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Effect of Different Growing Environments of Pigeonpea Cultivars on Population Dynamics of *Clavigralla gibbosa* and its Relationship with Microclimate

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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

The field experiment was carried out at research farm of Department of Agricultural Meteorology, Chaudhary Charan Singh Haryana Agricultural University, Hisar, during *Kharif* season 2017-18 to study the influence of different growing environments on *Clavigralla gibbosa* population dynamics and its relationship with microclimate of pigeonpea cultivars. The results revealed that the egg masses and adult population of *C. gibbosa* were first recorded during the 38th SMW and continued until crop harvesting in all cultivars and D_1 (First fortnight of May), and D_2 (First fortnight of June) sown crops, whereas it was observed during the 40^{th} SMW and 39^{th} SMW in the D_3 (Second fortnight of June) sown crop, respectively. Mean number of egg masses of *C. gibbosa* (0.15 egg

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masses/plant) and population of adults (1.24 adults/plant) recorded highest under D_1 sown crop, whereas, among cultivars, it was found higher (0.15 egg masses/plant) and (1.18 adults/plant) under cultivar Paras. The nymphal population of *C. gibbosa* initially noticed during 38th SMW in Manak cultivar sown on D_1 and D_2, while, in cultivars Paras and UPAS-120, it was noticed during 39th SMW and in D_3 sown crop on 40th SMW. Among different date of sowings, higher nymphal population (0.22 nymphs/plant) was found in D_1 sown crop while among different cultivars, it was highest (0.21 nymphs/plant) on cultivar Manak. Non-significant negative correlation was obtained between egg masses laid by *C. gibbosa* and temperature while non-significant positive correlation was obtained with relative humidity in cultivar Manak. In cultivar Paras, non-significant positive correlation with temperature while non-significant negative correlation with relative humidity. In cultivar UPAS-120, non-significant positive correlation was found with both temperature and relative humidity. Significant negative correlation was obtained between nymphal population of *C. gibbosa* and temperature while relative humidity showed significant positive correlation with tur pod bug nymphal population in all three cultivars. Adult population of *C. gibbosa* showed significant positive correlation with temperature while non-significant negative correlation with relative humidity in all cultivars. A negative linear relationship was found between temperature and nymphal population of *C. gibbosa* while relative humidity showed positive linear relationship on all the three varities *i.e.,* Manak, Paras and UPAS-120 explaining the variability up to 65 and 49 per cent, 58 and 59 per cent and 53 and 55 per cent, respectively.

Keywords: Clavigralla gibbosa; correlation; microclimate; pigeonpea; insect population.

1. INTRODUCTION

Pigeonpea (*Cajanus cajan* L.), commonly known as red gram, is an important tropical and subtropical grain legume with characteristics of yielding economic returns from every section of the plant [1]. Pigeonpea is rich source of protein (22.3%), supplying a major share of the protein requirement of the vegetarian population of the country, making it a valuable component for improving food security and nutrition for many poor families [2]. It is a multi-purpose crop used as *dal* (split grains), vegetable (green seeds and pods), fodder (green and dry leaves), feed (dry crushed grains) and fuel. It also helps in nitrogen fixation and can be grown for green manuring. 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 [3,4]. During 2019-20, India produces about 3.89 MT of pigeonpea on an area of 4.53 mha with a productivity of 859 kg/ha, whereas Haryana produces 1.24 thousand tonnes with a productivity of 1020 kg/ha on 1.11 thousand hectares [5]. The low productivity of Pigeonpea in the country can be attributed due to various biotic and abiotic factors, with insects and pests being the most important biotic constraints affecting the crop's yield and more than 250 insect species have been recorded feeding on pigeonpea but few cause significant and consistent damage [6-8]. Insect pest complex is the most limiting factor in pigeonpea production. These pests cause adequate economic damage leading to very low yield levels of 500 - 800 kg/ha as against the potential yield of 1800- 2000 kg/ha [9]. Therefore, 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 but information pertaining to diversity and seasonal occurrence of pests on this crop is of significance in effective pest management practices. In pigeonpea, *Clavigralla gibbosa* is a major insect-pest which attacks the crop from pod filling to pod maturity stage. Keeping all these factors in mind, the present study entitled "Effect of different growing environments of pigeonpea cultivars on population dynamics of *Clavigralla gibbosa* and its relationship with microclimate" was conducted to evaluate the influence of different growing environments on *Clavigralla gibbosa* population dynamics and its relationship with microclimate of pigeonpea cultivars.

