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Study the Impact of Abiotic Factors on the Population Fluctuation of Major Insect Pest of Field Pea

Bhavna Chouhan [a++], Rajkumar Choudhary [b#], Shreya Soneshwar [c#], Sanju Singh [d†], Deepali Vishwakarma [e#*], Kailash Kumar [f] and A. K. Bhowmick [g‡]

[a] Madhya Pradesh State Rural livelihood Mission Bhopal, (Government of M.P.), 462027, India.
[b] Department of Entomology, SKNAU, Jobner, Rajasthan, 303328, India.
[c] Department of Entomology, Sardar Vallabh Bhai Patel University of Agriculture and Technology, Meerut, Uttar Pradesh, 250110, India.
[d] Department of Agriculture, Fatehpur, (Government of U.P), 212601, India.
[e] Department of Entomology, RVSKVV, Madhya Pradesh, 474002, India.
[f] College of Agriculture, JNKVV, Jabalpur, M.P. 482004, India.
[g] Department of Entomology, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh, 482004, India.

Authors' contributions

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

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[++] Young Professionals;
[#] Research Scholar;
[†] Technical Assistant;
[‡] Retd. Professor And Head;
**Corresponding author: E-mail: 97deepalivishwakarma@gmail.com;*

ABSTRACT

The present investigation entitled Study the impact of abiotic factors on the population fluctuation of major insect pest of field pea was conducted at the Experiment field of Department of Plant breeding, seed Breeding farm, JNKVV Jabalpur (MP), Madhya Pradesh during the Rabi season 2020-21. Positive correlation of Acryothosiphon pissum, pod borer, and leafhopper with Maximum Temperature (0.581, 0.581, 0.582) and Acrythosiphon pissum with morning vapour pressure (0.453) may be given due weightage in formulating forewarning modules in the pest. Similarly positive correlation was found between Relative humidity and aphid (r = -0.304) and was found significant. Max temperature showed significant negative correlation (r=-0.581) with aphid, Pod borer and leafhopper's population where minimum temperature and rainfall showed negative correlation (r=-0.453 and r= - 0.153) with aphid population. Whereas min temperature showed positive non-significant correlation (r= 0.413). Max temperature showed significant negative correlation (r = -0.581) with pod borer population. Morning vapour pressure shows significant negative correlation (r=-0.453) with aphid population.

Keywords: Correlation; fieldpea; leafhopper; pod borer; Acryothosiphon pissum.

1. INTRODUCTION

Field pea is the self-pollinated diploid crop and it is the most important annual season crop that is valued as a high-quality protein food. It is commonly cultivated in the cooler temperate zones and tropical highlands around the world. The crop can be grown in variety of soil types, from light sandy loam to hard clays but it does not tolerate salty or wet conditions.

Field peas are rich in high quality vegetable protein and does contain all the essential amino acid. The seeds of peas are prized for their nutritional value. Sulphur containing amino acids including cysteine and methionine are scarce in pea, but lysine and other essential amino acids are plentiful [1,2]. It is a good source of essential amino acids in the form of protein (23-25%) which have high nutritional benefits to low-income families (Nawab *et al*. 2008). Furthermore, pea contains ample amounts of essential minerals such as calcium, phosphorus, and iron which are deficient in cereals (Haque *et al*. 2015). Peas have a starch content (20-25%), sugar content (4-10%), fat content (0.6-1.5%), and mineral content (2-4%) (Makasheva 1983). It is mainly an export and cash crop for the world, accounting for around 40% of the total world pulse trade.

The nitrogen fixing capacity of this crop help in restoring soil fertility (Singh *et al*., 2002). Due to high market price in the neighboring states of Maharashtra, Pea production for vegetable purpose in the Jabalpur district has been a huge success. Although its area has increase but the average production is modest [3,4].

Field pea is frequently used in forage crop mixtures with small grains. Protein content in field pea forage ranges from 18-20% [5-7]. Pea inter seeded at 60-100 pounds per acre with a small grain like oat will increase the protein concentration of the mixed forage by 2-4% points and relative feed value by 20 points.

