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Study of Population Dynamics of Insect-pests in Different Growing Environments and their Relationship with Microclimate of Pigeonpea Cultivars

Rajesh Kumar[1], Ram Niwas[1], M.L. Khichar[1], Mohit Kamboj[1], Kartik[2]

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ABSTRACT

Background: Pigeonpea is a low input, rainfed crop that provides economic returns every part of the plant. Insect-pests are the major biotic constraints limiting the productivity of this crop. Keeping all these factors in mind, the present experiment was conducted to study the population dynamics of insect-pests in different growing environments and their relationship with microclimate of pigeonpea cultivars.

Methods: A field experiment was conducted at research farm of Department of Agricultural Meteorology, Chaudhary Charan Singh Haryana Agricultural University, Hisar, during *Kharif* season 2017. Insect-pests population was recorded from the five tagged plants at weekly interval starting from 38th standard meteorological week (SMW) till harvesting of the crop. Ground sheet method was used to record the population of larvae of *M. vitrata and H. armigera.* Larvae of *M. vitrata* and *H. armigera* falling on cloth sheet of size 60 cm × 60 cm laid near plant stem were counted. Web formed by *M. vitrata* larvae were visually counted and then removed to count larvae feeding inside the webs.

Result: In our experiment, it was found that *H. armigera* infestation started from 38th SMW in all the varieties and D_1 and D_2 sown crop while in D_3 sown crop it started in 40th SMW. On the other hand the larval population of *M. vitrata* started from 38th SMW, 39th SMW and 40th SMW in all varieties and D_1, D_2 and D_3 sown crops, respectively where as the formation of webs in all the varieties and D_1 sown crop started from 38th SMW while in D_2 and D_3 sown crops started from 39th SMW and continued till 45th SMW. Mean larval population of *H. armigera*, *M. vitrata* and number of webs per plant was found highest in D_1 sown crop on variety Manak.

Key words: Correlation, *Helicoverpa armigera*, *Maruca vitrata*, Microclimate, Pigeonpea.

INTRODUCTION

Pigeonpea (*Cajanus cajan* L. Milli sp.) commonly known as red gram, is a low input, rainfed crop with characteristics that provide economic returns from each and every part of the plant. The Pigeon pea is grown for grains, green manuring, fodder and forage in all cropping systems *i.e.* as sole crop, intercrop, mixed crop and sequential crop mostly in tropical and sub tropical countries all over the world. Some of the countries with notable pigeonpea production are India, Nepal, Myanmar, Malawi and Uganda along with some other countries in eastern Africa and the Dominican Republic in the Americas (Ahlawat and Shivakumar, 2006). India accounts for 90 per cent of world's pigeonpea growing area and 85 per cent of world's production (Dahariya *et al.,* 2018). In world pigeonpea is cultivated on 6.93 mha with annual production of 6.67 MT. In India pigeonpea is cultivated on 5.38 m ha with a total production of 4.87 MT (FAO, 2017). In Haryana, it is cultivated on 15.1 thousand hectares with production and productivity of 16.4 thousand tonnes and 1086 kg/ha respectively (Anonymous, 2014).

It is grown as *Kharif* crop sown in month of June and July and is attacked by a large number of insects at all stages of growth *i.e.* seedling to harvest stage and as per a conservative estimate, losses due to these insect pests may vary from 27 per cent to even 100 per cent. Among the various constraints for low productivity in pigeonpea crop, the infestation of insect pests is the main contributor. Insect-pests are the major biotic constraints limiting the productivity of this crop. More than 250 insect species have been recorded feeding on pigeonpea and among these only few cause significant and consistent damage (Keval *et al.,* 2017). Information on pest complex in particular agro-climatic condition is a prerequisite, which helps in designing a successful pest management strategy. However, no systematic efforts have been made to observe the diversity of insect pests and their seasonal occurrence with relation to crop phenological stages. Pest menace on pigeonpea

[1]Department of Agricultural Meteorology, CCS Haryana Agricultural University, Hisar-125 004, Haryana, India.
[2]Department of Agronomy, Punjab Agricultural University, Ludhiana-141 001, Punjab, India.