2. MATERIALS AND METHODS

An experiment was conducted during *Kharif*, 2017-18 at research farm of department of Agricultural Meteorology, CCSHAU Hisar, Haryana. The field area was adjacent to Agrometeorological observatory at 290 10' N latitude, 750 46'E longitude and altitude of 215.2 m. The experiment was laid out in split-plot design with main-plots consisted of three dates of sowing *i.e.,* D_1 (First fortnight of May), D_2 (First fortnight of June) and D_3 (Second fortnight of June), while, the sub-plots treatments consisted of three cultivars *viz.* Manak, Paras and UPAS-120. For observing the population dynamics of *C. gibbosa* in pigeonpea cultivar, five randomly selected plants were tagged in all cultivars per replication. The population of adults and nymphs of *C. gibbosa* was recorded from the tagged plants at weekly intervals starting from the 38th standard meteorological week (SMW) until the crop was harvested, using the ground sheet method. A cloth sheet measuring 60 cm × 60 cm was laid near the plant stem, then the plant was tilted toward the sheet and gently jerked to make the insects fall down on the sheet, and adults and nymphs of *C. gibbosa* falling were counted and egg masses of *C. gibbosa* were visually counted on pods and leaves. Correlation and regression study were used to develop the relationship between the insect-pest population of pigeonpea cultivars with microclimatic characteristics.

3. RESULTS AND DISCUSSION

Egg masses of *C. gibbosa* were recorded on 38th SMW (3rd week of September) in D_1 and D_2 sown crops while in D_3 sown crop, it was recorded on 40th SMW (1st week of October) and continued up to harvesting of crop (Fig. 1). The range was found between 0.02 to 0.27, 0.00 to 0.27 and 0.00 to 0.16 egg masses per plant in D_1, D_2 and D_3 sown crops, respectively. Mean number of egg masses of *C. gibbosa* were highest in D_1 (0.15 egg masses/plant) sown crop followed by D_2 (0.13 egg masses/plant) and D_3 (0.08 egg masses/plant) sown crops. Egg masses of *C. gibbosa* were first recorded on 38th SMW (3rd week of September) and continued up to harvesting of crop in all the cultivars (Fig. 2). The egg masses ranged between 0.05 to 0.20, 0.05 to 0.29 and 0.05 to 0.16 egg masses per plant on with cultivar Manak, Paras and UPAS-120, respectively. On the basis of varietal mean of number of egg masses of *C. gibbosa*, highest egg masses were recorded on cultivar Paras (0.15 egg masses/plant) followed by Manak (0.12 egg masses/plant) and UPAS-120 (0.10 egg masses/plant). Similar findings were reported by Veda [10].

The nymphal population of *C. gibbosa* initially noticed during 38th SMW (3rd week of September) in D_1 and D_2 sown crops while in D_3 sown crop it was noticed on 40th SMW (1st week of October) as depicted in Fig. 3. The nymphal population of *C. gibbosa* was found maximum near harvesting of crop (48th SMW) (last week of November) in all the date of sowings. Among different date of sowings, highest nymphal population of *C. gibbosa* were recorded in D_1 (0.22 nymphs/plant) sown crop followed by D_2 (0.16 nymphs/plant) and D_3 (0.13 nymphs/plant) sown crops. Pandey et al. [11] also found that the tur pod bug nymphal population was active from 40th SMW up to harvest of the crop. The nymphal population of *C. gibbosa* initially noticed on 38th SMW (3rd week of September) in Manak cultivar while in cultivars Paras and UPAS-120 it was noticed on 39th SMW (4th week of September) depicted in Fig. 4. The nymphal population of *C. gibbosa* was found maximum near harvesting of crop (48th SMW) in all the cultivars. Among different cultivars, highest nymphal population of *C. gibbosa* was recorded on cultivar Manak (0.21 nymphs/plant) followed by Paras (0.16 nymphs/ plant) and UPAS-120 (0.16 nymphs/ plant).

