Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; 7(5): 1479-1483
Received: 04-07-2018
Accepted: 08-08-2018

KE Shewale
Department of Entomology, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh, India

PS Kolhe
Sam Higginbotham University of Agricultural technology and sciences Allahabad, Uttar Pradesh, India

CK Sonwane
College of Agriculture Parbhani, Maharashtra, India

Correspondence
KE Shewale
Department of Entomology, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh, India

Influence of crop biodiversity on population dynamics of *Aphis craccivora* (Koch) in pigeonpea and border crops

KE Shewale, PS Kolhe and CK Sonwane

Abstract
In a field trial influence of crop biodiversity on population dynamics of *Aphis craccivora* (Koch) 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). The mean minimum population of *Aphis craccivora* (Koch) was found in Pigeonpea + Sorghum fodder (SF) as border crop (1.88) while maximum in Pigeonpea sole unprotected (PP - UP) (2.94). Correlation between various abiotic factors and aphid population in leaf were found to be non significant.

Keywords: *Aphis craccivora*, 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 (Anonymous, 2009) [3]. The major pulse grown in India is gram which is cultivated on 9.21 million hectare with production and productivity of 8.25 million tonnes and 0.89 tonnes/ha respectively (Anonymous, 2011) [4].

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 (Shah and Agarwal, 2009) [7]. The countries with notable pigeonpea production are India, Nepal and Myanmar in Asia, Malawi and Uganda along with some other countries in eastern Africa and the Dominican Republic in the Americas (Ahlawat and Shivakumar, 2006) [2]. 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 (Ahlawat *et al*., 2005) [1].

In India pigeonpea occupies an area of about 4.42 million ha with a total production of 2.89 million tonnes with productivity of 655 kg / ha (Anonymous, 2011) [4]. To meet the growing demands, this needs to be increased at least by 28 percent in the next 10 years (Nadarajan, 2009) [6]. In the country, the crop is extensively grown in Uttar Pradesh, Madhya Pradesh, Maharashtra, Karnataka, Andhra Pradesh and Gujarat. Uttar Pradesh has an unique distinction of contributing about 20 percent production in the country followed by Madhya Pradesh. Pigeonpea is a rich source of protein (21.71%) and supplies a major share of pSrotein requirement of the vegetarian population of the country, besides it is also a rich source of iron, iodine and essential amino acids like arginine, cystine and lysine (Singh *et al*., 2007) [8].

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 (Anonymous, 2011) [4].

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 experiment was conducted with 4 treatments and 8 replications. 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 under protected and unprotected conditions. The varieties used for sowing were Pigeonpea - JA-4, Maize QPM-1, Sorghum fodder - MP Chari.

Observations on Aphids were recorded on 3 randomly selected pigeonpea plants from each block twice in a standard week from sole pigeonpea unprotected, pigeonpea having border crops of maize and sorghum fodder, respectively.

Thus a total of 24 pigeonpea plants were observed from 8 blocks of each treatment. Similarly observations on 25 plants of border crops *i.e.* maize and sorghum fodder were recorded twice in a standard week. Observations were started from the first appearance of the insect and were continued till their availability or maturity of the crop, which ever was earlier.

Results and Discussion

First appearance of the pest on the leaves was observed on 4th September *i.e.* during the 36th SW in all the three crop habitats. The number of aphids (nymph + adult) on twig was worked out as weekly average per 10 cm twig and the data are presented in Table 1.