The crop is destroyed by 17 insect pests which lowers the yield of crops both qualitatively and quantitatively. Prasad et al*.* [8] reported 19 species of insect pest of which 8 could be considered of major significance. Kushwaha [9] recorded "9 insect pests on pea crops at different stages of its growth and estimated losses ranged 13 to 17 percent at Jabalpur Madhya Pradesh, were as under".

Insect pests are among the main biotic constraints that cause huge losses worldwide. Among the biotic constraints, *i.e*., insect pests like pea leaf miner (*Chromatomyia horticola Goureau*), pea aphid (*Acrythosiphon pissum*), Pod borer complex (*Helicoverpa armigera (H*), *Lampides boeticus (L)* and (*Etiella zinckenella Tr*.) and thrips (*Caliothrips indicus Bagnall*) often causes substantial losses to the crop.

A large number of insect pests damage field pea at different phases of crop growth. Both abiotic (temperature, humidity and rainfall) and biotic factors (parasites and predators) are recognized as important factors for the multiplication of

insect pests influencing their population. Scanty information is available on the pest's status, crop losses, and management of crop pests of pea. Therefore, to update this information present study is proposed.

2. MATERIALS AND METHODS

The mean pest populations during different weather weeks were subjected sample to correlation studies considering studies considering weather parameters like that mean minimum and maximum temperature (°c) and minimum and maximum relative humidity (%) as the independent variables and the density of insect pests as the dependent variable.

Regression equations were worked out for insect populations showing correlation with weather parameters. Correlation and regression of the biotic factors on major insect pest populations were worked out by using the following formula as suggested by Snedecor and Cochran [10].

The following formula were used for various estimation, population were worked out by using the following formula.

Regression **Y= a+b**

$$\text{Correlation 'r'} = \frac{\sum xy - \frac{\sum x \sum y}{n}}{\sqrt{\left\{\sum_x 2 - \frac{(\sum x)^2}{n}\right\}\left\{\sum_y 2 - \frac{(\sum y)^2}{N}\right\}}}$$

Where,

a=Intercept
b=Regression coefficient
R^2=Coefficient of multiple determination

Test of significance of correlation coefficient

$$t = \frac{r}{\sqrt{1-r^2}}\sqrt{n-2}$$

Regression

Y = a + b x
b = Regression coefficient
R 2 =Coefficient of multiple determination

3. RESULTS AND DISCUSSION

3.1 Incidence of Aphid

The data presented in Table 1 revealed that, the population of aphid appeared on crop in the fourth week of December (three week after sowing) and built up in population started from 52nd standard week meaning fourth week of December and increased up to the third week of January and declined gradually till the crop was matured in March. The population of aphid ranged from 1.25 to 65.69 /10 cm apical twigs. The peak activity of aphid (65.69/10 cm apical twigs) was recorded in the 4th standard week or third week of January.

The incidence of aphid started when maximum and minimum temperature was 23.8°C and 7.2°C and morning relative humidity was 83% and evening relative humidity was 43%. The aphid population increased gradually and reached to its peak (65.69 aphid/10 cm apical twigs) at 24.6°C maximum, 8.6°C minimum temperature and 86 percent morning relative humidity and 49% Evening relative humidity. The data presented in Table 2 revealed that the maximum temperature showed a negative significant correlation (r= -0.581) and morning vapor pressure showed significant negative correlation (r= -0.453) with the aphid population, whereas, minimum temperature and rainfall showed negative correlation (r= -0.453 and r= -0.153) with the aphid population.

Biswal and Patel [11] identified aphid, whitefly and thrip's were the first to infiltrate and colonize the field crop, followed by leaf miner, and remained active until the crop was harvested.

Dixon and Harrington [12] found that the number of aphids fluctuated in lockstep with the temperature from January to July. Cool temperatures in January to February result in large number of aphids population. Their conclusion is consistent with the current studies, which shows that peak populations were observed at a minimum temperature of 9.7°C.