Adult population of *C. gibbosa* started appearing during 38th SMW (3rd week of September) in D_1 and D_2 sown crops while in D_3 sown crop it appeared during 39th SMW (4thweek of September) and continued till harvesting of crop (Fig. 5). The adult population reached its peak in 43rd SMW (4th week of October) in all date of sowings and after this, the population was declined up to harvesting of crop. Maximum number of adults per plant was 3.87, 3.60, and 3.53 in D_1, D_2 and D_3 sown crops, respectively. The range of adult population of *C. gibbosa* on different date of sowings was D_1 (0.15 to 3.87), D_2 (0.13 to 3.60) and D_3 (0.13 to 3.53) adults per plant. Mean population of *C. gibbosa* adults, was highest in D_1 (1.24 adults/plant) sown crop followed by D_2 (1.08 adults/plant) and D_3 (0.86 adults/plant) sown crops. Adult population of *C. gibbosa* started appearing on 38th SMW (3rd week of September) and continued till harvesting of crop (Fig. 6). The adult population reached its peak in 43rd SMW (4th week of October) in all cultivars and after this the population declined up to harvesting of crop. The maximum number of adults per plant for all the cultivar *viz.,* Paras, Manak and UPAS-120 was 3.87, 3.69, and 3.45, respectively. The range of adult population of *C. gibbosa* on different cultivars was 0.16 to 3.87 (Paras), 0.09 to 3.69 (Manak) and 0.11 to 3.45 (UPAS-120) adults per plant. On the basis of varietal mean of population of *C. gibbosa* adults, highest population was found on Paras (1.18 adults/plant) followed by Manak (1.06 adults/plant) and UPAS-120 (0.93 adults/plant).

3.1 Correlation and Regression Study

3.1.1 Insect-pests relationship with crop microclimate

Non-significant negative correlation was obtained between egg masses laid by *C. gibbosa* and temperature while non-significant positive correlation was obtained with relative humidity in cultivar Manak (Table 1). In cultivar Paras, non-significant positive with temperature while negative and non-significant with relative humidity. In cultivar UPAS-120, non-significant positive correlation was found with both temperature and relative humidity. Significant negative correlation was obtained between nymphal population of *C. gibbosa* and temperature while relative humidity showed significant positive correlation with tur pod bug nymphal population in all three cultivars. Adult population of *C. gibbosa* exhibited significant positive correlation with temperature while non-significant negative correlation with relative humidity in all cultivars.

3.1.2 Regression of tur pod bug (*C. gibbosa*) population with crop microclimate

Linear regression: A negative linear relationship was found between temperature and nymphal population of *C. gibbosa* while relative humidity showed positive linear relationship on Manak cultivar explaining the variability up to 65 and 49 per cent, respectively (Fig. 7). A negative linear relationship was found between temperature and nymphal population of *C. gibbosa* while relative humidity showed positive linear relationship on Paras cultivar explaining the variability up to 58 and 59 per cent, respectively (Fig. 8). A negative linear relationship was found between temperature and nymphal population of *C. gibbosa* while relative humidity showed positive linear relationship on UPAS-120 cultivar explaining the variability up to 53 and 55 per cent, respectively (Fig. 9).

Multiple regression: Multiple regression equation was developed for tur pod bug based on the significance of correlation coefficients using stepwise regression technique. In cultivar Manak, 66 per cent variability in tur pod bug population was explained by temperature and relative humidity collectively whereas in cultivar Paras and UPAS-120 it was found up to 64 and 60 percent, respectively. The data was pooled for cultivars and 78 per cent variability in tur pod bug population was explained by temperature and relative humidity collectively (Table 2).

Table 1. Correlation between the population of turpod bug (*C. gibbosa*) and microclimate of pigeonpea cultivars

Microclimate parameters	Egg masses/plant	Nymphs/plant	Adults/plant
Manak			
Temperature (°C)	-0.032	-0.651**	0.483**
Relative humidity (%)	0.169	0.495**	-0.060
Paras			
Temperature (°C)	0.247	-0.584**	0.460*
Relative humidity (%)	-0.032	0.590**	-0.050
UPAS-120			
Temperature (°C)	0.146	-0.528**	0.464**
Relative humidity (%)	0.079	0.548**	-0.037

**Significant at 5% level of significance*
***Significant at 1% level of significance*

Table 2. Multiple regression equation of *C. gibbosa* nymphs/plant and microclimatic parameters of different pigeonpea cultivars

Cultivars	*C. gibbosa* nymphs/plant (Y)	R^2
Manak	$Y= 0.617 - 0.021X_1 + 0.002X_2$	0.66
Paras	$Y= -0.117 - 0.012X_1+ 0.007X_2$	0.64
UPAS-120	$Y= -0.125 - 0.011X_1+ 0.005X_2$	0.60
Pooled cultivars	$Y= -0.187 - 0.008X_1+ 0.007X_2$	0.78

