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Interplay of Abiotic Factors on Various Phytophagous Beetles in Cucumber Under Different Agro-climatic Conditions

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Cucumber (*Cucumis sativus L*.2n = 14) is one of the widely cultivated summer vegetable crops from the gourd family of *Cucurbitaceae* which is native to India. The climatic conditions of northeast India especially Assam are highly conducive for reproduction of insects, and this region has been considered to be a biodiversity hotspot. Moreover, this region has huge potential for the production of vegetable crops especially cucurbits, but insect pests like fruit flies, pumpkin beetle and sucking

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pests are major limiting factors for successful cultivation of cucurbits like cucumber etc. Therefore, understanding population fluctuation in the field in relation to losses caused by insect pests are a function of their population dynamics which needs to be thoroughly studied. In view of above factors, an investigation on "Interplay of Abiotic and Biotic Factors on various phytophagous beetles of Cucumber Under Different Agro- Climatic Conditions" was carried out at Horticultural Farm, Assam Agricultural University, Jorhat. Population of phytophagous beetles were recorded on weekly intervals based on number of beetles per plant at seven days interval on 5 randomly selected plants after appearance of the pest. The results showed that during 2019 -2021 summer season, the red pumpkin beetle first appeared on 24th April 2019 and 7th May 2020 with initial population of 4.51 and 2.23 beetles per plant, respectively. However, maximum beetle populations were recorded on 8thMay 2019 and 3rd July 2020 with 6.15 and 6.52 beetles per plant, respectively.

Keywords: Population dynamics; weather parametric impactions; abiotic factors; correlation analysis.

1. INTRODUCTION

In Assam, the area grown under cucumber is 6.90 thousand hectares with an annual production of 71.30 metric tons [1]. Cucumber is widely consumed as fresh and processed vegetable product. According to USDA (United States Department of Agriculture) database, carbohydrates account for 2.16g per 100g of the edible portion of raw cucumber and it's further comprised of total dietary fiber (0.7g), total sugars (1.38g), glucose (0.63g), fructose (0.75g) and starch (0.08g) (Department of Agriculture, U. S., 2010). Cucurbit family is more prone to a high degree of sensitivity against frost. Therefore, in open field conditions, they require a warm climate for maximum production and in cool temperate, countries; they are usually grown in glass houses.

Cucumber is reported to be infested by a number of insect pests from the germination up to harvesting stage, of which red pumpkin beetle (*A. foveicollis)* is of serious concern that causes 35-75 per cent at seedling stage [2]. The percent damage gradually decreases from 75-15 per cent with increase in leaf canopy and sometimes the losses of this pest reported as 30-100 per cent in field conditions [3]. Cucumber is the most preferred one by this beetle while bitter gourd and sponge gourd are also equally important. Both larval and adult stages are injurious to the crop and cause severe damage to seedlings and young and tender leaves and flowers [4]. These beetles initiate feeding immediately after the seed germination and retard the growth of the seedlings due to severe foliar damage. Both the grubs and adults of this beetle cause damage where the grubs that live underground are destructive to the roots of the crop. These grubs enter into the roots, underground stem and also sometimes the fruits touching the ground. The adult beetles are mainly responsible for damaging the plant parts above the ground resulting in complete defoliation thus sometimes the entire field requires resowing. The beetle resumes its activity in March and remains in the field till October. The peak period of activity is from April to June while the population start declining from September onwards [5,6]. The second generation of these insects may appear close to harvesting and feed on the rind of developing fruits. This reflects that they are present throughout the growing season and feed on all parts of the plant, including the flowers and fruits. [7]. It is very much difficult to manage the pests simply through the application of chemical pesticides due to their peculiar biological features. Again, it is also established that before developing insect pest management programme for a specific agro-ecosystem, it is necessary to have basic information on the incidence of the pest in relation to weather parameters which help in determining appropriate time of action and suitable method of control. Monitoring pest population round the year is one of the most important basic information in formulating IPM concept for sustainable agriculture. The climatic conditions of Northeast India, especially Assam are highly conducive for reproduction of insects, and this region has been considered to be a biodiversity hotspot [8]. Moreover, this region has huge potential for the production of vegetable crops especially cucurbits, but insect pests like fruit flies, phytophagous beetle and sucking pests are major limiting factors for successful cultivation of cucurbits like cucumber etc. Therefore, the main objective is to understand the population fluctuation of various phytophagous beetles in the field in relation to weather parameters and function of their population dynamics to study their economic losses pertaining to the cucumber crop.

