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Seasonal incidence of *Aphis craccivora* Koch on *Vigna mungo* and *Vigna radiata* with its predator *Cheilomenes sexmaculata* (Fabricius) (Coleoptera: Coccinellidae)

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ABSTRACT

The knowledge of interaction of prey and predator in relation to host plants in particular season is very necessary for pest management. The seasonal study of *Aphis craccivora* Koch (Hemiptera: Aphididae) and its predator *Cheilomenes sexmaculata* (Fabricius) (Coleoptera: Coccinellidae) were carried out in two seasons on two most common pulses (*Vigna mungo* and *Vigna radiata*) under agroclimatic condition. The appearance and population buildup of *A. craccivora* and *C. sexmaculata* were observed host plants, temperature and humidity dependent. During both the years, one standard peak of infestation of *A. craccivora* was observed on *V. radiata*. However, one standard peak was observed on *V. mungo* only in the first year. The activity of aphids was recorded from October to January (4 months) on *V. radiata* and *V. mungo*. Generally, the first association of *C. sexmaculata* was observed after 6th weeks (16.9 ºC, 51% RH) on *V. radiata* and no association was recorded on *V. mungo* in first year but in the next year the first association was recorded after 8 weeks (16.9 ºC, 80%RH) on *V. mungo* from the date of appearance of aphid in the field. Aphids and predators interaction are greatly influenced by environmental conditions, such as temperature, relative humidity, rainfall, wind and sunshine hours. Thus, the seasonal study of aphids and their predator plays important role for effective management of pest and conservation of natural enemies.

Introduction

The study of relationship between insects and its environment provides basic information for interpreting spatial dynamics, designing efficient sampling programmes for population estimation and pest management, and the development of population models (Croft and Hoyt, 1983). *Vigna mungo* (L.) Hepper (Black gram) and *Vigna radiata* (L.) Wilzeck (Mung bean) are economically important pulse crops in India belong to family Fabaceae. In India they are widely cultivated in several states viz., Andhra Pradesh, Bihar, Maharashtra, Madhya Pradesh, Uttar Pradesh, Punjab, Tamil Nadu, Karnataka and Orissa etc. India contributes nearly 70 percent of world's production of *V. mungo* followed by Myanmar and Thailand. They have been used also throughout Asia in cuisine and medicine for thousands of years. It has been used as

an effective detoxifier. They are high in overall nutritional content, low in calories, sodium and fat and exhibit powerful antioxidant properties that fight disease and protect our body (Gautam *et al.,* 2012).

Aphis craccivora Koch (Hemiptera: Aphididae) is one of the major pest of *Vigna* spp. which reduces its market value. *A. craccivora* and its predator *Cheilomenes sexmaculata* (Coleoptera: Coccinelllidae) found abundantly in different localities of northeast Bihar (Ahmad *et al.,* 2012). *A. craccivora* mostly appeared in last week of October on *V. mungo* and in the first week of October on *V. radiata.* Several workers have also studied the seasonal dynamics and bioecology of different species of aphids and their natural enemies (Chua, 1979; Gupta and Yadav, 1990; Debaraj *et al.,* 1994; Malik *et al.,* 2000; Touhidur *et al.,* 2006; Mishra and Shukla, 2007; Piyaratne *et al.,* 2013; Piyaratne *et al.,* 2014). Several studies also made on its biology and predatory efficiency (Rakhshan and Ahmad 2015a, b; Kumar *et al.,* 2016). In India only few workers have studied the population dynamics of *A. craccivora* and its predator in relation to ecological factors (Parsana *et al.,* 1997; Thejaswi, 2008; Rakhshan and Ahmad 2017).

The knowledge of seasonal history of pest is very important because the biology of population is a result of interaction among individuals of the species and their habitats. Host plants exert considerable selective pressure on aphids and their predators because the plants constitute their feeding, mating and oviposition sites (Thomas *et al.,* 2012). It allows a better understanding of the relationship between an insect and its environment and provides basic information for interpreting spatial dynamics, designing efficient sampling programmes for population estimation and pest management and the development of population models. Thus, the seasonal study of *A. craccivora* and *C. sexmaculata* was made in two different seasons on two host plants because such type of information is considered very useful in biological control programme.