Table 1: Incidence of aphids, *Aphis craccivora* Koch on pigeonpea in different crop habitats at Jabalpur during 2012-2013

SW	Month	CA(D)	CGS	Mean aphid population per 10 cm twig on different crop habitats			
				PP+M	PP+S	PP	
						UP	P
36	Sept.'12	21	VS	1.50	1.65	1.32	1.32
37	Sept.'12	28	VS	1.06	0.66	0.64	0.64
38	Sept.'12	35	VS	0.74	0.65	0.96	0.96
39	Sept.'12	42	VS	1.04	1.24	0.96	0.96
40	Oct.'12	49	VS	0.74	0.72	0.98	0.98
41	Oct.'12	56	VS	1.00	0.80	1.00	1.00
42	Oct.'12	63	VS	1.30	0.96	1.10	1.10
43	Oct.'12	70	VS	1.18	2.34	2.50	2.50
44	Oct- Nov '12	77	VS	1.32	0.72	1.06	1.06
45	Nov.'12	84	RS	1.16	1.36	1.54	1.54
46	Nov.'12	91	RS	1.44	1.78	2.06	2.06
47	Nov.'12	98	RS	1.98	1.24	1.84	1.84
48	Nov- Dec '12	105	RS	2.98	2.04	3.86	3.86
49	Dec.'12	112	RS	1.78	2.40	2.64	2.64
50	Dec.'12	119	RS	1.30	1.56	1.22	1.22
51	Dec.'12	126	RS	1.36	1.54	1.16	1.46
52	Dec.'12	133	RS	2.00	1.96	2.62	2.68
1	Jan.'13	140	RS	4.22	4.86	4.32	2.22
2	Jan.'13	147	RS	3.54	3.58	5.02	3.28
3	Jan.'13	154	RS	4.80	3.72	3.92	2.96
4	Jan.'13	161	MS	3.20	3.86	2.08	2.70
5	Jan – Feb '13	168	MS	2.06	1.78	1.44	1.34
Mean				1.89	1.88	2.94	2.38

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 2 observation / SW 25 plants/observation & 10 cm twig / plant observed

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

From the table.1, it is seen that aphid population appeared from 36th SW and was available upto the 5th SW. Population attained its first peak (2.98 aphids / 10 cm twig) during 48th SW when maximum and minimum temperature was 28.4 and 11.5ºC 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 (4.22 aphids /10 cm twig) was attained during 1st SW when maximum and minimum temperature was 23.3 and 7.2ºC respectively, 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. Further, third peak (4.80 aphids /10 cm twig) was attained during 3rd SW when maximum and minimum temperature was 26.7 and 10.1ºC 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: (Table 2)

Positive correlation

Sunshine and wind speed exhibited positive correlation (r = 0.14 and 0.003 respectively) with aphid population, but statistically found to be non-significant.

Table 2: Correlation (r) and regression coefficient (byx) of abiotic factors on aphid population infesting on pigeonpea in different crop habitats during 2012-2013

Weather factors	Aphids 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)	-0.69**	-0.22	-0.71 **	-0.24	-0.57 **	-0.20	-0.55 **	-0.14
Min. temp. (^{0}C)	-0.64**	-0.11	-0.67 **	-0.12	-0.63 **	-0.12	-0.69 **	-0.02
Sunshine (hrs)	0.14 NS	-	0.16 NS	-	0.30 NS	-	0.42 *	0.20
Rainfall (mm)	-0.22 NS	-	-0.26 NS	-	-0.31 NS	-	-0.37 NS	-
Morning RH (%)	-0.24 NS	-	-0.22 NS	-	-0.26 NS	-	-0.28 NS	-
Evening RH (%)	-0.28 NS	-	-0.31 NS	-	-0.40 NS	-	-0.52 *	-0.02

Wind speed (Km/hr)	0.003 NS	-	-0.08 NS	-	-0.20 NS	-	-0.43 *	-0.36
Morning Vapour pressure (mm)	-0.66 **	-0.12	-0.61 **	-0.13	-0.61 **	-0.13	-0.67 **	-0.10
Evening Vapour pressure (mm)	-0.49 *	-0.11	-0.52*	-0.11	-0.53 **	-0.13	-0.63 **	-0.02
Evaporation (mm)	-0.42 NS	-	-0.42 *	-1.03	-0.43 *	-1.14	-0.50 *	-0.91
Rainy days	-0.24 NS	-	-0.24 NS	-	-0.32 NS	-	-0.33 NS	-

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

Negative correlation

Maximum temperature, minimum temperature, morning vapour pressure and evening vapour pressure showed significant negative correlation (r= -0.69, -0.64, -0.66 and -0.49, respectively) with aphid population.