Corresponding Author: Rajesh kumar, Department of Agricultural Meteorology, CCS Haryana Agricultural University, Hisar-125 004, Haryana, India. Email: sainirajeshagmhau@gmail.com

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(*Cajanus cajan*) has assumed serious proportions, even to the extent of suicidal deaths of farmers. Information related to diversity and seasonal occurrence of pests on this crop is very much important and is of great significance in effective pest management practices. Among the several insect pests attacking different parts of pigeonpea plants, pod borers are most injurious; they attack both the flowers as well as pods and cause major losses, often threatening the cultivation of this crop (Prasana and Bhalani, 1994 and Mittal and Ujagir, 2005). In pigeonpea, insect pests are one of the major hamper infesting the crop from seedling to harvest of crop and even the storage are highly vulnerable. Damage inflicted by *Helicoverpa armigera* larvae, is bound to flowers, seeds and pods and a single larva can destroy 30-40 pods, whereas *Maruca vitrata* larvae destroy the plants by causing bore into the pods and webbing to flowers (Sreekanth *et al.,* 2015). *M. obtusa* and *Clavigralla gibbosa* attack the crop from pod filling to pod maturity stage. Reddy *et al.* (2001) during their research work observed the impact of various abiotic factors on population built of pigeonpea pest *viz., Empoasca keri*, *Megalurothrips usitatus*, *Mylabris pustulata*, *H. armigera* and *M. testulalis*. They found that biotic and abiotic factor plays crucial role in the population build up of insect pests and predators. Keeping all these factors in mind, the present experiment was conducted during 2017 to study the population dynamics of major insect-pests in different growing environments and their relationship with microclimate of pigeonpea cultivars.

MATERIALS AND METHODS

This experiment was conducted in *Kharif* season 2017 at research farm, Department of Agricultural Meteorology, CCSHAU Hisar, Haryana. The field area was adjacent to Agrometeorological observatory at 29°10′ N latitude, 75° 46′ E longitude and altitude of 215.2 m. The experiment was laid out in split-plot design, the main-plots treatments consisted of three dates of sowing *i.e.* D_1 (First fortnight of May), D_2 (First fortnight of June), D_3 (Second fortnight of June). The sub-plots treatment consisted of three cultivars Manak, Paras and UPAS-120. Population dynamics of major insect-pests infesting pigeonpea *viz., M. vitrata* and *H. armigera* were observed on pigeonpea crop. Five randomly selected plants were tagged from each variety per replication. Insect-pests population was recorded from the tagged plants at weekly interval starting from 38th standard meteorological week (SMW) till harvesting of the crop. Ground sheet method was used to record the population of larvae of *M. vitrata* and *H. armigera.* A cloth sheet of size 60 cm × 60 cm was laid near plant stem. The plant was tilted toward the sheet and jerked gently to make the insects fall down on the sheet. Larvae of *M. vitrata and H. armigera* falling on cloth sheet were counted. Web formed by *M. vitrata* larvae were visually counted and then removed to count larvae feeding inside the webs. The seasonal incidence of test insect-pests was correlated with microclimatic parameters *viz*., temperature and relative humidity. Regression analysis was carried out to develop the relationship of insect-pests population of pigeonpea with microclimatic parameters.

RESULTS AND DISCUSSION

Gram pod borer (*Helicoverpa armigera*)

The overall range of *H. armigera* larval population among different date of sowings was found 0.09 to 0.61 larvae per plant as shown in Fig 1. *H. armigera* infestation started from 38th SMW (3rd week of September) in D_1 and D_2 sown crops while in D_3 sown crop, it started in 40th SMW (1st week of October), which gradually increased till 44th - 45th SMW and reached its peak in 44th SMW (1st week of November) in D_1 sown crop while in D_2 and D_3 sown crops, reached its peak in 45th SMW (2nd week of November) and after this started declined up to 48th SMW (last week of November). Mean larval population of *H. armigera*, among different date of sowings, was found highest (0.29 larvae/plant) in D_1 sown crop followed by D_2 (0.24 larvae/plant) and D_3 (0.19 larvae/ plant) sown crops. These results are in accordance with Verma (2006) and Surana (2001) who reported that infestation of *H. armigera* started from flowering to pod maturity stages.

The overall range of *H. armigera* larval population among different varieties was found 0.05 to 0.58 larvae per plant as shown in Fig 2. Similar results were reported by earlier workers *i.e.* 0.07 to 0.48 larvae per plant (Bajya *et al*., 2010) and less than 1.10 larvae /plant (Sujithra and Chander, 2014). *H. armigera* infestation started from 38th SMW in all the varieties, which gradually increased till 44th - 45th SMW and reached its peak in 45th SMW and then started decline up to 48th SMW. On the basis of varietal mean of number of larvae of *H. armigera*, among different varieties, highest larval population (0.29 larvae/plant) were found on variety Manak followed by Paras (0.24 larvae/plant) and UPAS-120 (0.18 larvae/plant).

