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Population dynamics of major insect pests in bottle gourd

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ABSTRACT: The experiment on population dynamics of insect pests in bottle gourd under semi-arid conditions was carried out, revealed that peak infestation of fruit fly *Zeugodacus cucurbitae* (Coquillett) (49.36%) reached during the 6th November 2023, and after that it declined gradually. The infestation of aphid *Aphis gossypii* (Glover), white fly *Bemisia tabaci* (Genn.), red pumpkin beetle *Aulacophora foveicollis* (Lucas), hadda beetle *Epilachnini demurli* (Mulsent), mirid bug *Nesidiocoris cruentatus* (Ballard) and leaf miner *Liriomyza trifoli* (Burgess) started in the first week of September (36th SMW). The infestation of *A. gossypii* (120.1 aphids three leaves/plant), *B. tabaci* (12.3 whiteflies per three leaves/ plant), *A. foveicollis* (4.7 adults/plant), *E. demurli* (5.9 adults/plant), *N. cruentatus* (14.2 mirid bugs three leaves/plant) and *L. trifoli* (53 % leaf infestation) reached its peak level in 44th, 40th, 41st, 43rd, 40th, and 43rd SMW respectively, after that it declined gradually. The correlation *Z. cucurbitae* infestation with abiotic factors revealed a significant negative correlation with minimum RH (r = -0.552), and maximum RH (r = -0.484). There existed a significant negative correlation between yield loss and minimum RH (r = -0.689).

KEY WORDS: Aphid, whitefly, fruit fly, leaf miner, red pumpkin beetle, mirid bug

INTRODUCTION

Bottle gourd [*Lagenaria siceraria* (Molina) Standley] also known as Calabash, is one of the most important cucurbitaceous vegetable crops grown in both rainy and summer seasons (Srivastiva *et al.,* 2002). Like other cucurbits, bottle gourd is vulnerable to a variety of insect and non-insect pests, the primary pests affecting it include the fruit fly, red pumpkin beetle, leaf miner, aphids, whitefly, and mites (Tiwari *et al*., 2012). These pests can cause damage from the early growth stages of the crop until the harvest in India. The impact of various insect pests on cucurbits has caused yield losses of 30 to 100 percent, varying by host type and seasonal factors in various locations around the globe (Dhillon *et al*., 2005; Haldhar *et al*., 2015a, b). The population dynamics of the insect pests help in the study of pest behaviour, its population trend with natural enemies, and other abiotic factors and thus, play an important role in pest management. It will help to decide on the timely application of insecticides as it reveals the insect pest's activity and insect-free periods during crop growth. Hence, this study are crucial for understanding pest behaviour, population trends influenced by natural enemies and abiotic factors, and their role in effective pest management.

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MATERIALS AND METHODS

This study was carried out at the Instructional Farm of the College of Agriculture, Agriculture University, Jodhpur, Rajasthan. The bottle gourd sown in lines in August 2023. The bottle gourd variety Pusa Naveen was replicated three times in a plot measuring 3 × 3m^2 keeping row-to-row and plant-to-plant distance of 3m and 0.75m, respectively. All agronomic practices were followed as per the recommendation of the package of practices of Zone-1a (Arid Western Plains).

Insect pest incidence was systematically monitored at weekly intervals using standardized protocols to quantify damage and pest pressure across bottle gourd crops. Fruit fly infestation was assessed from the onset of fruit formation until final harvest, with fruit health evaluated every three days based on marketable size. Infestation levels were determined by calculating the percentage of infested fruits relative to the total picked fruits, while yield losses were quantified by comparing the weight of infested fruits to the total harvested yield. For sucking pests, i.e., aphid, whitefly and mirid bug, observations were recorded by counting on three compound leaves i.e., one each from the top, middle, and bottom canopy of the plants. For defoliators, number of adult beetles was counted per plant. Leaf miner infestation was evaluated by calculating the proportion of infested leaves to total observed leaves per plant. To study the influence of various abiotic factors (minimum and maximum temperature, maximum and minimum relative humidity, and rainfall) on the incidence of population dynamics of insect pests in bottle gourd, the correlation coefficient was worked out. Multiple linear forms of the regression model were used to assess the effect of the abiotic factors on incidence of insect pests of bottle gourd by using the SPSS software.