2. MATERIALS AND METHODS

The field experiment was carried out in the experimental farm, Department of Horticulture, Assam Agricultural University, Jorhat during summer 2019 and 2020. The farm is located at 26.75°N and 94.22°E with an average elevation of 116 meters (381 ft). The experiment was conducted in field conditions adopting Randomized Block Design (RBD), with four replications. The gross area for the experiment was 600 sq. m (30m x 20m). The area was divided into 4 blocks. Each block was further divided into 6 plots measuring 10.5 sq. m (3.5m x 3m) each.

2.1 Field Preparation and Raising of Crop

The field was prepared by thorough ploughing followed by planking and plots were made free from clods and weeds. A cucumber variety named ‘Khira-90’ was sown for the present study on population dynamics and crop loos assessment against various insect pests. The recommended doses of fertilizers were applied and hand weeding was done to keep the weeds under check. The crops were raised as per the recommended package of practices of *Kharif* [9].

2.2 Meteorological Observations

The observation on various meteorological parameters *viz*., maximum and minimum temperatures (°C), maximum and minimum relative humidity (%), bright sun shine hours and rainfall (mm) were collected from meteorological observatory of ICR farm, Department of Agrometeorology, Assam Agricultural University, Jorhat during summer 2019 and 2020, and are presented in Table 1.

2.3 Population Fluctuation of Phytophagous Beetle on Cucumber During 2019 and 2020

Population of phytophagous beetles were recorded on weekly basis. Observations of insect pests were recorded in the morning (8-10am) as well as in the evening (3.30-4.30pm) based on individual plant.

a)* Red Pumpkin Beetle (*Aulacophora foveicollis)

The observations were recorded based on number of beetles per plant at seven days interval on 5 randomly selected plants after appearance of the pest. Relationship of weekly population counts of the red pumpkin beetle at weekly interval with abiotic factors *viz*., minimum temperature, maximum temperature, mean relative humidity, rainfall and sunshine hours was also worked out.

b)* Epilachna beetle *(Epilachna vigintioctopunctata)

The observations were recorded on the basis of number of grubs, pupae and adults per plant by observing 5 randomly selected plants. The observations were made at weekly intervals after appearance of the pest. Moreover, the correlation of population counts of the Epilachna beetle with abiotic factors *viz*., minimum temperature, maximum temperature, mean relative humidity, rainfall and sunshine hours were worked out.

c)* Black cucurbit beetle (*Aulacophora frontalis)

The observations were recorded based on number of beetles per plant at seven days interval on 5 randomly selected plants after appearance of the pest. Relationship of weekly population counts of the red pumpkin beetle at weekly interval with abiotic factors *viz*., minimum temperature, maximum temperature, mean relative humidity, rainfall and sunshine hours was also worked out.

3. RESULTS AND DISCUSSION

In the present investigation, cucumber variety “Khira 90” was grown at Horticultural farm, Assam Agricultural University, Jorhat during 2019 and 2020 as per the recommended package of practices except insecticidal application. The population dynamics and correlation studies of various Phytophagous beetle *viz*., red pumpkin beetle, *Aulacophora foveicollis* (Chrysomelidae: Coleoptera), black cucurbit beetle, *Aulacophora frontalis* (Chrysomelidae: Coleoptera) and epilachna beetle, *Epilachna vigntioctopunctata* (Coccinellidae: Coleoptera) of cucumber in relation to abiotic factors had been thoroughly investigated during the field experiments.

