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Impact of Weather Parameters on Seasonal Abundance of Major Insect-Pests of Bottle Gourd in Arid Climates

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ABSTRACT

The field experiment was conducted during Kharif, 2023 season at Sri Karan Narendra College of Agriculture, Jobner to investigate the impact of weather parameters on seasonal abundance of major insect-pests on bottle gourd (Lagenaria siceraria). The study revealed that red pumpkin beetle population was prevalent during vegetative and reproductive stages of the crop, while the fruit fly population was primarily associated with the reproductive stage. The incidence of red pumpkin beetle on bottle gourd varied from 0.28 to 3.72 beetles per plant, and leaf damaged escalated to 31.20% by 40th SMW. Fruit flies commenced in 36th SMW, initially with infestation rates of 16.67% by number and 15.07% by weight basis. As the season progressed, infestation levels increased, reaching their 40th SMW at 31.82% by number and 29.27% by weight basis. Correlation studies showed a significant positive relationship between the red pumpkin beetles and leaf damage with maximum temperature. For fruit flies, infestation levels were positively with sunshine hours, while minimum temperature and evaporation exhibited significantly negative correlations with fruit fly infestation both in terms of number and weight basis. This study provides valuable insights into the seasonal abundance of major insect-pests on bottle gourd during its vegetative and reproductive stages in the arid climate of Rajasthan and will help appropriate pest management strategies under prevailing climatic conditions.

Keywords: Bottle gourd, Correlation, Fruit fly, Leaf damage, Infestation, Red pumpkin beetle, Regression

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INTRODUCTION

Bottle gourd, Lagenaria siceraria (Molina) Standley, is indeed a highly valued crop in both culinary and medicinal fields, cultivated year-round and available in various markets. Its versatility is reflected in the wide range of names it is known by such as calabash gourd, doodhi, lauki or ghia, birdhouse gourd, trumpet gourd and white flowered gourd (Thakur et al., 2015; Gajera et al., 2017). Nutritionally, bottle gourd is a rich source of vitamin B complex, iron, minerals and a high amount of choline, along with fair amounts of vitamin C (Milind and Satvir, 2011). It is also known to aid in relieving constipation, night blindness and cough while helping reduce cholesterol and triglycerides. In India, bottle gourd is cultivated over an area of 187 thousand hectares with a total production of 3011 thousand metric tonnes (Anonymous, 2018-19). The major bottle gourd-producing states in India include Uttar Pradesh, Rajasthan, Gujarat, Punjab, Bihar, West Bengal, Madhya Pradesh and Maharashtra. Specifically, in Rajasthan, the crop covers 4.98 thousand hectares, producing 25.42 thousand metric tonnes with a productivity rate of 5.10 t/ha (Anonymous, 2021-22).

Insect-pests are major limiting factors affecting the quality and quantity of cucurbitaceous crops. Yield losses due to pest attacks ranged from 20–100%, depending upon cucurbit species and season in different parts of the world (Bhowmik and Saha, 2017; Rashid et al., 2014 and Halder and Rai, 2021). Bottle gourd is affected by red pumpkin beetle, Aulacophora foveicollis Lucas; melon fruit fly, Bactrocera cucurbitae Coquillett; mirid bug, Nesidiocoris cruentatus (Ballard); Hadda beetle, Epilachna dermurili (Mulsant), Jassid, Amrasca biguttula biguttula (Ishida); aphids, Aphis gossypii Glower; white fly, Bemisia tabaci Gennadius and leaf miner, Liriomyza trifolii Burgess (Bhowmik and Saha, 2017; Haldhar and Maheshwari, 2018; Halder et al., 2021). Out of these, red pumpkin beetle is a widely distributed, polyphagous in nature that attacks crops at both early and later stages. Adults feed voraciously on leaves, flower buds, and flowers, creating irregular holes. Grubs feed on roots

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and underground portions of the host, touching the soil and half ripe, rendering such fruits unsuitable for human consumption (Sarkar et al., 2022). Field losses due to this pest have been reported to range from 30-100 per cent (Rashid Khan et al., 2014). Fruit flies also have polyphagous and cosmopolitan distributions in the world's tropical, sub-tropical and temperate regions. It poses a significant threat at the fruiting stage (Ram et al., 2009). Maggots feed on the internal tissues of the fruit, leading to the premature dropping of fruits, degrading the quality and making them unfit for consumption (Sarkar et al., 2017). The infestation varies from 30-100% in different cucurbitaceous crops (Dhillon et al., 2005). Atwal and Dhaliwal (2005) reported that fruit flies caused 50% of the damage on cucurbits in India and depending on the environmental condition and susceptibility of crop species, the extent of losses varied up to 100 per cent.