X_1: Temperature X_2: Relative humidity

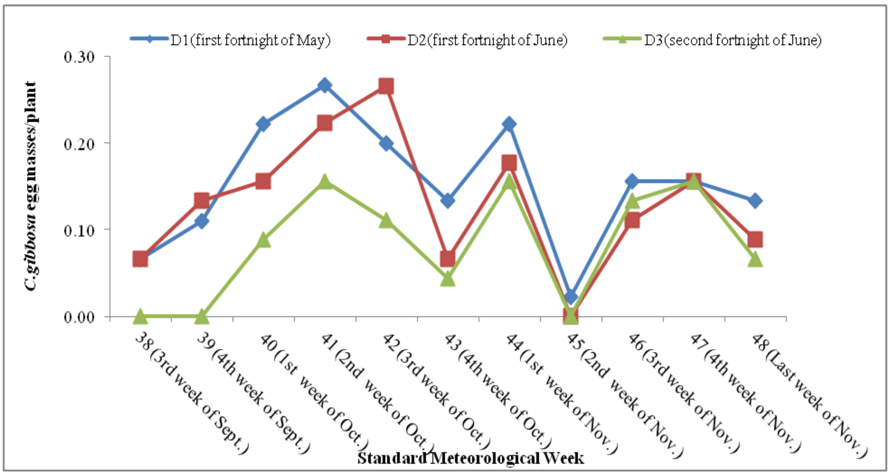


Fig. 1. Number of egg masses of turpod bug (*C. gibbosa*) in different date of sowings

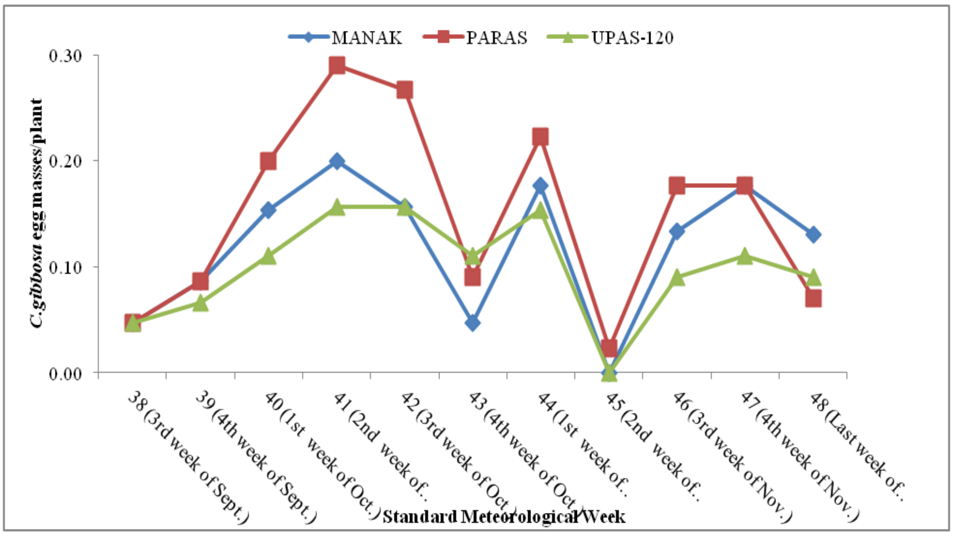


Fig. 2. Number of egg masses of tur pod bug (*C. gibbosa*) on cultivars of pigeonpea