Spotted pod borer (*Maruca vitrata*)

The larval population of *M. vitrata* started from 38th SMW (3rd week of September), 39th SMW (4th week of September) and 40th SMW (1st week of October) in D_1, D_2 and D_3 sown crops, respectively (Fig 3). Larval population was maximum during 41st SMW (2nd week of October) and after this the population was declined up to 45th SMW (2nd week of November) in all date of sowings. After 45th SMW (2nd week of November), no larval population of *M. vitrata* was found. During the entire period larval population of *M. vitrata* ranged from 0.13 to 0.84 larvae per plant. Mean larval population of *M. vitrata*, was highest in D_1 (0.26 larvae/plant) sown crop followed by D_2 (0.21 larvae/plant) and D_3 (0.17 larvae/plant) sown crops. These findings are in accordance with the finding of Sujithra and Chander (2014) who reported that *M. vitrata* larval population started appearing from 36th SMW to 44th SMW and reached its peak during 39th SMW. The larval population during the entire period ranged from 0.02

to 0.82 larvae per plant. Similarly, Verma (2006) and Surana (2001) reported 0.50 insect per plant during entire crop duration.

The larval population of *M. vitrata* started from 38th SMW (3rd week of September) in all varieties (Fig 4). Larval population was found maximum during 41st SMW (2nd week of October) and after this, the population was declined up to 45th SMW (2nd week of November) in all the varieties. After 45th SMW (2nd week of November) no larval population of *M. vitrata* was recorded. During the entire period, larval population of *M. vitrata* ranged from 0.02 to 0.82 larvae per plant. On the basis of varietal mean of number of larvae of *M. vitrata*, highest larval population were recorded on variety Manak (0.24 larvae/plant) followed by Paras (0.22 larvae/plant) and UPAS-120 (0.18 larvae/plant).

Web formed by *M. vitrata* larvae were visually counted from selected plants (Fig 5). The formation of webs in D_1 sown crop started from 38th SMW (3rd week of September) while in D_2 and D_3 sown crops it was started in 39th SMW (4th week of September) and continued till 45th SMW (2nd week of November). After 45th SMW (2nd week of November) no web formation by *M. vitrata* was recorded. Maximum number of webs per plant was recorded in D_1 (3.36 webs/plant) sown crop followed by D_2 (3.18 webs/plant) and D_3 (3.09 webs/plant) sown crops during 41st SMW (2nd week of October). Among different date of sowings, highest number of webs per plant was found in D_1 (1.06 webs/plant) sown crop followed by D_2 (1.00 webs/plant) and D_3 (0.84 webs/plant) sown crops.

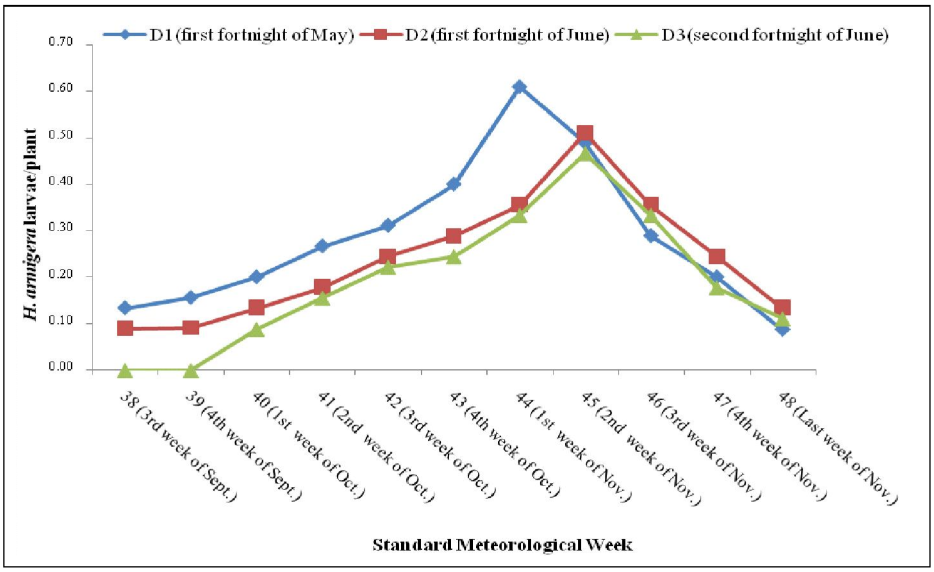

Fig 1: Larval population of gram pod borer (*H. armigera*) in different date of sowings.