RESULTS AND DISCUSSION

The major insect pests observed throughout the cropping season were only studied for population dynamics in response to weather conditions. The major pests studied were *Zeugodacus cucurbitae* (Coquillett), defoliators, *Aulacophora foveicollis* (Lucas), *Epilachna demurili* Mulsant, sucking pests (*Aphis gossypii* (Glover), *Bemisia tabaci* (Genn.) and *Nesidiocoris cruentatus* (Ballard)), leaf miner, *Liriomyza trifolii* (Burgess).

Fruit fly, *Z. cucurbitae:* Infestation began in the third week of October, reaching a peak in the first week of November (49.36%). Subsequently, it declined (20.36%) but remained above 20 per cent throughout the season (Table 1). Yield losses due to infestation followed a similar trend, reaching a peak (41.55%) in the first week of November. These results are in agreement with Raghuvanshi *et al.* (2012) who reported mean fruit damage of 40 per cent.

The correlation *Z. cucurbitae* infestation and abiotic factors revealed a significant negative correlation with minimum RH (r = -0.552), and maximum RH (r = -0.484). There existed a significant negative correlation between yield loss and minimum relative humidity (r = -0.689) (Table 2). Bhowmik *et al.* (2014) found a negative correlation with per cent Morning and Evening relative humidity (r=-0.809 and r=-0.717). Parkash *et al.* (2023) found a non-significant positive correlation of fruit fly infestation with minimum and maximum temperature. The present results are in agreement with Ravikumar and Viraktmath (2006) who reported a non-significant negative correlation, however, Banerji *et al.* (2005) could not observe relationship between rainfall and fruit fly population in bitter gourd.

Sucking pests: The incidence of *A. gossypii*, *B. tabaci* and *N. cruentatus* was presented in Table 3. Aphid infestation began in the first week of September, peaking at 120.1 aphids per three leaves during the first week of November (44th SMW), the results are in agreement with Parkash *et al.* (2023), who observed the initial infestation in the 34th SMW and peak infestation in 39th SMW. Whitefly population was at peak during the 40th SMW (12.3 per three leaves). The results corroborate reports of Gangurde *et al.* (2021) in bitter gourd and Parkash *et al.* (2023), who reported peak infestations in September. Population of *N. cruentatus* was reaching a maximum of 14.2 bugs in three leaves per plant in the 40th SMW

Table 1. Weather parameters and bottle gourd fruit infestation and yield loss due to *Zeugodacus cucurbitae* on during 2023

Observation date	% Fruit infestation	Yield loss
16th October	16.96	15.76
19th October	19.36	17.31
22nd October	23.31	19.07
25th October	27.02	25.31
28th October	33.30	30.21
31st October	40.06	31.83
3rd November	46.81	32.29
6th November	49.36	41.55
9th November	47.53	39.18
12th November	42.06	39.79
15th November	37.12	38.26
18th November	36.19	36.80
21st November	34.15	35.05
24th November	27.17	34.27
27th November	26.99	28.55
30th November	24.05	22.53
3rd December	20.36	21.72

before declining towards season's end. The present results are consistent with Halder *et al.* (2017) and Sharath *et al.* (2021), who noted similar trends in mirid bug populations on snake gourd during the rabi season and the lowest counts during severe winter conditions.

The correlation analysis of pest populations with weather parameters revealed significant trends for *A. gossypii*, *B. tabaci* and *N. cruentatus*. Aphid population showed significant negative correlation with maximum (r = -0.701) and minimum RH (r = -0.643), aligning with previous studies by Konar *et al.* (2013) who indicated negative correlation of aphid incidence in okra with humidity. Whitefly population showed a significant negative correlation with minimum temperature (r = -0.761) and both maximum and minimum relative humidity (r = -0.621 and r = -0.764). Khaliq *et al.* (2023) also reported that maximum temperature had a positive relationship with whitefly population in mung bean while the minimum temperature and morning relative humidity revealed a negative one, and evening relative humidity and rainfall showed a highly significant but negative correlation. Bairwa and Singh (2017) also reported a non-significant negative correlation between rainfall and whitefly population infesting green gram. Mirid bug, *N. cruentatus* population exhibited negative non-significant correlation with abiotic factors. These findings diverge from Sharath *et al.* (2021), who reported significant correlations with various weather parameters.