3.1 Study on Some Important Ecological Parameters of Various Phytophagous Beetles Associated with Cucumber

3.1.1 Population fluctuation of red pumpkin beetle (*A. foveicollis)*

Red pumpkin beetle was an important insect pest causing damage to cucumber. The insect occurred persistently throughout the entire crop seasons in both the years of experiment. During 2019, the beetle first appeared in the field on 24th April 2019 with an initial population of 4.51 beetles per plant and the population was observed to vary from 4.36 to 6.51 beetles per plant during the crop season of cucumber. However, the red pumpkin beetle population attained the peak on 8th May 2019 with a mean population of 6.51 beetles per plant. Thereafter, the beetle population started fluctuating and showed a decreasing trend recording 4.36 beetle per plant on 27th June, 2019. Subsequently, a second trend of increase in population (5.68 beetle per plant) on 11th July 2019 was observed (Table 1). Similarly, during 2020, the beetle first appeared on 7th May, 2020 with a mean population of 2.23 beetles per plant. Afterwards, the population suddenly raised with an increasing trend to 6.15 beetles per plant on 3rd July, 2020 and later declined to 5.20 beetle per plant on 2nd August, 2020 (Table 2). In both the years of experiment, highest number of leaf damage was observed in middle canopy than top and lower canopies of the plant. Therefore, it may be concluded that moderately old leaves were most preferred by red pumpkin beetle (8th May 2019 with a mean population of 6.51 beetles per plant). The present findings are also in agreement with Khursheed et al. [10] who studied red pumpkin beetle on cucumber attained during 2nd and 4th weeks of May and 3rd week of July, 2009 and 2010. Similarly, Saljoqi and Khan [11] also reported that the infestation of red pumpkin beetle was high from May to June. In bitter gourd the incidence of defoliator, pumpkin beetle number varied in kharif from 0.00 to 0.30 with a mean of 0.07 per plant and in rabi, 0.00 to 0.23 with a mean of 0.05 per plant as reported by Sunil and Jayram [12]. Also, according to Shinde et al. [5] findings were recorded initially during 26th SMW (25th June- 1st July), whereas, maximum (3.64 ± 1.20) and the minimum (0.48 ± 1.20) infestation were recorded during 32nd SMW (6th-12th August) and 37th SMW (10th – 16th September) respectively.

3.1.2 Population fluctuation of black cucurbit beetle (*A. frontalis)*

During 2019, the beetle first appeared on 24th April 2019 with an initial population of 1.71 beetles per plant. The population of beetle attained a peak level on 27th June, 2019 with mean population of 4.16 beetles per plant. Thereafter, the beetle population was observed to fluctuate with a mean population of 1.71 to 4.16 beetle per plant during 24th April, 2019 to 2nd August,2019 (Table 1). Similarly, during 2020, the beetle first appeared on 7th May, 2020 with an initial population of 2.05 beetles per plant. The population increased gradually and maximum mean population (3.09 beetles per plant) was observed on 8th August, 2020. However, on 19th July 2020, a decreasing trend of its population was observed with 2.03 beetles per plant (Table 2).

3.1.3 Population fluctuation of epilachna beetle (*Epilachna vigntioctopunctata)*

Epilachna beetle is an important pest as both larval and adult stages feed on the foliages of cucumber. The incidence of beetle recorded from last week of April to first week of August for the both years of 2019 and 2020. During 2019, the beetle recorded for the first time on 24th April 2019 with an initial population of 1.75 beetles per plant. Thereafter, the beetle population was started fluctuating and showed a decreasing trend of 1.55 beetles per plant during 11th July, 2019. Subsequently, this was followed again by an increasing trend of 3.59 beetles per plant during 2nd August 2019 (Table 1). Similarly, during 2020, the beetle was first appeared in the field on 7th May, 2020 with an initial population of 0.75 beetles per plant. Afterwards, the population was suddenly showed an increasing trend with 3.07 beetles per plant on 3rd July, 2020 and later the population declined to 2.16 beetles per plant on 9th August, 2020 (Table 2). The present findings were in conformity with Barma and Jha [13] who showed the highest population of 1.83, 2.14 and 3.12 beetles per plant during second week of March, third week of April and end of May of 2008, 2009 and 2010, respectively. However, Sunil and Jayram [12] reported that the incidence of epilachna beetle during *rabi* season varied from 0.00 to 0.13 with a mean population of 0.01 beetles per plant in cucumber. Similarly, Jamwal [14] also recorded the beetle population during *rabi* season with 0.05 beetle per plant in cucumber.