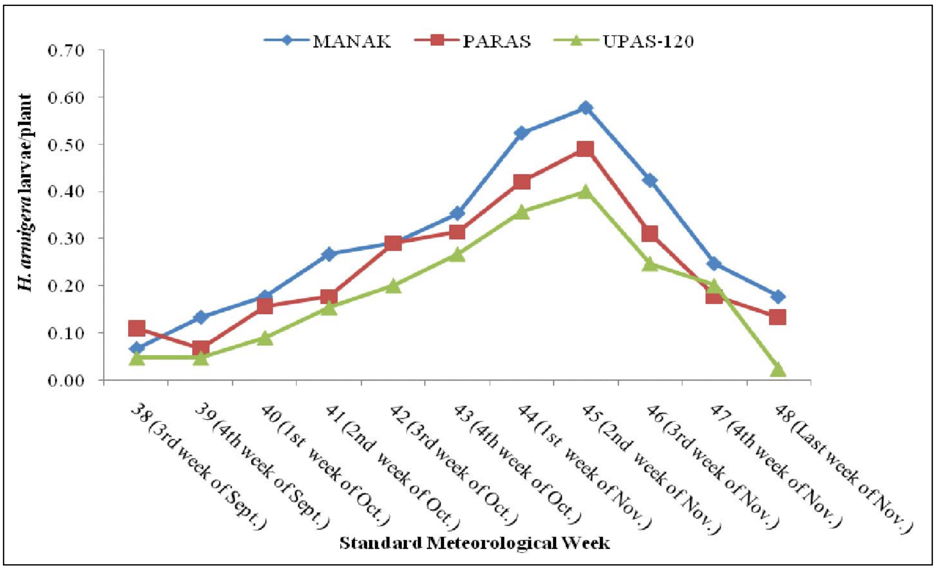

Fig 2: Larval population of gram pod borer (*H. armigera*) on varieties of pigeonpea.

The formation of webs in all the varieties started from 38th SMW (3rd week of September) and continued till 45th SMW (2nd week of November) (Fig 6). After 45th SMW (2nd week of November) no web formation by *M. vitrata* was recorded. Maximum number of webs per plant was recorded on variety Manak (3.31 webs/plant) followed by UPAS-120 (3.11 webs/plant) and Paras (2.98 webs/plant) during 41st SMW (2nd week of October). Among different varieties, highest number of webs per plant was found on Manak (1.04 webs/plant) followed by Paras (0.95 webs/plant) and UPAS-120 (0.89 webs/plant).

Insect-pests relationship with crop microclimate

Correlation of major insect-pests population with microclimate of pigeonpea cultivars

Larval population of *H. armigera* showed non-significant positive correlation with temperature while significant positive correlation with relative humidity in all three varieties (Table 1). *M. vitrata* webs showed significant positive correlation with both temperature and relative humidity while larval population of *M. vitrata* was non-significantly positive correlated with both temperature and relative humidity in all the three varieties. *M. vitrata* webs showed significant positive correlation with both temperature and relative humidity while larval population of *M. vitrata* showed non-