The regression equations being:

$\hat{Y} = 8.34 - 0.22 \text{ x } (R^2 = 0.48)$

$\hat{Y} = 3.44 - 0.11 \text{ x } (R^2 = 0.41)$

$\hat{Y} = 3.49 - 0.12 \text{ x } (R^2 = 0.37)$

$\hat{Y} = 3.49 - 0.11 \text{ x } (R^2 = 0.24)$ respectively.

From the above equations it may be expressed that with every unit increase in maximum temperature, minimum temperature, morning vapour pressure and evening vapour pressure there was a decrease of 0.22, 0.11, 0.12 and 0.11 aphid population per 10 cm per twig, respectively.

Correlation studies further revealed that rainfall, morning relative humidity, evening relative humidity evaporation and rainy days exhibited negative correlation (r = -0.22, -0.24, -0.28, -0.42 and -0.24, respectively) with aphid population, but statistically found to be non-significant.

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

From the table.1, it is seen that aphid population appeared from 36th SW and was available upto the 5th SW. Population attained its first peak (2.34 aphids / 10 cm twig) during 43rd SW when maximum and minimum temperature was 31.6 and 15.20C respectively, whereas morning and evening relative humidity were 82 and 35% respectively. Further sunshine, wind speed, morning and evening vapour pressure and evaporation were 8.4 hrs, 1.9 km/hr, 13.7mm, 11.8 mm, and 3.2 mm, respectively. There was no rainfall received during this week. Further, second peak (1.78 aphids /10 cm twig) was attained during 46th SW, when maximum and minimum temperature was 28.6 and 10oC respectively, whereas morning and evening relative humidity was 85 and 28%, respectively. Further sunshine, wind speed, morning and evening vapour pressure and evaporation were 8.4 hrs, 2.7 km/hr, 10.0 mm, 7.8 mm and 3 mm respectively. There was no rainfall received during this week. Further, third peak (2.40 aphids /10 cm twig) was attained during 49th SW, when maximum and minimum temperature was 28.7 and 10.6oC respectively, 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, fourth peak (4.86 aphids /10 cm twig) was attained during 1st SW. When maximum and minimum temperature was 23.3 and 7.2oC respectively, 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. Further, fifth peak (3.86 aphids /10 cm twig) was attained during 4th SW, when maximum and minimum temperature was 21.4 and 5oC respectively, whereas morning and evening relative humidity was 81 and 36%, respectively. Further sunshine, wind speed, morning and evening vapour pressure and evaporation were 7.6 hrs, 2.9 km/hr, 6.6 mm, 7 mm and 2.5 mm respectively. There was no rainfall received during this week.

Correlation studies: (Table 2)

Positive correlation

Sunshine exhibited positive correlation (r = 0.16) with aphid population, but statistically found to be non-significant.

Negative correlation

Maximum temperature, minimum temperature, morning vapour pressure, evening vapour pressure and evaporation showed significant negative correlation (r = -0.71, -0.67, -0.61, -0.52 and -0.42, respectively) with aphid population.