Knowledge of the seasonal abundance of insect pests of different growth stages of bottle gourd is vital for developing an effective management schedule for effective control of major pests. Many workers generated information on seasonal incidence (Bhowmik and Saha, 2017; Sarkar, 2022; Meena et al., 2019; Konyak et al., 2023) in a different region, but in the semi-arid region of Rajasthan, it is still lacking in the semi-arid region of Rajasthan. Further climatic conditions will also change frequently. Hence, the study on the seasonal abundance of major insect pests of bottle gourd in relation to weather parameters was undertaken, and it can effectively be utilized in formulating a pest management programme.

MATERIALS AND METHODS

To record the seasonal abundance of major insect pests on bottle gourd variety Pusa Naveen was sown in the first week of July in the five plots, each plot 2.0 m x 5.0 m. The row-to-row distance was maintained at 2.5 m, and plant-to-plant distance at 0.5 m. The recommenced agronomic packages of practices were adopted for raising the crop, excluding plant protection measures. The crop was left to natural infestation for recording the infestation of major insect pests of bottle gourd.

Methods of observations

The populations of red pumpkin beetles were recorded weekly on five randomly selected and tagged plants from each plot during early morning hours, without disturbing the flora and fauna. Additionally, leaf damage was also recorded on these five plants, with five leaves from each plant selected randomly at weekly intervals. For fruit fly incidence, observations were made from the fruit formation stage to the last picking stage of the bottle gourd. The assessments based on the number of marketable size fruits, where the total number of infested fruits and their weights were recorded. The percentage of fruit fly infestation was then calculated based on both the number of infested fruits and their weight.

Interpretation of data

Simple correlation and regression analysis was conducted between the major insect pests of bottle gourd (red pumpkin beetle and fruit flies) and abiotic factors such as temperature (maximum and minimum), relative humidity (morning and evening), rainfall, evaporation and sunshine hours. Statistical analysis was carried out using MS Excel program.

RESULTS AND DISCUSSION

In this present investigation, an attempt was made to study the seasonal abundance of major insect pests of bottle gourd under prevailing climatic conditions of the semi-arid region of Rajasthan during Kharif 2023. Red pumpkin beetle and fruit fly were recorded as major pests in this region. The red pumpkin beetle population was associated with both the vegetative and reproductive stages of the crop. Meanwhile, the fruit fly population was associated with the reproductive stage of the crop.

Population of red pumpkin beetle and leaf damage

The results showed that the population of red pumpkin beetle commenced in the second week of August (33rd SMW), i.e., 0.40 beetle /plant, which gradually increased and reached its peak (3.72 beetles /plant) in the second week of September (37th SMW). After that, the population of red pumpkin beetles started declining. In the last observations (44th SMW), the population of red pumpkin beetle was lowest (0.28 beetle /plant). The peak population of red pumpkin beetle (3.72 beetles /plant) was recorded at 36°C (maximum temperature), 22.7°C (minimum temperature), 77 per cent morning relative humidity, 50 per cent evening relative humidity, 7 mm rainfall, 4.1 mm evaporation and 6.1 hours bright sunshine hours (Table 1). The results of correlation studies indicated that the population of red pumpkin beetle on bottle gourd crop had a significant positive correlation with maximum temperature ($r=0.716$, $p<0.05$) and non-significant positive correlation with minimum temperature ($r=0.382$), morning relative

Table 1: Seasonal abundance of major insect-pests of bottle gourd during Kharif season, 2023

S. No.	SMW	Temperature (°C)		Relative humidity (%)		Rainfall (mm)	Evaporation (mm)	Sunshine hours	Red pumpkin beetle		Fruit fly infestation (%)	
		Max.	Min.	Mor.	Eve.				Population / plant	Leaf damage (%)	Number basis	Weight basis
1	33	34.4	22.5	69.0	50.0	0.0	4.8	5.3	0.40	3.20	0.00	0.00
2	34	33.8	22.8	72.0	52.0	0.0	4.5	2.6	0.72	7.20	0.00	0.00
3	35	35.5	21.3	59.0	41.0	0.0	5.2	7.3	1.84	12.80	0.00	0.00
4	36	37.0	21.5	71.0	41.0	0.8	5.0	8.7	3.12	21.60	16.67	15.07
5	37	36.0	22.7	77.0	50.0	7.0	4.1	6.1	3.72	23.20	23.08	21.54
6	38	32.4	21.8	83.0	61.0	49.8	3.5	4.8	2.08	18.40	19.05	18.24
7	39	35.6	19.8	68.0	41.0	2.4	4.0	7.8	3.24	28.80	27.78	27.21
8	40	36.3	15.5	63.0	26.0	0.0	4.4	8.7	2.76	31.20	31.82	29.27
9	41	35.5	16.4	65.0	30.0	0.0	4.1	8.9	1.72	24.80	26.09	25.49
10	42	33.0	15.1	70.0	32.0	0.0	3.5	7.6	0.60	16.00	29.17	24.48
11	43	33.0	13.0	64.0	30.0	0.0	3.4	8.9	0.76	10.40	25.00	28.86
12	44	33.7	13.3	69.0	26.0	0.0	3.4	7.5	0.28	7.20	21.43	20.59