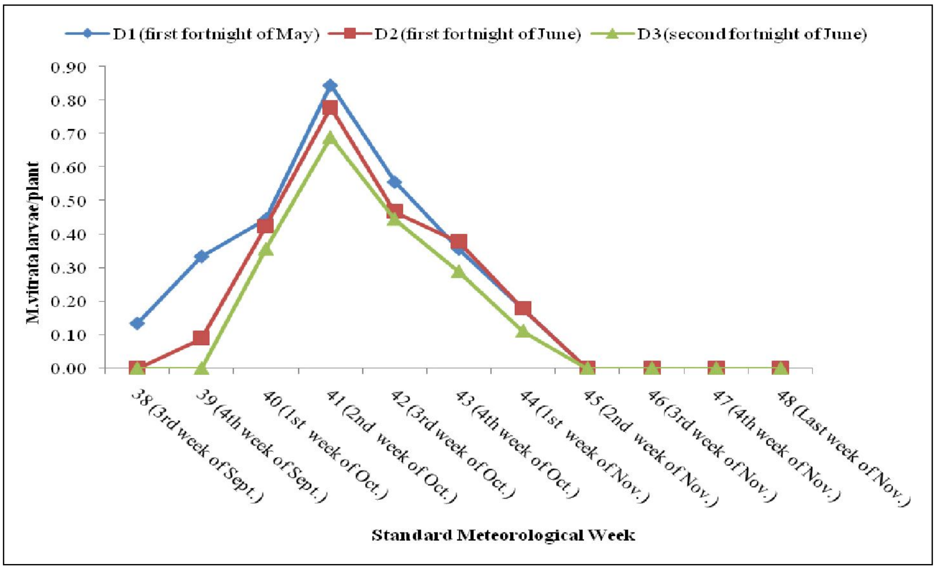

Fig 3: Larval population of spotted pod borer (*M. vitrata*) in different date of sowings.

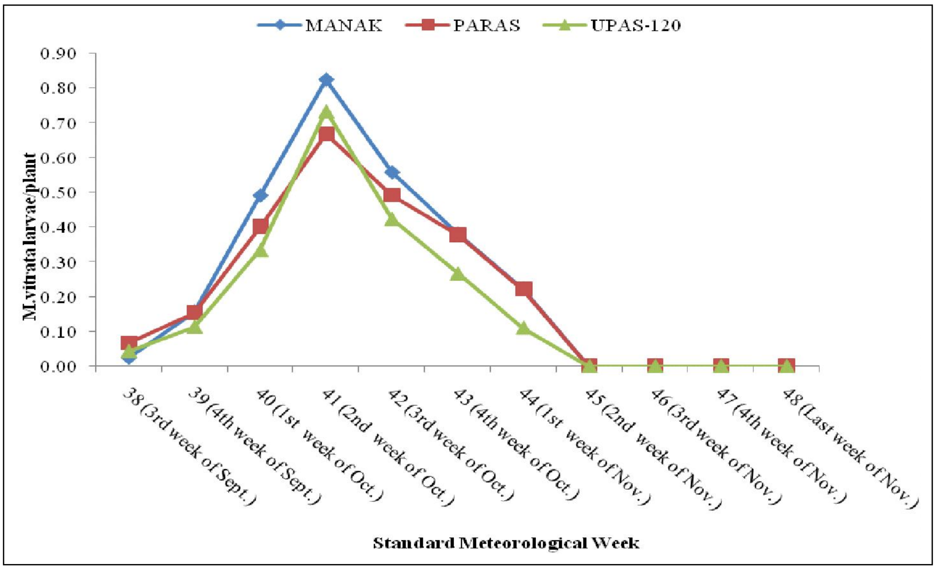

Fig 4: Larval population of spotted pod borer (*M. vitrata*) on varieties of pigeonpea.

significant positive correlation with both temperature and relative humidity in all the three varieties. These findings are in accordance with the findings of Sahoo and Behera (2001).

Regression of major insect-pests population with crop microclimate

Linear regression

A linear direct relationship was found between temperature and larval population of *H. armigera* and *M. vitrata* webs on Manak variety explaining the variability up to 5 and 40 per cent, respectively. Relative humidity showed positive linear relationship with larval population of *H. armigera* and *M. vitrata* webs explaining the variability up to 50 and 36 per cent, respectively (Fig 7).

A linear direct relationship was found between temperature and larval population of *H. armigera* and *M. vitrata* webs on Paras variety explaining the variability up to 9 and 42 per cent, respectively. Relative humidity showed positive linear relationship with larval population of *H. armigera* and *M. vitrata* webs explaining the variability up to 41 and 34 per cent, respectively (Fig 8).

A linear direct relationship was found between temperature and larval population of *H. armigera* and *M. vitrata* webs on UPAS-120 variety explaining the variability up to 12 and 40 per cent, respectively. Relative humidity showed positive linear relationship with larval population of *H. armigera* and *M. vitrata* webs explaining the variability up to 44 and 39 per cent, respectively (Fig 9).

