestation in okra initiated in the first week of March (10th SMW). The leafhopper populations gradually increased and reached the first peak during the fourth week of March and the second peak during the fourth week of April. Jat & Singh (2019) [6], the infestation of leafhopper in okra commenced in the first week of March (12th SMW) and reached its peak in the fourth week of March. Patel *et al.* (2022) [8] revealed that the leafhopper population in okra started from 12-14 days after sowing. Thus, the present findings are more or less in conformity with earlier reports.

Table 1: Population dynamics of leafhopper and natural enemies in okra

Month and Week		SMW	WAG	Leafhopper/ leaf	Natural enemies/ plant	
					Coccinellids	Spiders
March	1	10	1	1.23	0.00	0.00
	2	11	2	3.45	0.00	0.00
	3	12	3	6.18	0.08	0.00
	4	13	4	10.32	0.18	0.00
April	1	14	5	10.77	0.32	0.34
	2	15	6	12.30	0.56	0.38
	3	16	7	12.80	0.87	0.44
	4	17	8	13.50	0.88	0.49
May	1	18	9	14.56	1.06	0.56
	2	19	10	13.57	1.10	0.72
	3	20	11	12.98	0.92	0.58
	4	21	12	11.40	0.78	0.43

SMW: Standard Meteorological Week, WAG: Week after germination, No. of observations (n) = 12

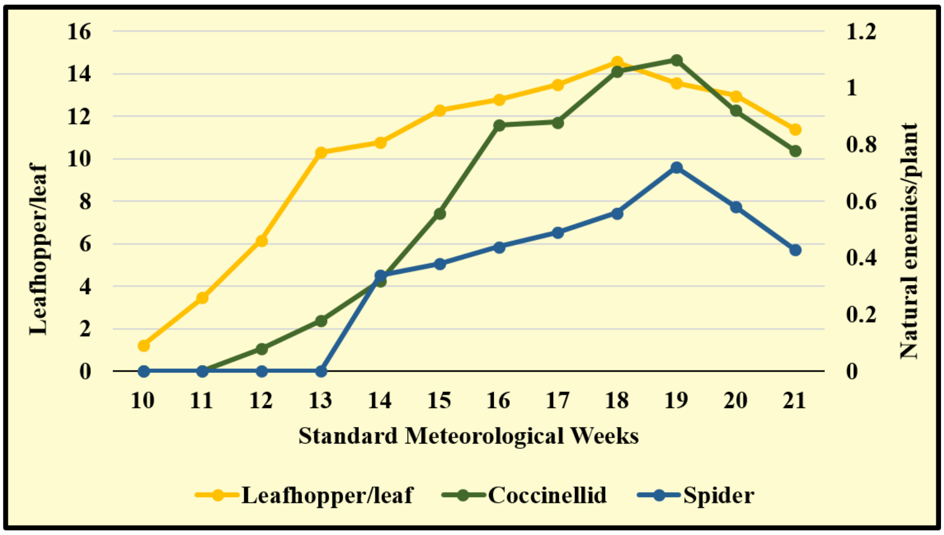

Fig 1: Population dynamics of leafhopper and activity of natural enemies in okra during Summer, 2023

Effect of weather parameters

The correlation coefficient data (Table 2) indicated that maximum temperature (r = 0.585*) had significantly positive correlation with leafhopper population. The minimum temperature (r = 0.740**), bright sunshine hours (r = 0.794**) and evaporation (r = 0.797**) had highly significant positive correlation with leafhopper population.

Jadhav *et al*. (2015) [5] also reported that leafhopper population in okra had a significant positive correlation with maximum temperature and a significant negative correlation with evening relative humidity. Aarwe *et al.* (2016) [1] reported that maximum temperature and average sunshine hours had a significant positive correlation with the leafhopper population in okra. Pathan and Bharpoda (2016) [10, 11] reported that rainfall and evening relative humidity showed a negative correlation, whereas maximum temperature and minimum temperature had a positive impact on the fluctuation of leafhopper population in okra. Thus, the present findings are more or less in conformity of earlier reports. However, correlation between leafhopper population and abiotic parameters is different might be due to different regions, sowing periods, crop stages and prevailing environmental conditions *etc*.