Defoliators: The study on pest dynamics of defoliators in bottle gourd highlighted notable population trends of *A. foveicollis* and *E. demurili*. *A. foveicollis* population varied from 1.4 to 4.7 adults per plant, peaking at 4.7 adults per plant during the 41st SMW (Table 3). This is consistent with earlier findings by Rathod and Borad (2010), who observed maximum infestations on pumpkin from August to September, and Parkash *et al.* (2023), who recorded the highest population in the 38th SMW on bottle gourd. Meanwhile, the *E. demurili* population increased gradually from the 36th SMW, reaching a peak of 5.9 adults per plant in the 43rd SMW before declining to 3.3 adults per plant, indicating fluctuating pest dynamics throughout the growing season.

The correlation analysis of *A. foveicollis* and *E. demurili* populations with abiotic factors revealed significant negative relationships. For *A. foveicollis*, a significant negative correlation was observed with minimum temperature (r = -0.496) and minimum

Table 2. Correlation between the incidence of fruit fly, *Z. cucurbitae* and abiotic factors

Parameters	Infestation %	Yield loss
Max temperature	0.267^{NS}	-0.005^{NS}
Min temperature	0.136^{NS}	-0.233^{NS}
Max RH	-0.484^{*}	-0.413^{NS}
Min RH	-0.552^{*}	-0.689^{*}
Rainfall	-0.384^{NS}	-0.437^{NS}

* Correlation is significant at $p \leq 0.05$ level

Table 3. Effect of weather parameter on incidence of major insect pest complex of bottle gourd during 2023

SMW	Observation	Mean population					
		Aphid	Whitefly	Red beetle	Mirid bug	Hadda beetle	Leaf miner
33	13 Aug – 19Aug	0.0	0.0	0.0	0.0	0.0	0.0
34	20 Aug – 26Aug	0.0	0.0	0.0	0.0	0.0	0.0
35	27 Aug – 02Sep	0.0	0.0	0.0	0.0	0.0	0.0
36	03 Sep – 09 Sep	3.0	2.5	1.4	4.1	0.3	14.9
37	10 Sep – 16 Sep	15.0	3.5	3.3	6.7	0.9	21.7
38	17 Sep – 23 Sep	20.3	3.6	3.3	10.1	1.6	27.4
39	24 Sep – 30 Sep	40.2	4.8	3.5	12.0	1.8	33.2
40	01 Oct – 07 Oct	60.1	12.3	3.9	14.2	2.6	35.6
41	08 Oct – 14 Oct	90.0	6.2	4.7	12.9	4.5	37.8
42	15 Oct – 21 Oct	100.0	7.1	4.3	11.7	5.3	50.0
43	22 Oct – 28 Oct	105.1	7.8	4.1	10.1	5.9	53.0
44	29 Oct – 4 Nov	120.1	9.6	4.1	9.3	4.8	49.6
45	5 Nov– 11 Nov	95.0	12.2	4.3	8.5	4.5	46.1
46	12 Nov – 18Nov	85.0	11.6	4.0	8.0	4.0	42.1
47	19 Nov – 25Nov	55.0	10.3	3.8	6.2	3.6	40.0
48	26 Nov – 2 Dec	23.9	8.3	3.4	5.1	3.3	33.2

*SMW- Standard Metrological Week; Aphid/ 3 leaves/plant; Whitefly/ 3 leaves/plant; Red pumpkin beetle/ plant; Mirid bug/ 3 leaves/ plant; Hadda beetle/ plant; Leaf miner/ 3 leaves/ /plant