The population of *Acrythosiphon pissum* indicated more affinity with evening relative humidity with r value of 0.398 and the regression equation obtained was y = 0.872x – 7.445. Whereas Wale [13] observed a negative correlation with aphid population and relative humidity.

Melease and Singh [14] reported "a negative correlation of rainfall with aphid population (r = -0.98) means when rainfall decreased, the aphid population increased at P<0.05. A negative correlation was also found between aphid

population and minimum temperature (r=-0.453) but it was non-significant. A significant negative correlation was found between maximum temperature and aphid population".

Correlation was observed between aphid population and wind speed, morning relative humidity, evening relative humidity and it was positively correlated but was found non-significant. The correlation was observed between aphid population and morning vapor pressure so it was negatively correlated and found significant.

Bhadauria (1993) Chakraborty & Dutta [15] Kushwaha [16] Mittal & Ram [17] and Singh & Mishra (2013) have reported "the incidence of pod borers in green peas. However, under Jabalpur conditions, the borer's incidence in green peas was almost absent".

Tomar et al. [1] reported "the most favorable period of insect pests from first week of December to the second week of January for green pea. Relative humidity and rainfall were favorable for the development of almost all the pest (except *spodoptera litura*). The maximum and minimum temperatures were negatively correlated with the population of all the insect pests".

Positive correlation was found between minimum temperature and percentage pod damage by pod borer. A negative correlation was found between percentage pod damage by pod borer and Maximum temperature, rainfall, relative humidity and was found to be significant. The peak population of gram pod borer occurred in December and January and the temp. R.H. showed a positive correlation with pest population while rainfall was negatively correlated.

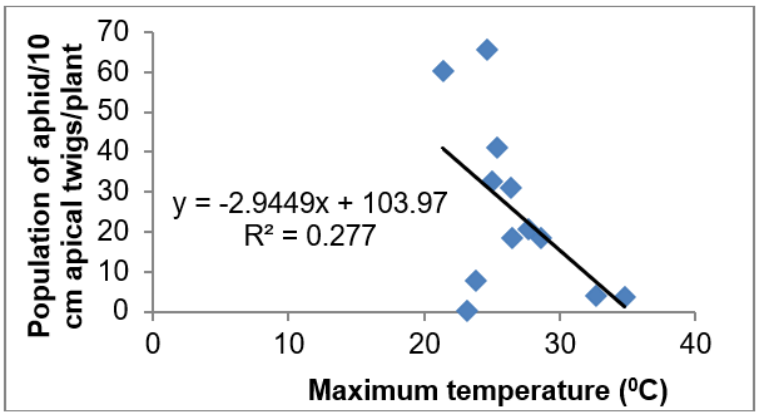

Fig. 1. Impact of maximum temperature on aphid

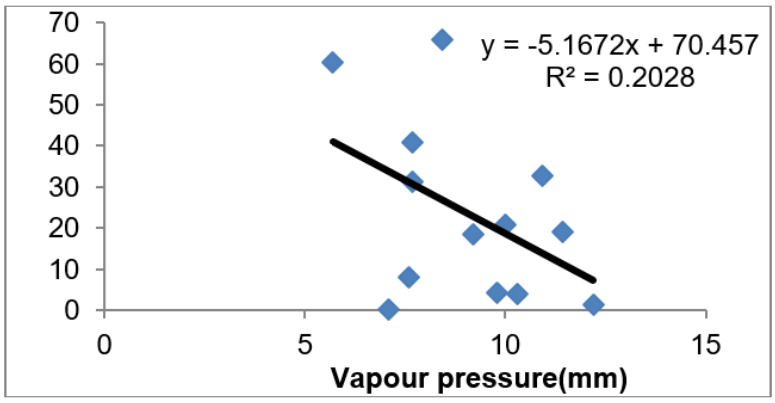

Fig. 2. Impact of morning vapour pressure on incidence of aphid

3.2 Incidence of leaf Hopper

The observations on the population of leafhopper on pea were recorded three weeks after sowing and till the maturity of the crop. The data is presented in the Table 1 revealed that the leaf hopper remained on pea crop throughout the crop season and population varied from 0.23 to 4.96 /six leaves/plants. In the starting the population was low but it increased gradually and reached its peak in 4th standard weeks *i.e*., third week of January and then declined.