Table 2: Correlation coefficient (r) between weather parameters and population of leafhopper and natural enemies in okra

Weather Parameters	Correlation coefficient (r)		
	Leafhopper	Coccinellids	Spiders
Maximum Temperature	0.585*	0.723**	0.734**
Minimum Temperature	0.740**	0.874**	0.842**
Morning Relative Humidity	0.202	0.253	0.158
Evening Relative Humidity	-0.160	-0.328	-0.449
Bright Sunshine Hours	0.794**	0.833**	0.911**
Rainfall	-0.278	-0.485	-0.595*
Rainy Days	-0.420	-0.596*	-0.700
Evaporation	0.797**	0.934**	0.943**

*Significant at 5 per cent level of significance (r= 0.576)
** Significant at 1 per cent level of significance (r= 0.708)

Population dynamics of natural enemies

Coccinellids

The data presented in Table 1 and graphically depicted in Fig. revealed that the population of ladybird beetle ranged between 0.08 and 1.10 per plant with an average of 6.02 per plant. Ladybird beetle per plant was found active on summer okra between 12th SMW (*i.e.*, 5th week after sowing) to 21st SMW (*i.e.*, 14th week after sowing). It appeared in the crop at 5th week after sowing (12th SMW) with 0.08 ladybird beetle per plant. Thereafter, its population increased gradually and reached a peak level of 1.10 ladybird beetle per plant during 12th week after sowing (19th SMW). The ladybird beetle showed a decline in its population in the subsequent weeks and remained on crop till maturity 21st SMW *i.e.*, 14th week after sowing.

Spiders

The activity of the predator *i.e*., spider was recorded during the summer is presented in (Table 1 and depicted in Fig 1). The activity of spider commenced from the 7th week after sowing (14th SMW) with a population of 0.34 spider per plant. The population of spider was increased up to 0.72 spider per plant in the 12th week after sowing (19th SMW). Spider population declined quickly up to 0.43 spider per plant in 14th week after sowing (21st SMW).

Effect of weather parameters

The data on correlation coefficient between weather parameters and population of coccinellids are presented in Table 2. The coccinellid population showed highly significant positive correlation with maximum temperature (r = 0.723**), minimum temperature (r = 0.874**), evaporation (r = 0.934**) and bright sunshine hours (r= 0.833**). Population of coccinellid showed highly significant positive correlation (r= 0.880) with leafhopper population (Table 3). In past, Jat and Singh (2019) [6] reported that coccinellid population had a significant positive correlation with temperature and leafhopper population, whereas it exhibited significant negative correlation with relative humidity. The variation might be due to difference in locality or season.

Effect of weather parameters

Correlation coefficient values between weather parameters and spider population are presented in Table 2, which showed that maximum temperature (r = 0.734**), minimum temperature (r = 0.842**), evaporation (r = 0.943**) and bright sunshine hours (r= 0.911**) had highly significantly positive correlation with spider population. The rainfall (r = -0.595*) was significant negative correlation with spider population. Population of spiders showed highly significant positive correlation (r= 0.849**) with leafhopper population. (Table 3). Present finding are supported by the findings of Pathan and Bharpoda (2018) [9], who reported that spider population had a significantly positive correlation with maximum temperature. They further reported that morning and evening relative humidity showed non-significant negative correlation with spider population.

Table 3: Correlation coefficient (r) between the population of leaf hopper and natural enemies in okra

Natural enemies	Correlation coefficient (r)
Coccinellids	0.880**
Spiders	0.849**

*Significant at 0.05% level of significance (r= 0.576)
**Significant at 0.01% level of significance (r= 708)

Conclusion

The activity of leafhopper, *A. biguttula biguttula* in summer okra was higher during the month of May (17th to 20th SMW). Leafhopper population exhibited significant positive correlation with maximum temperature, whereas it showed highly significant positive correlation with minimum temperature, bright sunshine hours and evaporation. Population of coccinellids and spider had highly significant positive correlation with leafhopper population.

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