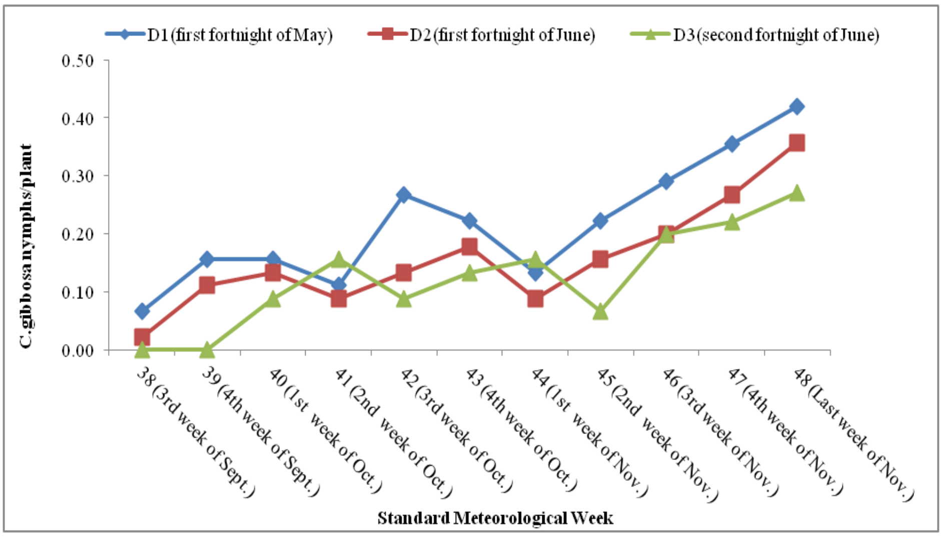


Fig. 3. Nymphal population of tur pod bug (*C. gibbosa*) in different date of sowings

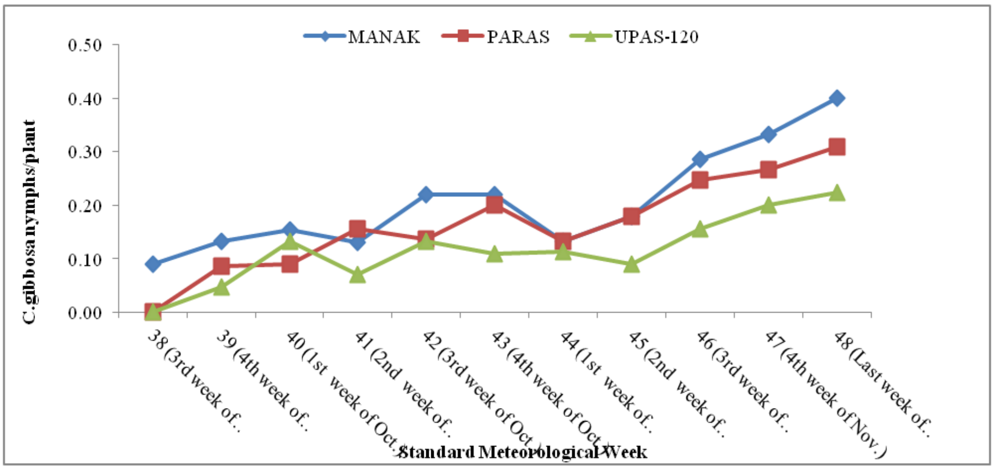


Fig. 4. Nymphal population of tur pod bug (*C. gibbosa*) on cultivars of pigeonpea

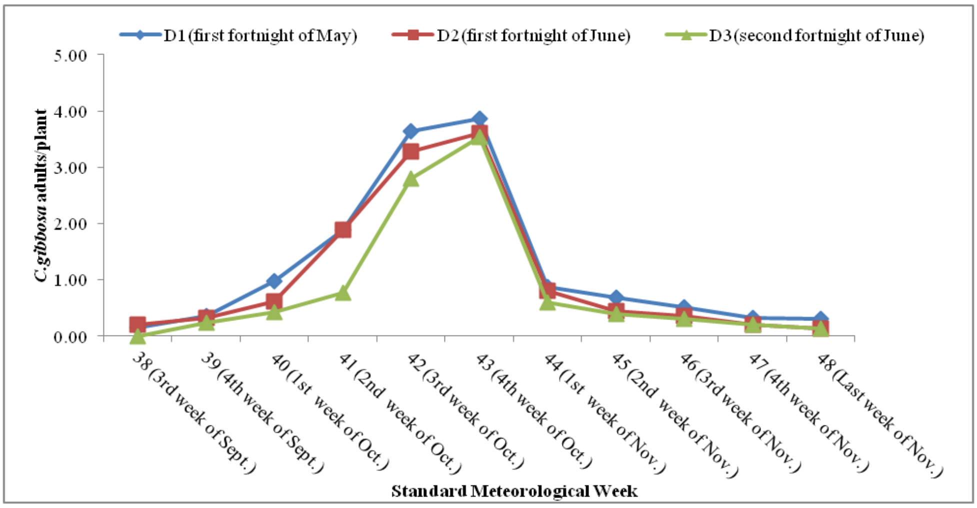


Fig. 5. Adult population of tur pod bug (*C. gibbosa*) in different date of sowings