The incidence of leaf hopper started when maximum and minimum temperature was 23.8°C and 7.2°C morning relative humidity was 83% and evening relative humidity was 43%. The leaf hopper population increased gradually and reached to its peak (4.96 leaf hopper/six leaves/plants) at 24.6°C maximum, 8.6°C minimum temperature, 86% morning relative humidity and 49% evening relative humidity and rainfall was none and when the morning vapor pressure was 8.4 and evening vapor pressure was 9.4. The data presented in Table 2 revealed that the maximum temperature showed negative significant correlation (r= -0.582) with the population, whereas, minimum temperature and rainfall showed a negative non-significant correlation (r = -0.363 and r = -0.176) and minimum temperature showed positive non-significant correlation (r= 0.413) with leafhopper population.

Findings of Darandale et al. [4] are partially supported the present findings they reported that the incidence of leaf hopper was started from the fourth week of sowing *i.e.,* second week of December (0.27 jassid/leaf). Initially the population was low, increased slowly and reached the peak level (8.52 jassids/ leaf) at 12th week after sowing coinciding with 5th week of January.

3.3 Incidence of *Helicoverpa armigera*

The data is presented in Table 1 revealed that the incidence of *Helicoverpa armigera* was observed in the third week of December (one month after sowing). The population increased gradually with slight up and down and reached to its peak (0.65 *Helicoverpa armigera*/plant) in the second week of January (2nd standard meteorological week) thereafter, it decreased gradually. The population of *Helicoverpa armigera* on pea crop ranged from 0.05 to 0.65 *Helicoverpa armigera* /plant throughout the crop period

The incidence of *Helicoverpa armigera* started when maximum and minimum temperature was 23.2°C and 5.5°C, morning relative humidity was 74% and evening relative humidity was 31% and rainfall was none. The *Helicoverpa armigera* population increased gradually and reached its peak (0.65 *Helicoverpa armigera*/ plants) at 25.0°C maximum, 11.8°C minimum temperature, 86% morning relative humidity and 49% evening relative humidity whereas rainfall was none. The data is presented in Table 2 revealed that the maximum temperature showed a significant negative correlation (r= -0.581) with the population, whereas minimum temperature and rainfall showed a negative non-significant correlation (r = -0.367 and r = -0.324) with *Helicoverpa armigera* population.

