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Influence of crop biodiversity on population dynamics of *Exelastis atomosa* (Wal.) in pigeonpea and border crops

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Abstract
The present investigation was carried out in the experimental field of Department of Entomology, Live Stock Farm, Adhartal, J.N. Krishi Vishwa Vidyalaya, Jabalpur (M.P.) during *kharif* season of 2012-2013. in a field trial was conducted to evaluate the influence of crop biodiversity on population dynamics of *Exelastis atomosa* (Wal.) in pigeonpea was studied with four treatments *i.e.* Pigeonpea + Maize (M) as border crop, Pigeonpea + Sorghum fodder (SF) as border crop, Pigeonpea sole unprotected (PP – UP) and Pigeonpea sole protected (PP – P) with eight replication. The mean minimum population of *Exelastis atomosa* was found in Pigeonpea + Maize (M) as border crop (1.07) while maximum population found in Pigeonpea sole unprotected (PP – UP) (1.71). Correlation between various abiotic factors and plume moth larval population showed that maximum and minimum temperature and morning vapour pressure had negative impact on pest population.

Keywords: *Exelastis atomosa*, pigeonpea, population dynamics

Introduction
India is the largest producer of pulses in the world and the domestic pulses production is about 14 - 15 million tonnes, but the demand is higher, of about 18 - 19 million tonnes **[3].** Immediately after gram, pigeonpea is the next important pulse crop, which is grown world over, mostly in tropical and sub-tropical countries for grains, green manuring, fodder and forage as sole crop, intercrop, mixed crop and in sequential cropping systems [10]. Pigeonpea crop accounts 5% of global acreage (4.16 million ha) and production (2.85 million tonnes), of which Asia is nearly the sole contributor [1].

In Madhya Pradesh, pigeonpea is cultivated in an area of about 3.50 lakh hectare with a production and productivity of 2.17 lakh tonnes and 620 kg/ha, respectively and contributes about 9.64% of the total pigeonpea production in India [4]. Abiotic and biotic stresses are the most limiting factors in pigeonpea production. Among the biotic pressures, large numbers of insect pests have been identified to infest pigeonpea. The low yields of pigeonpea crop which have remained stagnant for the past 3 to 4 decades are due to pod borer complex and physiological shriveling [5]. The pod borer complex includes *Helicoverpa armigera, Exelastis atomosa, Clavigralla gibbosa, Melanagromyza obtuse* which cause considerable losses in grain yield ranging from 30 to 100% by attacking the reproductive parts of the plants [9]. Keeping the fact in present investigation are under taken on study the influence of crop biodiversity on population dynamics of major insects of pigeonpea and border crops.

Materials and Methods
The present investigation was carried out in the experimental field of Department of Entomology, Live Stock Farm, Adhartal, J.N. Krishi Vishwa Vidyalaya, Jabalpur (M.P.) during *kharif* season of 2012-2013. The present experiment was conducted with 4 treatments and with 8 replication, respectively. For conducting studies on the above mentioned aspect, observations were carried out on three different situations *viz.*, maize and sorghum fodder were sown around pigeonpea plots as border crops and pigeonpea sole plots protected and unprotected condition, respectively. The varieties used for sowing were Pigeonpea - JA-4, Maize - QPM-1, Sorghum fodder - MP Chari.

Method of observation

Observations of tur plume moth larvae nymphs + adult, maggots and pupae were recorded on/in 5 pods from each block. Thus a total of 40 pods were collected and observed from 8 blocks of each treatment.

Statistical analysis

Results

First appearance of the tur plume moth larva was observed on 6th November *i.e.* during 45th SW on pigeonpea pods in all the three different crop habitats. The numbers of tur plume moth larvae were worked out as weekly average / pod. Data are presented in the Table 1.

Table 1: Incidence of Tur plume moth, *Exelastis atomosa* on pigeonpea in different crop habitats at Jabalpur during 2012-2013

SW	Month	CA (D)	CGS	Mean tur plume moth larvae per pod			
				PP+M	PP+S	PP	
						UP	P
45	Nov.'12	84	RS	0.38	0.34	0.40	0.40
46	Nov.'12	91	RS	0.40	0.36	0.44	0.44
47	Nov.'12	98	RS	0.36	0.34	0.38	0.38
48	Oct-Nov.'12	105	RS	0.46	0.54	0.48	0.48
49	Dec.'12	112	RS	0.50	0.88	0.60	0.60
50	Dec.'12	119	RS	0.44	0.54	0.58	0.58
51	Dec.'12	126	RS	1.58	1.96	1.76	1.12
52	Dec.'12	133	RS	1.92	1.80	1.64	0.74
1	Jan.'13	140	RS	1.92	2.48	2.34	0.82
2	Jan.'13	147	RS	1.94	1.84	2.72	0.82
3	Jan.'13	154	RS	1.86	1.48	1.60	1.00
4	Jan.'13	161	MS	1.46	1.34	1.30	0.86
5	Jan-Feb.'13	168	MS	0.74	0.68	0.58	0.54
Mean				1.07	1.12	1.71	1.12