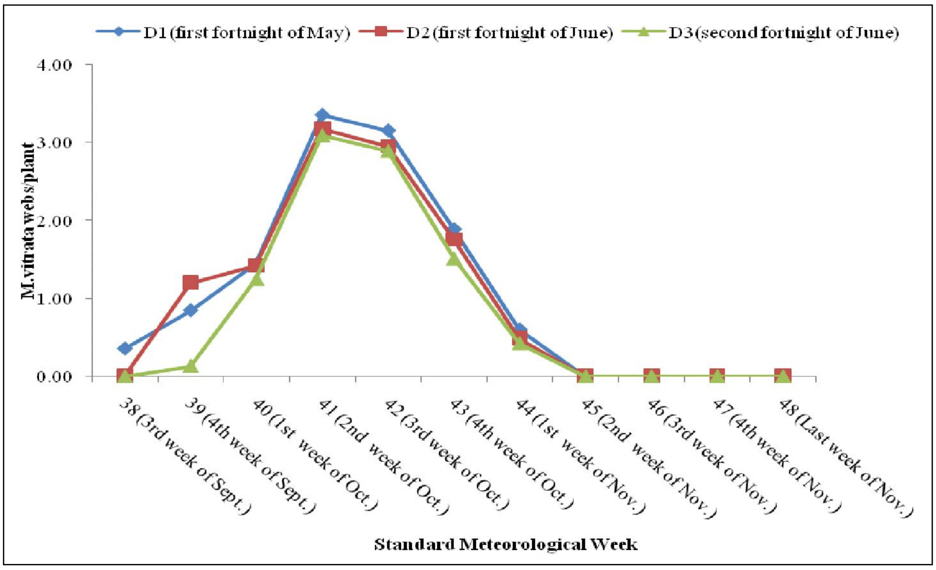

Fig 5: Web of spotted pod borer (*M. vitrata*) larvae in different date of sowings.

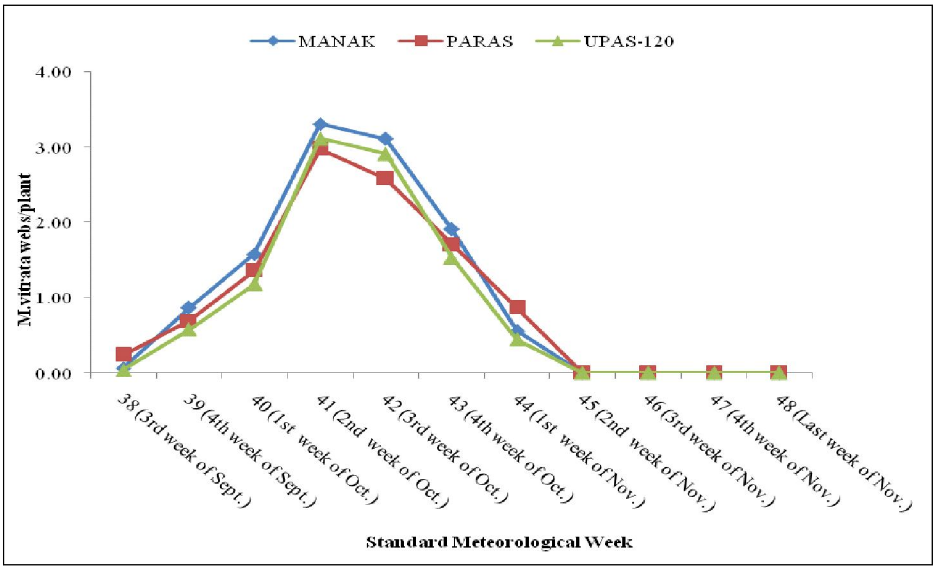

Fig 6: Web of spotted pod borer (*M. vitrata*) larvae on varieties of pigeonpea.