Humidity (r=0.179), evening relative humidity (r=0.192), rainfall(r=0.176), evaporation(r=0.273) and sunshine hours (r=0.236).

The leaf damage caused by the red pumpkin beetle was initiated in the second week of August, with 3.20%. The leaf damage increased and reached its peak in the 40th SMW (31.20% leaf damage), followed by the 39th SMW (28.80%) and 41st SMW (24.80). The correlation studies indicated that the leaf damage showed a significant positive correlation with maximum temperature (r=0.584; $p<0.05$) and non-significant negative correlation with minimum temperature, morning and evening relative humidity (r=-0.046, r=-0.008, r=-0.190) and non-significant positive correlation with rainfall (r=0.099), evaporation (r=0.003) and bright sunshine hours (r=0.484).

The findings align with Sarkar et al. (2022) who documented that red pumpkin beetle was present throughout the year with peak activity recorded from March to October. Rathod and Borad (2010) noted that the highest incidence during the kharif period (August-September) and summer (March–April). Kumar and Saini (2018) further supported this by stating that red pumpkin beetle occurrence began during the 35th SMW and peak population was observed during the first week of October (4.80 beetles /five plants). Their study found a positive correlation between the red pumpkin beetle population and mean temperature but a significant negative correlation with mean relative humidity and rainfall.

These results conform with Shinde et al. (2018), who found that infestation of red pumpkin beetles started in the 26th SMW with an initial population of 2.48 beetles /plant. The minimum infestation (0.48 ± 1.20 beetles per plant) was recorded in the 37th SMW, while the maximum infestation (3.64±1.20 beetles per plant) occurred during the 32nd SMW. Likewise, Yadav et al. (2017) reported that the incidence of the red pumpkin beetles began in the first week of June (16 beetles /5 plants) and peaked in the 26th SMW (34 beetles/5 plants). These findings indicate that red pumpkin beetle infestation depends significantly on the season, particularly during the summer and Kharif seasons and its population is associated with the crop throughout its growth stages. The present study corroborates the findings of Gurjar et al. (2022), who observed that the population of red pumpkin beetle and leaf damage on bottle gourd began in 32nd SMW and peaked at 40th SMW (5.8 beetles /plant) and observed substantial leaf damage 28.6%. Correlation studies revealed that the population of red pumpkin beetle showed a significant positive correlation with maximum temperature and a significant negative correlation with relative humidity. Patra et al. (2022) reported that the population of red pumpkin beetles started within a week after the germination of seeds and maintained a moderate number almost one month after the population increased and reached the second peak. The beetle population was noticed until the last harvesting of the crops. Average fruit flies infestation was recorded from first picking losses up to 47.18%. The present findings may be corroborated by the observation of Rajak (2000) who reported the positive association between red pumpkin beetle population and temperature.