Table 4. Correlation of major insect pests of bottle gourd with prevailing weather parameters

Parameters	Aphid	Whitefly	Pumpkin beetle	Mirid bug	Hadda beetle	Leaf miner
Min temperature	-0.467^{NS}	-0.761*	-0.496*	-0.140^{NS}	-0.625*	-0.584*
Max temperature	-0.090^{NS}	-0.369^{NS}	-0.161^{NS}	0.216^{NS}	-0.292^{NS}	-0.209^{NS}
Max RH	-0.701*	-0.621*	-0.413^{NS}	-0.276^{NS}	-0.595*	-0.573*
Min RH	-0.643*	-0.764*	-0.503*	-0.230^{NS}	-0.612*	-0.626*
Rainfall	-0.333^{NS}	-0.280^{NS}	-0.008^{NS}	-0.051^{NS}	-0.334^{NS}	-0.203^{NS}

* Correlation is significant at $p \leq 0.05$ level

relative humidity (r = -0.503). Dubale *et al.* (2018) also indicated similar negative correlations of red pumpkin beetle population on ridge gourd with maximum temperature and other weather factors. Bhowmik and Saha (2017) confirmed that minimum temperature was negatively correlated with red pumpkin beetle population. In contrast, the *E. demurili* showed a negative significant correlation with minimum temperature (r = -0.625), as well as maximum (r = -0.595) and minimum relative humidity (r = -0.612). These results partially align with Sharma and Tayde (2017) and Naveen *et al.* (2023), who also identified significant negative correlations with humidity and rainfall in brinjal.

Leaf miner*:* *L. trifolii* infestation in bottle gourd

Table 5. Multiple linear regression between abiotic factors and insect pests of bottle gourd

Insects		Regression equations	R^2 value
Fruit fly	Fruit infestation %	$Y = 48.10 + (-0.536) X_4$	0.305
	yield loss %	$Y = 46.41 + (-0.534), X_4, -11.227 X_5$	0.655
Red pumpkin beetle		$Y = 5.45 + (-0.064) X_4$	0.252
Hadda beetle		$Y = -2.56 + 0.519 X_1, 0.557 X_2$	0.567
Aphid		$Y = 219.32 + (-2.417) X_3$	0.491
White fly		$Y = 16.01 + -0.257 X_4$	0.584
Mirid bug		No regression	
Leaf miner		$Y = 63.686 + (-0.877) X_4$	0.391

Y = Dependent variable X_1 = Max. Temp. (ºC), X_2= Min. Temp. (ºC), X_3= Maximum RH (%), X_4= minimum RH (%), X_5= Rainfall(mm)

initiated in the 36th SMW and gradually increased, reaching its peak in the 43rd SMW with 53 per cent leaf infestation. These findings are consistent with the observations of Sharath *et al.* (2021) in snake gourd and Kachave *et al.* (2020) in tomato. Correlation analysis revealed a significant negative correlation between *L. trifolii* infestation and minimum temperature (r = -0.584), minimum relative humidity (r = -0.626), and maximum relative humidity (r = -0.573). The present findings corroborate with Sharath *et al.* (2021) who reported a significant negative correlation between minimum temperature and morning relative humidity, and a non-significant negative correlation with maximum temperature in snake gourd.

The study on the population dynamics of major insect pests infesting bottle gourd under semi-arid conditions of Jodhpur revealed distinct seasonal patterns influenced by prevailing abiotic factors. The fruit fly *Z. cucurbitae* caused the highest fruit damage, peaking in early November, while other key pests such as aphids, whiteflies, red pumpkin beetles, hadda beetles, mirid bugs, and leaf miners exhibited peak activity between the 40th and 44th standard meteorological weeks. Correlation analysis indicated that maximum and minimum relative humidity generally showed significant negative relationships with pest populations, whereas temperature variations influenced pest incidences differently depending on species. These findings emphasize that understanding pest population trends in relation to weather parameters can facilitate timely pest management decisions, minimize crop losses, and support sustainable production of bottle gourd in arid and semi-arid regions of Rajasthan.

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