The regression equations being:

$\hat{Y} = 8.69 - 0.24 \text{ x } (R^2 = 0.50)$

$\hat{Y} = 3.54 - 0.12 \text{ x } (R^2 = 0.45)$

$\hat{Y} = 3.52 - 0.13 \text{ x } (R^2 = 0.37)$

$\hat{Y} = 3.28 - 0.11 \text{ x } (R^2 = 0.27)$

$\hat{Y} = 4.80 - 1.03 \text{ x } (R^2 = 0.18)$ respectively

From the above equations it may be expressed that with every unit increase in maximum temperature, minimum temperature, morning vapour pressure, evening vapour pressure and evaporation there was a decrease of 0.24,0.12, 0.13, 0.11 and 1.03 aphid population per 10 cm twig, respectively. Correlation studies further revealed that rainfall, morning relative humidity, evening relative humidity, wind speed and rainy days exhibited negative correlation (r = -0.26, -0.22, -0.31, -0.08 and -0.24, respectively) with aphid population, but statistically found to be non-significant.

(iii) Pigeonpea sole unprotected

From the table.1, it is seen that aphid population appeared from 36th SW and was available upto the 5th SW. Population attained its first peak (2.50 aphids / 10 cm twig) during 43rd SW when maximum and minimum temperature was 31.6 and 15.2^{0}C respectively, whereas morning and evening relative humidity were 82 and 35% respectively. Further sunshine, wind speed, morning and evening vapour pressure and evaporation were 8.4 hrs, 1.9 km/hr, 13.7 mm, 11.8 mm and 3.2. mm, respectively. There was no rainfall received during this week. Further, second peak (2.06 aphids /10 cm twig) was attained during 46thSW, when maximum and minimum temperature was 28.6 and 10.^{o}C respectively, whereas morning and evening relative humidity was 85 and 28%, respectively. Further sunshine, wind speed, morning and evening vapour pressure and evaporation were 8.4 hrs, 2.7 km/hr, 10.0 mm, 7.8 mm and 3.0 mm respectively. There was no rainfall received during this week. Further, third peak (5.02 aphids /10 cm twig) 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: (Table 2)

Positive correlation
Sunshine exhibited positive correlation (r = 0.30) with aphid population, but statistically found to be non-significant.

Negative correlation
Maximum temperature, minimum temperature, morning vapour pressure, evening vapour pressure and evaporation showed significant negative correlation (r= -0.57, -0.63, -0.61, -0.53 and -0.43, respectively) with aphid population.
The regression equations being:

$\hat{Y} = 7.85 - 0.20 x (R^2 = 0.31)$

$\hat{Y} = 3.69 - 0.12 x (R^2 = 0.40)$

$\hat{Y} = 3.76 - 0.13 x (R^2 = 0.37)$

$\hat{Y} = 3.55 - 0.13 x (R^2 = 0.29)$

$\hat{Y} = 5.2 - 1.14 x (R^2 = 0.19)$

From the above equations it may be expressed that with every unit increase in maximum temperature, minimum temperature, morning vapour pressure, evening vapour pressure and evaporation there was a decrease of 0.20, 0.12, 0.13, 0.13 and 1.14 aphid population per 10 cm twig, respectively. Correlation studies further revealed that rainfall, morning relative humidity, evening relative humidity, wind speed and rainy days exhibited negative correlation (r = -0.31, -0.26, -0.40, -0.20 and -0.32, respectively) with aphid population, but statistically found to be non-significant.

(iv) Pigeonpea sole protected
From the table.1, it is seen that aphid population appeared from 36th SW and was available upto the 5th SW. Population attained its first peak (2.50 aphids / 10 cm twig) during 43rd SW, when maximum and minimum temperature was 31.6 and 15.2°C respectively, whereas morning and evening relative humidity were 82 and 35% respectively. Further sunshine, wind speed, morning and evening vapour pressure and evaporation were 8.4 hrs, 1.9 km/hr, 13.7 mm, 11.8 mm and 3.2 mm, respectively. There was no rainfall received during this week. Further, second peak (3.86 aphids /10 cm twig) was attained during 48th SW, when maximum and minimum temperature was 28.8 and 11.5°C respectively, whereas morning and evening relative humidity was 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, third peak (2.68 aphids /10 cm twig) was attained during 52nd SW, when maximum and minimum temperature was 23.8 and 5°C respectively, whereas morning and evening relative humidity was 87 and 42%, respectively. Further sunshine, wind speed, morning and evening vapour pressure and evaporation were 9.1 hrs, 2.2 km/hr, 6.8 mm, 7.4 mm and 2.3 mm respectively. There was no rainfall received during this week. Further, fourth peak (3.28 aphids /10 cm twig) 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: (Table 2)