PP+M = Pigeonpea bordered with maize PP+S = Pigeonpea bordered with sorghum fodder UP = Unprotected P = Protected
CA (D) = Crop age in day CGS=Crop growth stage SW= Standard week VS= Vegetative stage
RS= Reproductive stage MS = Maturity stage PP =Pigeonpea sole
Mean of 2 observation / SW 40 pods / observation

Table 2: Correlation (r) and regression coefficient (byx) of abiotic factors on tur plume moth larvae infesting pigeonpea in different crop habitats

Weather factors	Tur plume moth larvae on pigeonpea in different crop habitats							
	Pigeonpea + maize border crop		Pigeonpea + sorghum fodder border crop		Pigeonpea sole			
					UP		P	
	R	byx	R	byx	R	byx	R	byx
Max. temp. (^{0}C)	-0.79 **	-0.21	-0.73 **	-0.20	-0.74 **	-0.22	-0.59*	-1.86
Min. temp. (^{0}C)	-0.76 **	-3.51	-0.71 **	-0.16	-0.70 **	-0.17	-0.58*	-3.78
Sunshine (hrs)	0.06 NS	-	-0.03 NS	-	0.05 NS	-	0.10 NS	-
Rainfall (mm)	-0.27 NS	-	-0.23 NS	-	-0.20 NS	-	-0.12 NS	-
Morning RH (%)	0.10 NS	-	0.15 NS	-	0.16 NS	-	0.07 NS	-
Evening RH (%)	0.28 NS	-	0.29 NS	-	0.28 NS	-	0.23 NS	-
Wind speed (Km/hr)	0.48 NS	-	0.39 NS	-	0.41 NS	-	0.40 NS	-
Morning Vapour pressure (mm)	- 0.76 **	-2.02	-0.73 **	-0.28	-0.70 **	-0.30	-0.62 *	-2.76
Evening Vapour pressure (mm)	-0.44 NS	-	-0.43 NS	-	-0.41 NS	-	-0.40 NS	-
Evaporation (mm)	-0.14 NS	-	-0.35 NS	-	-0.19 NS	-	-0.04 NS	-
Rainy days	-0.27 NS	-	-0.23 NS	-	-0.20 NS	-	-0.12 NS	-

UP= Unprotected P=Protected ** Significant at 1 % level. NS = Non - significant *Significant at 5 % level.

(i) Pigeonpea bordered with maize (PP+M)

From the Table.1, it is seen that plume moth larval population appeared from 45th SW and was available upto 5th SW. Larval population attained its first peak (1.94 larvae / pod) during 2nd SW when maximum and minimum temperature was 23.0 and 5.2 ^{o}C, respectively, whereas morning and evening relative humidity was 84 and 36% respectively. Further sunshine, wind speed, morning and evening vapour pressure and evaporation were 9.2 hrs, 2.6 km/hr, 6.7 mm, 7.3 mm and 2.6 mm, respectively. There was no rainfall received during this week.

Correlation studies

Positive correlation

Sunshine, morning and evening relative humidity and wind speed exhibited positive correlation (r = 0.06, 0.10, 0.28 and 0.48, respectively) with plume moth larval population, but statistically found to be non-significant. (Table 2)

Negative correlation

Maximum and minimum temperature, morning vapour pressure significant negative correlation (r = -0.79, -0.76 and -0.76 respectively) with plume moth larval population.

$$\hat{Y} = 6.58 - 0.21\ x\ (R^2 = 0.62)$$

$$\hat{Y} = 12.8 - 3.51\ x\ (R^2 = 0.57)$$

$$\hat{Y} = 3.62 - 2.28\ x\ (R^2 = 0.58)$$

From the above equations it may be expressed that with every unit increase in maximum and minimum temperature and morning vapour pressure there was a decrease of 0.21, 3.51 and 2.28 larvae per pod.

Correlation studies further revealed that rainfall, evening vapour pressure, evaporation and rainy days showed negative correlation (r = -0.27, -0.44, -0.14 and -0.27, respectively) with tur plume moth larval population, but statistically found to be non-significant.

(ii) Pigeonpea bordered with sorghum fodder (PP+S)

From the Table.1, it is seen that plume moth larval population appeared from 45th SW and was available upto 5th SW. Larval population attained its first peak (0.88 larvae / pod) during 49th SW when maximum and minimum temperature was 28.7 and 10.6 °C, whereas morning and evening relative humidity was 85 and 26%, respectively. Further sunshine, wind speed, morning and evening vapour pressure and evaporation were 9 hrs, 2.1 km/hr, 9.4 mm, 7.8 mm and 2.4 mm respectively. There was no rainfall received during this week.