Table 1. Population dynamics of various phytophagous beetles on cucumber during 2019-2020

Date of observation	Tmax	Tmin	RH (M)	RH (E)	RF (mm)	BSSH	No of red pumpkin beetle/plan (adults)	No of black cucurbit beetle/plant (adults)	No of epilachna beetle/plant (adults)
24.04.2019	32.4	21.4	89	68	32.5	4.6	4.51	1.71	1.75
01.05.2019	25.9	21.1	98	83	192.2	1.7	6.00	2.50	0.65
08.05.2019	26.1	20.6	96	84	51.6	1.5	6.51	2.75	2.13
15.05.2019	28.3	21.2	95	79	52.9	1.9	5.88	2.39	2.05
22.05.2019	28.4	22.5	93	80	75.9	1.4	5.56	2.17	2.08
29.05.2019	31.2	23.7	90	67	14.0	4.8	4.94	3.09	2.23
06.06.2019	32.2	24.9	93	74	48.8	2.6	5.31	2.06	2.20
13.06.2019	33.7	25.9	86	71	55.9	3.6	5.44	3.35	2.55
20.06.2019	32.8	25.6	90	76	149.5	4.5	4.68	3.43	2.84
27.06.2019	32.7	25.4	90	76	65.4	3.8	4.36	4.16	2.85
04.07.2019	33.8	25.7	95	76	194.9	3.9	4.94	3.14	2.53
11.07.2019	29.3	25.1	93	90	65.4	0.0	5.68	3.13	1.55
18.07.2019	32.6	25.5	89	79	43.7	2.7	5.05	3.81	2.81
25.07.2019	31.4	25.2	92	78	74.2	1.8	5.48	4.05	3.36
02.08.2019	31.9	25.4	93	78	78.3	3.5	5.25	3.86	3.59

**Mean of 4 number of replications*

Table 2. Population dynamics of various phytophagous beetles on cucumber during 2020-2021

Date of observation	Tmax	Tmin	RH(M)	RH(E)	RF (mm)	BSSH	No of red pumpkin beetle/plant (adults)	No of black cucurbit beetle/plant (adults)	No of epilachna beetle/plant (adults)
07.05.2020	31.6	20.1	87	65	14.1	6.3	2.23	2.05	0.75
14.05.2020	29	21.2	95	75	42.5	2.6	3.86	2.01	1.48
21.05.2020	27.5	21.9	98	86	126.2	0.5	4.00	2.33	2.06
28.05.2020	30.2	21.8	93	70	123.5	5.3	4.23	2.13	2.03
05.06.2020	29.4	23.2	94	78	15	3.8	5.30	2.17	1.86
12.06.2020	33	24.9	95	77	102.5	4.3	5.19	2.03	2.09
19.06.2020	33	25	96	76	146.5	4.8	5.38	2.03	2.05
26.06.2020	31.4	24.9	96	82	35.4	2.4	5.64	3.09	2.19
03.07.2020	33.5	25.4	95	74	41.6	3.6	6.15	3.21	3.07
10.07.2020	30.8	24.8	98	87	121	1.3	6.10	2.51	2.29
17.07.2020	31	25	97	79	75.1	0.9	6.08	2.81	2.33
25.07.2020	30.9	25	97	84	96.4	1.1	5.91	3.06	2.46
02.08.2020	33.7	26.4	92	71	24.9	5.8	5.20	2.85	2.72
09.08.2020	33.9	25.8	94	78	169.2	3.7	5.48	3.09	2.16

**Mean of 4 number of replications*

Table 3. Correlation coefficients (r) of phytophagous beetles with abiotic factors on cucumber during 2019-2021

Abiotic Factors	Red Pumpkin Beetle		Black Cucurbit Beetle		Epilachana Beetle	
	2019 -2020	2020 -2021	2019-2020	2020-2021	2019-2020	2020-2021
Maximum Temperature (Tmax)	-0.345	0.355	0.400	0.399	0.344	0.400
Minimum Temperature (Tmin)	-0.109	0.875**	0.698**	0.670**	0.755**	0.840**
Relative Humidity (Morning) RH(M)	0.364	0.674**	-0.305	0.256	-0.175	0.498
Relative Humidity (Evening) RH(E)	0.314	0.560*	0.100	0.300	0.201	0.450
Rainfall (RF)	0.104	0.223	0.065	-0.032	0.085	0.483
Bright Sun Shine Hours	-0.414	-0.427	0.135	-0.331	-0.046	-0.277