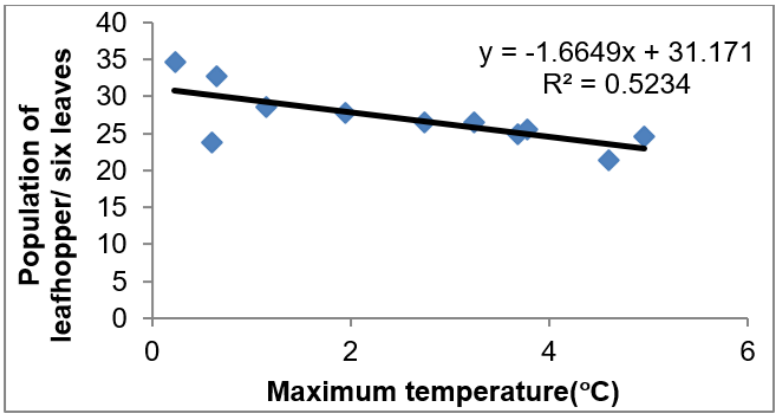

Fig. 3. Impact of maximum temperature on incidence of leafhopper

Table 1. Seasonal incidence of major insect pests of field pea

SMW	Meteorological parameters										
	Insect pests			Temperature (^{0}C)		Wind speed (km/hr.)	Total rainfall (mm)	Vapour pressure (mm)		Relative humidity (%)	
	Aphid/ 10cm apical twigs/ plant	Pod borer/ plant	Leaf hopper/6 leaves/plant	Maximum	Minimum			Morning	Evening	Morning	Evening
51	0	0	0.6	23.2	5.5	1.6	0.0	7.1	6.5	74	31
52	8.08	0.6	0.25	23.8	7.2	2.2	0.0	7.6	8.9	83	43
1	18.8	2.75	0.36	26.5	12.4	2.1	0.5	11.4	12.9	87	50
2	32.68	3.69	0.65	25	11.8	3.2	0.4	10.9	11.3	86	49
3	40.96	3.78	0.3	25.4	8	2.6	0.0	7.7	7.9	75	31
4	65.69	4.96	0.24	24.6	8.6	3.2	0.0	8.4	9.4	86	49
5	60.15	4.61	0.1	21.4	4.8	3.7	0.0	5.7	6.1	73	31
6	31.25	3.25	0.05	26.4	8.9	3.2	0.0	7.7	8.1	72	34
7	20.84	1.95	0	27.7	11.8	2.7	12.6	10.0	10.8	83	42
8	18.64	1.15	0	28.6	10.6	1.9	0.0	9.2	8.2	79	28
9	4.19	0.65	0	32.7	12.4	2.9	0.0	9.8	8.9	74	25
10	3.69	0.23	0	34.8	13	2.8	0.0	10.3	7.8	74	20
11	1.25	0	0	32.3	15.3	3.6	6.2	12.2	10.1	78	29

Table 2. Correlation coefficient between the pest population and weather parameters of field pea

Insect pests	Rainfall	Temperature		Relative humidity		Wind speed	Vapour Pressure	
		Max.	Min.	Mor.	Eve.		Mor.	Eve.
Aphid	-0.175 (NS)	-0.581* (S)	- 0.453 (NS)	0.166 (NS)	0.398 (NS)	0.465 (NS)	-0.453* (S)	-0.104 (NS)
Gram pod borer	-0.324 (NS)	-0.581* (S)	0.367 (NS)	0.309 (NS)	0.477 (NS)	-0.362 (NS)	-0.127 (NS)	0.102 (NS)
Leaf hopper	-0.176 (NS)	-0.582* (S)	-0.363 (NS)	0.242 (NS)	0.515 (NS)	0.440 (NS)	-0.333 (NS)	0.075 (NS)

NS = Non significant
S = Significant
** = Mean of 3 replications*

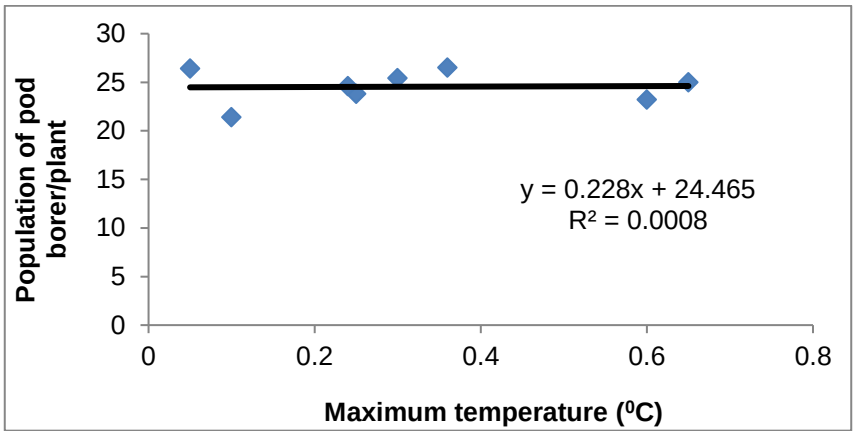

Fig. 4. Impact of maximum temperature on incidence on pod bore

4. CONCLUSION

Field pea crop was found to be affected by four major insect pest, aphid and borer appear in the early stage while leafhopper appears in first week of January. These insect pests major reason for reducing the yield of crop. Seasonal activity of insect pest indicated a high population of *Acrythosiphon pissum* during SMW # 4, high incidence or gram pod borer at SMW #52 and a high incidence of leafhopper during SMW # 4. Hence the last week of January was the most crucial period for the application of insecticidal measures.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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