Further, second peak (1.96 larvae / pod) was attained during 51stSW when maximum and minimum temperature was 25.3 and 7.1 °C, whereas morning and evening relative humidity was 88 and 29%, respectively. Further sunshine, wind speed, morning and evening vapour pressure and evaporation were 8.6 hrs, 2.3 km/hr, 7.3 mm, 6.7 mm and 2.4 mm respectively. There was no rainfall received during this week.

Further, third peak (2.48 larvae / pod) during 1st SW when maximum and minimum temperature was 23.3 and 7.2 °C, whereas morning and evening relative humidity was 87 and 32%, respectively. Further sunshine, wind speed, morning and evening vapour pressure and evaporation were 5.9 hrs, 3.6 km/hr, 7.7 mm, 8.7 mm and 2.2 mm respectively. There was no rainfall received during this week.

Correlation studies

Positive correlation

Morning and evening relative humidity and wind speed exhibited positive correlation (r = 0.15, 0.29 and 0.39, respectively) with plume moth larval population but statistically found to be non-significant. (Table 2)

Negative correlation

Maximum temperature, minimum temperature and morning vapour pressure showed significant negative correlation (r = -0.73, -0.71 and -0.73, respectively) with plume moth larval population.

The regression equations being:

$$\hat{Y} = 6.50 - 0.20 \text{ x } (R^2 = 0.54)$$

$$\hat{Y} = 2.59 - 0.16 \text{ x } (R^2 = 0.51)$$

$$\hat{Y} = 3.67 - 0.28 \text{ x } (R^2 = 0.53)$$

From the above equations it may be expressed that with every unit increase in minimum temperature, maximum temperature and morning vapour pressure there was a decrease of 0.20, 0.16 and 0.28 larvae per pod, respectively.

Correlation studies further revealed that sunshine, rainfall, evening vapour pressure, evaporation and rainy days showed a negative correlation (r = -0.03, -0.23, -0.43, -0.35 and -0.23, respectively) with tur plume moth larval population, but statistically found to be non-significant.

(iii) Pigeonpea sole unprotected

From the Table.1, it is seen that plume moth larval population appeared from 45th SW and was available upto the 5th SW. Larval population attained its first peak (1.76 larvae / pod) during 51st SW when maximum and minimum temperature was 25.3 and 7.1 ^{0}C respectively, whereas morning and evening relative humidity were 84 and 29% respectively. Further sunshine, wind speed, morning and evening vapour pressure and evaporation were 8.6 hrs, 2.3 km/hr, 7.3 mm, 6.7 mm and 2.4 mm respectively. There was no rainfall received during this week.

Further, second peak (2.72 larvae / pod) was attained during 2nd SW when maximum and minimum temperature was 23 and 5.2 °C, respectively, whereas morning and evening relative humidity was 84 and 36%, respectively. Further, sunshine, wind speed, morning and evening vapour pressure and evaporation were 9.2 hrs, 2.6 km/hr, 6.7 mm, 7.3 mm and 2.6 mm, respectively. There was no rainfall received during this week.

Correlation studies

Positive correlation

Sunshine, morning and evening relative humidity and wind speed exhibited positive correlation (r = 0.05, 0.16, 0.28 and 0.41, respectively) with plume moth larval population, but statistically found to be non-significant. (Table 2)

Negative correlation

Maximum temperature, minimum temperature and morning vapour pressure, showed significant negative correlation (r= -0.74, -0.70 and -0.70 respectively) with plume moth larval population.

The regression equations being

$$\hat{Y} = 7.07 - 0.22 \text{ x } (R^2 = 0.54)$$

$$\hat{Y} = 2.72 - 0.17 \text{ x } (R^2 = 0.49)$$

$$\hat{Y} = 3.83 - 0.30 \text{ x } (R^2 = 0.49)$$

From the above equations it may be expressed that with every unit increase in maximum temperature, minimum temperature and morning vapour pressure, there was a decrease of 0.22, 0.17 and 0.30 larval population per pod respectively.

Correlation studies further revealed that rainfall, evening vapour pressure, evaporation and rainy days exhibited negative correlation (r = -0.20, -0.41, -0.19, and -0.20 respectively) with plume moth larval population, but statistically found to be non-significant.

(iv) Pigeon pea sole protected

From the Table.1, it is seen that plume moth larval population appeared from 45th SW and was available upto the 5th SW. Larval population attained its first peak (0.48 larvae /pod) during 48th SW when maximum and minimum temperature was 28.4 and 11.5 ^{0}C respectively, whereas morning and evening relative humidity were 83 and 33%, respectively. Further sunshine, wind speed, morning and evening vapour pressure and evaporation were 8.4 hrs, 2.1 km/hr, 9.7 mm, 9.1 mm and 2.3 mm, respectively. There was no rainfall received during this week.