***Significant at P= 0.01 level*
**Significant at P= 0.05 level*

3.2 Correlation Coefficient Analysis of Various Phytophagous Beetles on Cucumber with Different Weather Parameters

3.2.1 Correlation relationship between red pumpkin beetle (*A. foveicollis)* and abiotic factors

During 2019, the population of *A. foveicollis indicated* a positive relationship with rainfall (r=0.104), relative humidity morning (r=0.364), evening hours (r=0.314). Whereas, negative correlation was noticed with bright sun shine hours (r=-0.414), maximum (r=-0.345) and minimum temperature (r=-0.109) which presented in Table 3. Similarly, during 2020, the population of *A. foveicollis* showed significant positive correlation with minimum temperature (r=0.875**), rainfall (r=0.223), relative humidity morning (r=0.674**) and evening hours (r=0.560*). A negative correlation (r=-0.427) was also observed with bright sun shine hours (Table 3). However, the results were found to be contradictory with the findings of Shinde et al. [5] who reported that the mean infestation of red pumpkin beetle exhibited significant positive correlation (r= 0.576) with maximum temperature. They also reported the positive association of relative humidity with the population of red pumpkin beetle which was in accordance with the results of the present investigation. Similarly, Khursheed [10] revealed that the average minimum temperature showed significant negative correlation with the beetle population at farmer's field.

3.2.2 Correlation relationship between black cucurbit beetle (*A. frontalis)* and abiotic factors

The population of *A. frontalis* during 2019, indicated a positive relationship with maximum temperature (r=0.400), minimum temperature(r=0.698). A relative humidity evening hours (r=0.100) and rainfall (r= 0.065). A negative correlation was noticed with relative humidity morning hours (r=-0.305). Similarly, during 2020, the population of *A. frontalis* showed significant positive correlation with minimum temperature (r=0.670**), maximum temperature (r= 0.399), relative humidity morning (r=0.256) and evening hours (r=0.300). However, a negative correlation was also observed with rainfall (r= -0.032) and bright sun shine hours (r=-0.331) which were presented in Table 3.

3.2.3 Correlation relationship between epilachna beetle (*E.vigntioctopunctata)* and abiotic factors

During 2019, the beetle population showed significant positive correlation with minimum temperature (r= 0.755) and relative humidity evening hours (r=0.201), while there was a negative impact with bright sun shine hours (r=-0.046) and relative humidity morning hour (r=-0.175) which were shown in Table 3. Similarly, during 2020, the beetle population showed a significant positive impact with minimum temperature (r= 0.840*), relative humidity morning hours (r=0.498) and relative humidity evening hours (r=0.450). Whereas, the bright sun shine hours (r=-0.277) showed negative correlation with the beetle population (Table 3). In similar manner Jamwal (2011) reported minimum temperature (r = 0.515), morning relative humidity (r = 0.669) and evening relative humidity (r = 0.796) showed a significant positive impact with the beetle population with 81.9 per cent. According to Jamwal et al., [14] *Henosepilachna vigintioctopunctata* abundance is significantly influenced by lowest temperature and relative humidity. Bhowmik and Saha [15] reported a negative relationship between rainfall and relative humidity and the number of epilachna beetles. Epilachna beetle infestation was found to significantly positively correlate with the maximum air temperature, according to Raghuraman and Veeravel [16] Sagarika [17] found that while minimum relative humidity held a positive link with Epilachna beetle incidence but was not statistically significant, maximum relative humidity held a negative correlation with the insect [18].

4. CONCLUSION

The study revealed that in both the years of experiment *i.e* during 2019 and 2020 the highest number of leaf damage due to phytophagous beetle was observed in middle canopy than top and lower canopies of the plant. Therefore, it may be concluded that moderately old leaves were most preferred by leaf eating beetles. The peak incidence of beetles recorded from last week of April to first week of August for the both years of 2019 and 2020.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscript.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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