Materials and Methods

The seeds were sown (30x10cm) spacing in an area of 500 m^2 in the 1st week of August (Kharif crop) during two consecutive years (2012-2013 and 2013-2014). The crop area was divided into five equal quadrates. From each quadrates five plants were selected randomly and tagged with label for records of intensity of infestation of *A. craccivora* and population of *C. sexmaculata.* Weekly investigation of *A. craccivora* and its predator *C. sexmaculata* was done for the study of population on *V. radiata* and *V. mungo* in the experimental field. The temperature and humidity were also recorded every week during observation by using electronic thermometer and hygrometer in the field.

Assessment of incidence and infestation rate of aphids

The intensity of infestation by aphids on different host plants was also done according to Kataria and Kumar, (2013).

Low infestation (+) = Few aphids on a plant.

Moderate infestation (++) =Infestation on any one branch of the plant.

High infestation (+++) =Infestation on half portion of the plant/ more than one branch.

Very high infestation (++++) =Severe infestation on the whole plant.

The record of population of predators was done according to Rakhshan & Ahmad, (2017).

Low population (+) = 1 predator on one plant.

Moderate population (++) = 2-5 predators on one plant.

High population (+++) = 6-10 predators on one plant.

Very high population (++++) = More than 10 predators on one plant.

Results

The first appearance of *A. craccivora* was observed during different weeks of October on both host plants. The appearance and intensity of infestation was varied on the different host plants. The population started to build up in the month of November and reached its peak in the month of December than the population started to decrease from the end of January and disappeared in the month of February. The appearance of the, predator *C. sexmaculata* was observed in the month of November but its population increased with the increase of aphid population. The maximum population was recorded during November to December (Table 01 & 02).

(A) Seasonal study of A. craccivora on two host plants

(i) *Vigna radiata*

In 2012, the first appearance of aphids was observed in the mid of October with very low intensity of infestation (26.6 ºC, 58% RH) (Figure 01-A). Its high intensity of infestation was observed in the 2nd and 3rd week of December (17.5 ºC and 16.9 ºC and 60% and 61 % RH) (Figure 01-B) (Table 01).

However during 2013-2014, the aphid population was attained single standard peak. The first appearance was seen in the 1st week of October at 26.3ºC and 56% RH. Its moderate to high intensity of infestation was observed from 2nd week of October to 3rd week of January. It attained only one peak during 4th week of December (Table 02).

(ii) *Vigna mungo*

The population density of *A. craccivora* on *V. mungo* was observed minimum than other host plants. In 2012-2013, the first appearance of aphid was recorded during 4th standard week of October (22.4 ºC, 60% RH). Its low to moderate infestation was observed at the end of November. Its high intensity of infestation was observed in first week of December at 15.8 ºC and 55% RH and continued till the end of December at 10.5ºC and 72% RH. Thereafter, their population disappeared in January (Table 01).

During 2013-2014, the first appearance of aphid was recorded in the 3rd week of October with low intensity of infestation at 24.9ºC and 50% RH and its population continued till the 1st week of January. From the 2nd week of January the aphid infestation started to decrease (Table 02).

(B) Seasonal study of C. sexmaculata on two host plants

(i) *Vigna radiata*

During both the years, the *C. sexmaculata* was recorded during November to December on *V. radiata*. During 2012-2013, it appeared first time in the 4th week of November (16.9 ºC; 51% RH). Thereafter, its population increased gradually and attained its peak level during 3rd week of December (16.9ºC; 61% RH). Then its population disappeared in the 4th week of December (10.5ºC, 72% RH) (Table 01).