Fruit fly infestation-number and weight basis

The seasonal incidence of fruit flies, based on number of infestations, began in the second week of September (36th SMW) with a 16.67% infestation rate. This infestation progressively increased and reached its peak at 31.82% in the first week of October (40th SMW). Significant peaks in infestation were also observed during the 39th SMW (27.78%) and 41th SMW (26.09%). Following these peaks, the infestation rate started to decline gradually (Table 1). The fruit fly infestation showed a significant negative correlation with minimum temperature (r = -0.641; p<0.05), evaporation (r = -0.636; p<0.05), and sunshine hours (r = -0.642; p<0.05). Other weather parameters, such as relative humidity and rainfall, were found to have a non-significant negative correlation with fruit fly infestation (Table 2). The seasonal incidence of fruit flies, based on weight, began in the first week of September (36th SMW) at 15.07%. This damage gradually increased, peaking at 29.27% in the first week of October (40th SMW). Subsequently, the infestation rate declined gradually, reaching its lowest point at 20.59% (Table 1). The fruit fly infestation on a weight basis had a significant negative correlation with minimum temperature (r = -0.673; p<0.05) and evaporation (r = -0.666; p<0.05). Stimulatingly, sunshine hours had a positive significant correlation with fruit fly infestation (r=0.662; p<0.05). The maximum temperature showed a non-significant positive correlation with fruit fly infestation on a weight basis (r = 0.025). There were non-significant negative correlations with relative humidity (r = -0.002), rainfall (r = -0.555), and rainfall (r = -0.046) (Table 2). Multiple linear regression (MLR) analysis explained the variations in pest populations and infestation levels: 93% of the variation in red pumpkin beetle population, 81% of the variation in leaf damage, 91% of the variation in fruit fly infestation on a number basis and 94% of the variation in fruit fly infestation on a weight basis were attributed to the combined contribution of all-weather parameters (Table 3)

These results align with those of Meena et al. (2019) who reported that fruit fly infestation was observed on bottle gourd from the third week of May. The peak infestation was recorded in the first week of June, while maximum and minimum temperatures had significant positive correlations with fruit fly infestation. The relative humidity had a non-significant correlation with the infestation of fruits. It could be due to the different sowing times and weather parameters across different locations. The present findings are also in agreement with Kannan and Venugopala (2006) and Win et al. (2014), who showed a positive association between fruit flies and temperature. Relative humidity and rainfall had a non-significant negative association with fruit flies (Meena et al., 2019). Patra et al. (2022) support the present findings and reported that relative humidity showed a significant negative correlation with fruit fly infestation.

Table 2: Correlation coefficient between red pumpkin beetle, fruit flies infestation and weather parameters during Kharif, 2023

S. No.	Weather parameters	Red pumpkin beetle		Fruit fly infestation (%)	
		Population/plant	Leaf damage (%)	Number basis	Weight basis
1	Maximum Temperature (°C)	0.716**	0.584*	0.059NS	0.025NS
2	Minimum Temperature (°C)	0.382NS	-0.046NS	-0.641*	-0.673*
3	Morning relative humidity (%)	0.179NS	-0.008NS	-0.035NS	-0.002NS
4	Evening relative humidity (%)	0.192NS	-0.190NS	-0.547NS	-0.555NS
5	Rainfall (mm)	0.176NS	0.099NS	-0.048NS	-0.046NS
6	Evaporation (mm)	0.273NS	0.003NS	-0.636*	-0.666*
7	Sunshine hours	0.236NS	0.484NS	0.642*	0.662*

Table 3: Multiple liner regression analysis between red pumpkin beetle, fruit flies infestations and weather parameters during Kharif, 2023

Pest (s)	Regression equitation (Y=a+bX)	R2 Value
Red pumpkin beetle	Y=-29.28a + (1.11)TMax.+ (0.03)TMin. +(-0.07)RHMor.+ (0.07)RHEve.mm + (0.03)RF + (-1.66)EVE + (0.08)Sunshine	0.93
Leaf damage (%)	Y=-116.10a + (6.42)TMax.+ (2.79)TMin. +(-0.66)RHMor.+ (-0.76)RHEve.mm + (0.48)RF + (-16.17)EVE + (-0.13)Sunshine	0.81
FFI number basis (%)	Y=-106.01a + (5.32)TMax.+ (-0.06)TMin. +(0.15)RHMor.+ (-0.20)RHEve.mm + (0.15)RF + (-17.22)EVE + (1.37)Sunshine	0.91
FFI weight basis (%)	Y=-150.83a + (7.50)TMax.+ (-3.32)TMin. +(-0.20)RHMor.+ (1.03)RHEve.mm + (0.02)RF + (-15.85)EVE + (1.28)Sunshine	0.94

CONCLUSION

The red pumpkin beetle incidence on bottle gourd ranged from 0.28 to 3.72 beetles/plant, with leaf infestation reached 31.20% in the 40th SMW. There was a significant positive correlation between red pumpkin beetle and leaf damage with maximum temperature. Fruit fly occurrence began in 36th SMW with initial infestation rates of 16.67% by number and 15.07% by weight basis, increased to 31.82% by number and 29.29% by weight by the 40th SMW.

Overall, pest populations were significantly influenced by environmental factors, with red pumpkin beetles correlating with maximum temperature and fruit flies with sunshine hours, minimum temperature and evaporation.

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