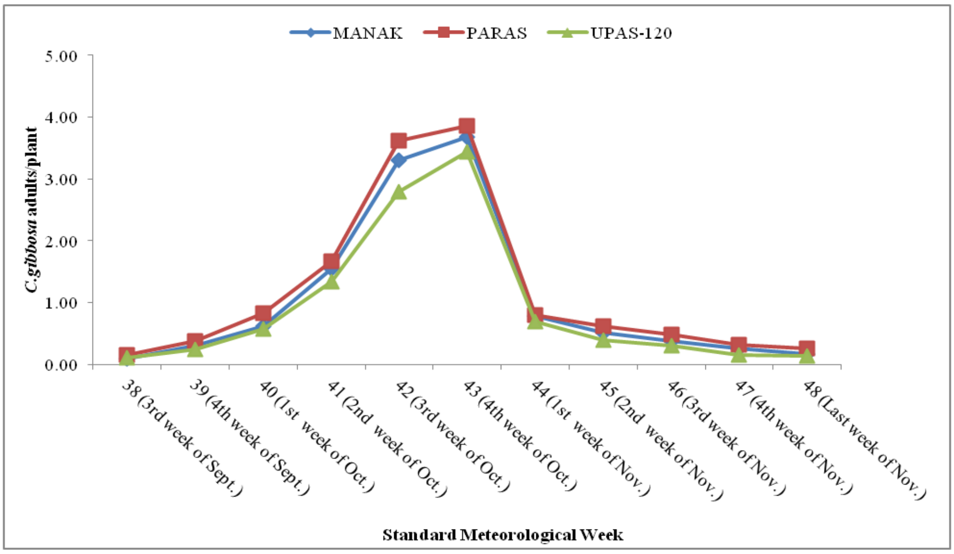


Fig. 6. Adult population of tur pod bug (*C. gibbosa*) on cultivars of pigeonpea

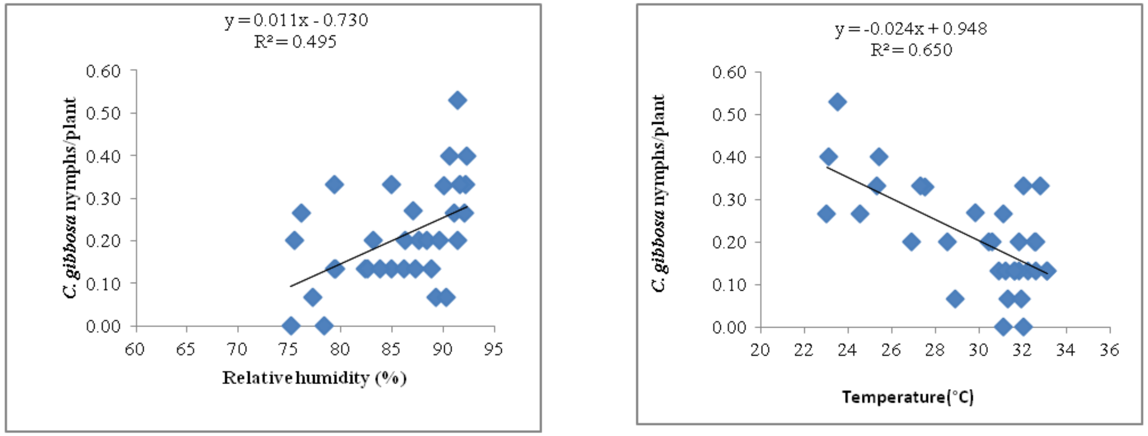


Fig. 7. Relationship of nymphal population of *C.gibbosa* with microclimate of pigeonpea cultivar Manak