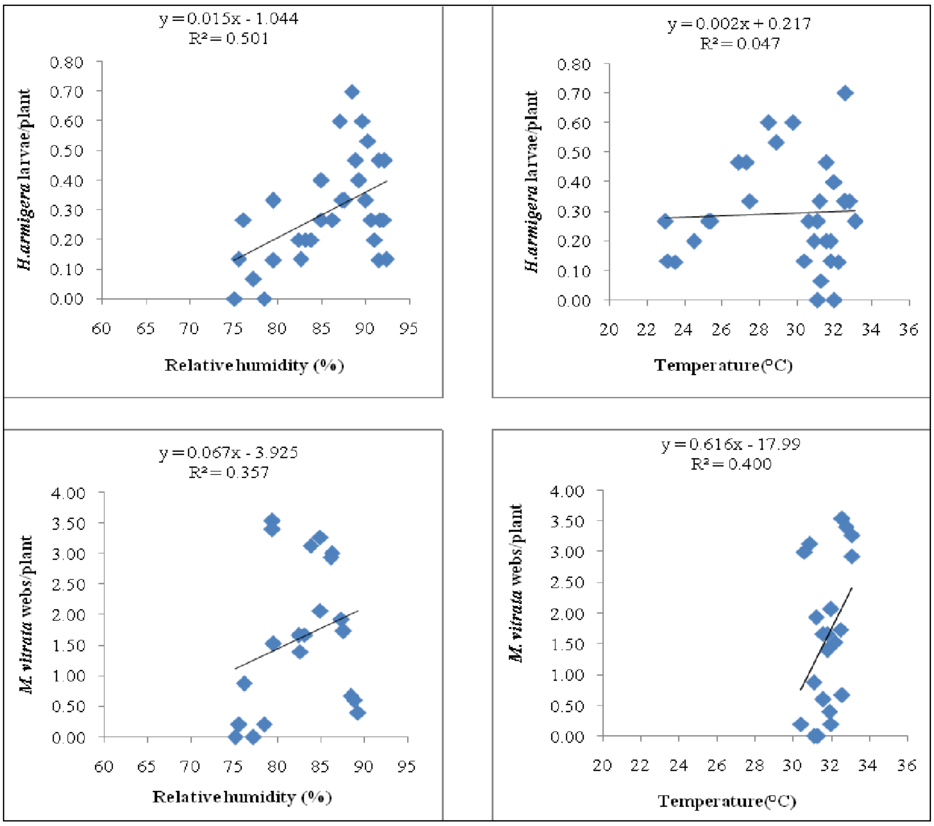

Fig 7: Relationship of major insect-pests population with microclimate of pigeonpea variety Manak.

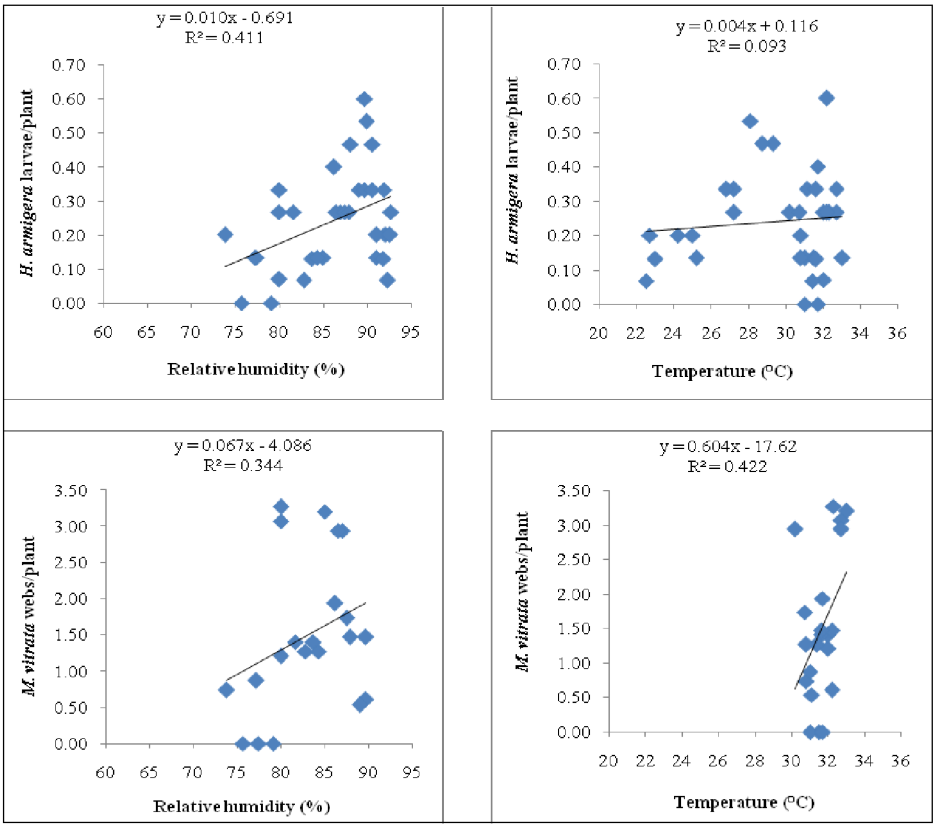

Fig 8: Relationship of major insect-pests population with microclimate of pigeonpea variety Paras.

Table 1: Correlation of major insect-pests population with microclimate of pigeonpea cultivars.