Further, second peak (1.12 larvae / pod) was attained during 51st SW when maximum and minimum temperature was 25.3 and 7.1 °C, respectively, whereas morning and evening relative humidity was 88 and 29%, respectively. Further, sunshine, wind speed, morning and evening vapour pressure and evaporation were 8.6 hrs, 2.3 km/hr, 7.3 mm, 6.7 mm and

2.4 mm, respectively. There was no rainfall received during this week.

Further, third peak (1.0 larvae / pod) was attained during 3rd SW when maximum and minimum temperature was 26.7 and 10.1 ºC, respectively, whereas morning and evening relative humidity was 86 and 36%, respectively. Further, sunshine, wind speed, morning and evening vapour pressure and evaporation were 8.1 hrs, 4 km/hr, 9 mm, 9.1 mm and 3.1 mm, respectively. There was no rainfall received during this week.

Correlation studies

Positive correlation

Sunshine, morning and evening relative humidity and wind speed exhibited positive correlation (r = 0.10, 0.07, 0.23 and 0.40, respectively) with plume moth larval population, but statistically found to be non-significant. (Table 2)

Negative correlation

Maximum temperature, minimum temperature and morning vapour pressure showed significant negative correlation (r= -0.59, -0.58 and -0.62 respectively) with plume moth larval population.

The regression equations being

$$\hat{Y} = 27.5 - 1.86 \text{ x } (R^2 = 0.01)$$

$$\hat{Y} = 12.1 - 3.78 \text{ x } (R^2 = 0.04)$$

$$\hat{Y} = 10.9 - 2.76 \text{ x } (R^2 = 0.07)$$

From the above equations it may be expressed that with every unit increase in maximum temperature, minimum temperature and morning vapour pressure, there was a decrease of 1.86, 3.78 and 2.76 larval population per pod, respectively.

Correlation studies further revealed that rainfall, evening vapour pressure, evaporation and rainy days exhibited negative correlation (r = -0.12, -0.40, -0.04 and -0.12, respectively), with plume moth larval population, but statistically found to be non-significant.

Discussion

In PP+M, the peak population of the larvae was first observed during 2nd SW (*i.e* 2nd week of January). The present findings confirm the findings of [6] and [2].They reported that minimum temperature had negative influence on larval population. In the present findings sunshine and evening vapour pressure had negative impact on larval population, but were statistically found to be non-significant. Similar findings have been reported by [7], but were statistically significant. The present findings contradicts the findings of [8], he reported that maximum temperature, morning vapour pressure and evaporation had negative influence on the larval population.

In PP + S, plume moth attained three peaks *viz.*, 49th SW (*i.e.*1st week of December), 51stSW (*i.e.*3rd week of December) and 1st SW (*i.e.*1st week of January). Correlation with various abiotic factors showed that maximum and minimum temperature and morning vapour pressure exhibited negative influence on the plume moth larval population, respectively. The present finding confirms the findings of (6). They reported that minimum temperature had negative influence on larval population. On the contrary, (8) reported that maximum temperature showed positive influence on the larval population.

In PP sole- UP, plume moth attained two peaks *viz*, 51st SW (*i.e.*3rd week of December) and 2nd SW (*i.e.*2nd week of January). Correlation with various abiotic factors showed that maximum and minimum temperature, morning vapour pressure exhibited negative influence on the plume moth larval population, respectively. The present findings confirms the findings of (6). They reported that minimum temperature had negative influence on the larval population. On the contrary, (8) reported that maximum temperature showed positive influence on larval population.

In PPsole - P, plume moth attained three peaks *viz*, 48th SW (5th week of November), 51st SW (3rd week of December)and 3rd SW (3rd week of January). Correlation with various abiotic factors showed that maximum and minimum temperature,morning vapour pressure exhibited negative influence on the plume moth larval population.The present finding confirms the findings of [6]. They reported that minimum temperature had negative influence on larval population. On the contrary, [8] reported that maximum temperature showed positive influence on larval population. In the present study, sunshine and evening vapour pressure showed positive and negative impact on tur plume moth larval population respectively, but were found to be non-significant. On the contrary [7] reported that sunshine and evening vapour pressure had significant negative influence on larval population in pigeonpea.

Conclusions

Correlation between various abiotic factors and jassid population on leaves of pigeonpea bordered with maize crop, sorghum fodder, pigeonpea sole under unprotected condition revealed that maximum and minimum temperature, rainfall, evening relative humidity, wind speed, morning and evening vapour pressure, evaporation and rainy days showed significant negative impact. While, jassid on sole pigeonpea under protected were found to be non-significant.

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