Positive correlation
Sunshine showed significant positive correlation (r = 0.42) with aphid population.
The regression equation being:

$\hat{Y} = 0.32 + 0.20x (R^2 = 0.18)$

From the above equation it may be expressed that with every unit increase in sunshine there was an increase of 0.20 aphids per 10 cm twig.

Negative correlation
Maximum temperature, minimum temperature, evening relative humidity, wind speed, morning vapour pressure, evening vapour pressure and evaporation showed significant negative correlation (r= -0.55,-0.69, -0.52, -0.43, -0.67, -0.63 and -0.50, respectively) with aphid population.
The regression equations being:

$\hat{Y} = 5.8 - 0.14 x (R^2 = 0.30)$

$\hat{Y} = 3.13 - 0.02 x (R^2 = 0.47)$

$\hat{Y} = 3.05 - 0.02 x (R^2 = 0.27)$

$\hat{Y} = 2.93 - 0.36 x (R^2 = 0.15)$

$\hat{Y} = 3.20 - 0.10 x (R^2 = 0.44)$

$\hat{Y} = 4.80 - 0.91 x (R^2 = 0.23)$

$\hat{Y} = 3.30 - 0.26 x (R^2 = 0.23)$

From the above equations it may be expressed that with every unit increase in maximum temperature, minimum temperature, evening relative humidity, wind speed, morning vapour pressure, evening vapour pressure and evaporation there was a decrease of 0.14, 0.02, 0.02, 0.36, 0.10, 0.91 and 0.26 aphid population per 10 cm twig, respectively.
Correlation studies further revealed that rainfall, morning relative humidity and rainy days exhibited negative correlation (r = -0.37, -0.28 and -0.32 respectively) with aphid population, but statistically found to be non-significant.

Acknowledgements
Words cannot express my profound sense of gratitude and thanks to most esteemed guide and chairman of the Advisory Committee Dr. S. B. Das, Professor, Department of Entomology, College of Agriculture, JNKVV, Jabalpur for his most valuable and inspiring guidance, close supervision, keen interest, constant encouragement and constructive criticism coupled with valuable suggestions during the course of this investigation and in preparation of this manuscript.

References
1. Ahlawat IPS, Gangaiah B, Singh IP. Pigeonpea (*Cajanus cajan*) in India - an overview. Indian J agric. Sci. 2005; 75(6):309-20.

2. Ahlawat IPS, Shivakumar B. Textbook of Field Crops Production. Third Edition, Pub. By Directorate of Information and Publication of Agriculture, ICAR, Krisi Anusandhan Bhavan, Pusa, New Delhi, 2006, 252-317.
3. Anonymous Financial Express, Agricultural news (Based on Media Clippings), Section 2: Crops: Pulses. NACS, 30th Dec. 2009 New Delhi. 2009; 15(84):85.
4. Anonymous. Area and production of gram and pigeonpea in India.4th Advance, 2011.
5. Estimates released on 19th July, by Directorate of Economics and Statistics, Department of Agriculture and Cooperation, New Delhi, 2011.
6. Nandarajan N. *"Directors Desk"*, Pulses Newsletter, Indian Institute of Pulses Research, Kanpur, July-Sep, 2009; 20(8):8.
7. Shah K, Agarwal A. Status of Pulses in India. India Agriculture Review (Ghana). 2009; 10:138-151.
8. Singh CP, Singh R. Singh Modern Techniques of Raising Field Crops. Second Edition, Oxford & IBH Pub. Co. Pvt. Ltd., New Delhi, 2007, 229-30.