Microclimate parameters	*H.armigera* larvae/ plant	*M.vitrata* larvae/ plant	*M.vitrata* webs/ plant
		Manak	
Temperature (°C)	0.047	0.323	0.400*
Relative humidity (%)	0.501**	0.247	0.357*
		Paras	
Temperature (°C)	0.093	0.376*	0.422*
Relative humidity (%)	0.412*	0.258	0.344*
		UPAS-120	
Temperature (°C)	0.122	0.214	0.397*
Relative humidity (%)	0.437*	0.190	0.390*

*Significant at 5% level of significance.

**Significant at 1% level of significance.

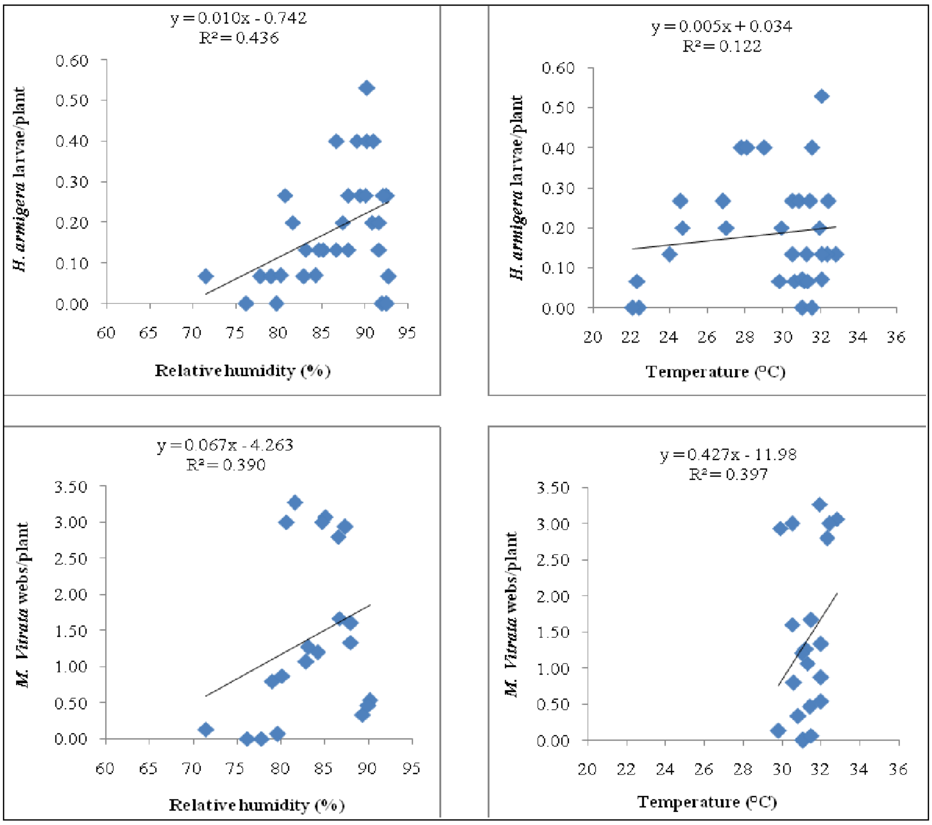

Fig 9: Relationship of major insect-pests population with microclimate of pigeonpea.

CONCLUSION

This experiment was conducted to study the population dynamics of major insect-pests in different growing environments and their relationship with microclimate of pigeonpea cultivars. According to the results obtained, *H. armigera* infestation started from 38th SMW (3rd week of September) in all the varieties and D_1 and D_2 sown crop while in D_3 sown crop it started in 40th SMW (1st week of October). On the other hand the larval population of *M. vitrata* started from 38th SMW, 39th SMW and 40th SMW in all varieties and D_1, D_2 and D_3 sown crops, respectively where as the formation of webs in all the varieties and D_1 sown crop started from 38th SMW while in D_2 and D_3 sown crops started from 39th SMW and continued till 45th SMW. Mean larval population of *H. armigera*, was found highest in D_1 sown crop followed by D_2 and D_3 sown crops. Mean larval population was maximum on variety Manak followed by Paras and UPAS-120. Same trend was followed in mean larval population of *M. vitrata* and number of webs per plant.

Larval population of *H. armigera* showed non-significant positive correlation with temperature while significant positive correlation with relative humidity in all three varieties. *M. vitrata* webs showed significant positive correlation with both temperature and relative humidity while larval population of *M. vitrata* showed non-significant positive correlation with both temperature and relative humidity in all the three varieties. Larval population of *H. armigera* and *M. vitrata* webs showed a linear direct relationship with both temperature and relative humidity in all the three varieties.

Conflict of interest: None.

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