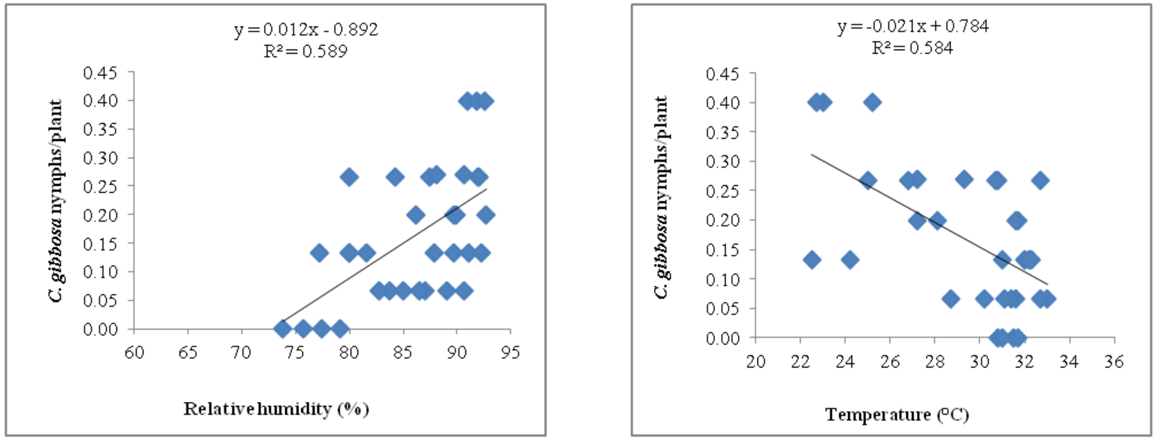
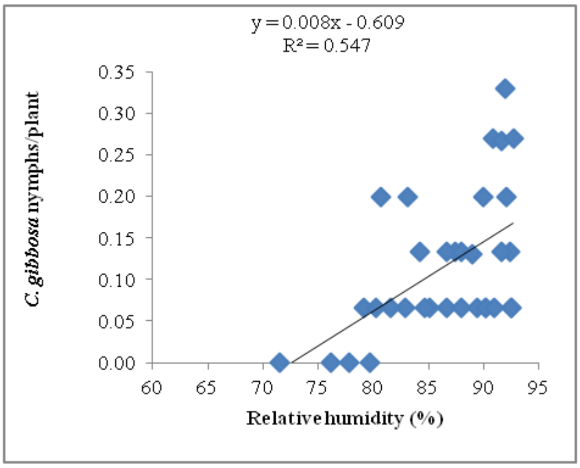


Fig. 8. Relationship of nymphal population of *C.gibbosa* with microclimate of pigeonpea cultivar Paras



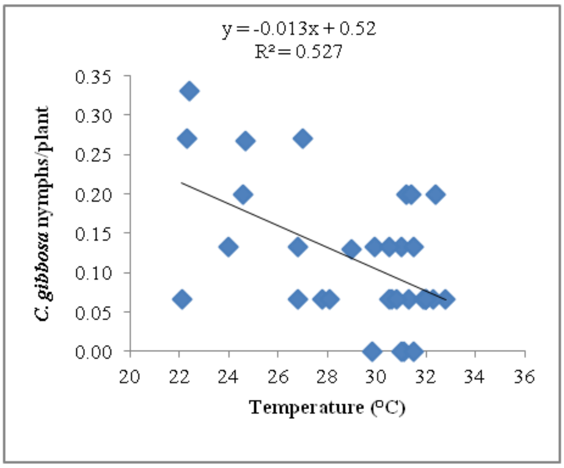


Fig. 9. Relationship of nymphal population of *C.gibbosa* with microclimate of pigeonpea cultivar UPAS-120

4. CONCLUSION

From the study it can be concluded that mean number of egg masses of *C. gibbosa*, highest in D_1 sown crop followed by D_2 and D_3 sown crops while among different cultivars, Egg masses were recorded highest on cultivar Paras followed by Manak and UPAS-120. Same trend was followed in mean population of *C. gibbosa* adults among different date of sowings and different cultivars. On the other hand, in case of mean nymphal population, trend was same among different date of sowings where as among different cultivars, highest was found on cultivar Manak followed by Paras and UPAS-120. Non-significant negative correlation was obtained between egg masses laid by *C. gibbosa* and temperature while non-significant positive correlation was obtained with relative humidity in cultivar Manak. In cultivar Paras, non-significant positive correlation with temperature while non-significant negative correlation with relative humidity. In cultivar UPAS-120, non-significant positive correlation was found with both temperature and relative humidity. Significant negative correlation was obtained between nymphal population of *C. gibbosa* and temperature while relative humidity showed significant positive correlation with tur pod bug nymphal population in all three cultivars. Adult population of *C. gibbosa* showed significant positive correlation with temperature while non-significant negative correlation with relative humidity in all cultivars. A negative linear relationship was found between temperature and nymphal population of *C. gibbosa* in all the three cultivars while relative humidity showed positive linear relationship in all the three cultivars.

DISCLAIMER

The contents and views expressed in this study are the views of the authors and do not necessarily reflect the views of the organizations they belong to.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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