The moderate intensity of population was recorded first time in the 2nd week of November (21.2 ºC, 57% RH) on *V. radiata* during 2013-2014. Thereafter, *C. sexmaculata* completely disappeared from the field. Then, it reappeared in the 2nd week of December at 17.5ºC and 82% RH with low association. The activity of *C. sexmaculata* from the 2nd week of December to the 1st week of January was seen with low to high intensity of population but not any peak level recorded in this season (Table 02).

ii) *Vigna mungo*

Activity of *C. sexmaculata* was not recorded during 2012-2013 on *V. mungo* (*Table 0*1). During 2013-2014, its first appearance was observed first time in the field during 3rd week of December (16.9 ºC; 80% RH). In the 5th week of December and 1st week of January, its population was increased slightly and completely disappeared from the field in the 2nd week of January at (10.8 ºC; 80% RH) (Table 02).

(C) Association of C. sexmaculata with A. craccivora on two host plants

Table 01. Association of *A. craccivora* and *C. sexmaculata* on two host plants (2012 – 2013).

Date	Temp.	Humidity	*V. radiata*		*V. mungo*	
			Intensity of infestation of *A. craccivora*	Intensity of population of *C. sexmaculata*	Intensity of infestation of *A. craccivora*	Intensity of population of *C. sexmaculata*
1 Oct.	33.1ºC	69%	-	-	-	-
8 Oct.	28.2ºC	56%	-	-		-
15 Oct.	26.6 ºC	58%	+*	-	-	-
22 Oct.	24.9 ºC	50%	+	-	-	-
29 Oct.	22.4 ºC	60%	+	-	+*	-
5 Nov.	22.2 ºC	64% rainfall	++	-	++	-
12 Nov.	21.8 ºC	63%	+	-	++	-
19 Nov.	19.1ºC	50%	+	-	+	-
26 Nov.	16.9ºC	51%	++	++*	++	-
3 Dec.	15.8ºC	55%	+++	++	+++	-
10 Dec.	17.5ºC	60%	++++	+++	+++	-
17 Dec.	16.9ºC	61%	++++	++++	+++	-
24 Dec.	10.5ºC	72%	+++	**	+++	-
31 Dec.	6.2ºC	81%	**	***	++	-
7 Jan.	6.8ºC	86%	***	-	+	-
14 Jan.	12.3ºC	78%	-	-	**	-
21 Jan.	11.6ºC	69%	-	-	***	-

*= Appearance of aphids and predators, **= Disappearance of aphids and predators, ***= Plant on brink of death

Table 02. Association of *A. craccivora* and *C. sexmaculata* on two host plants (2013 – 2014).

Date	Temp.	Humidity	*V. radiata*		*V. mungo*	
			Intensity of infestation of *A. craccivora*	Intensity of population of *C. sexmaculata*	Intensity of infestation of *A. craccivora*	Intensity of population of *C. sexmaculata*
7 Oct.	26.3ºC	56%	-	-	+*	-
14 Oct.	25.1ºC	58%	-	-	++	-
21 Oct.	24.9ºC	50%	+*	-	++	-
28 Oct.	22.5 ºC	60%	+	-	++	-
4 Nov.	22.8ºC	59%	+	-	+	-
11 Nov.	21.2 ºC	57%	++	-	+++	+*
18 Nov.	19.9ºC	51%	++	-	+++	-
25 Nov.	16.9ºC	80%	+++	-	+++	-
2 Dec.	15.8ºC	81%	+++	-	++	-
9 Dec.	17.5ºC	82%	++	-	+++	+
16 Dec.	16.9ºC	80%	+++	+*	+++	+
23 Dec.	10.5ºC	80%	+++	+	++++	++
30 Dec.	9.6ºC	81%	+++	++	+++	+++
6 Jan.	7.8ºC	80%	++++	++	++	+++
13 Jan.	10.8ºC	80%	++	+	++	**
20 Jan.	13.4ºC	70%	++	**	++	***
27 Jan.	14.4ºC	65%	++	***	**	-
3 Feb.	17.8ºC	62%	+	-	***	-
10 Feb.	17.9ºC	57%	+	-	-	-
17Feb.	18.4ºC	58%	**	-	-	-
24 Feb.	19.8ºC	57%	***	-	-	-

*= Appearance of aphids and predators, **= Disappearance of aphids and predators, ***= Plant on brink of death

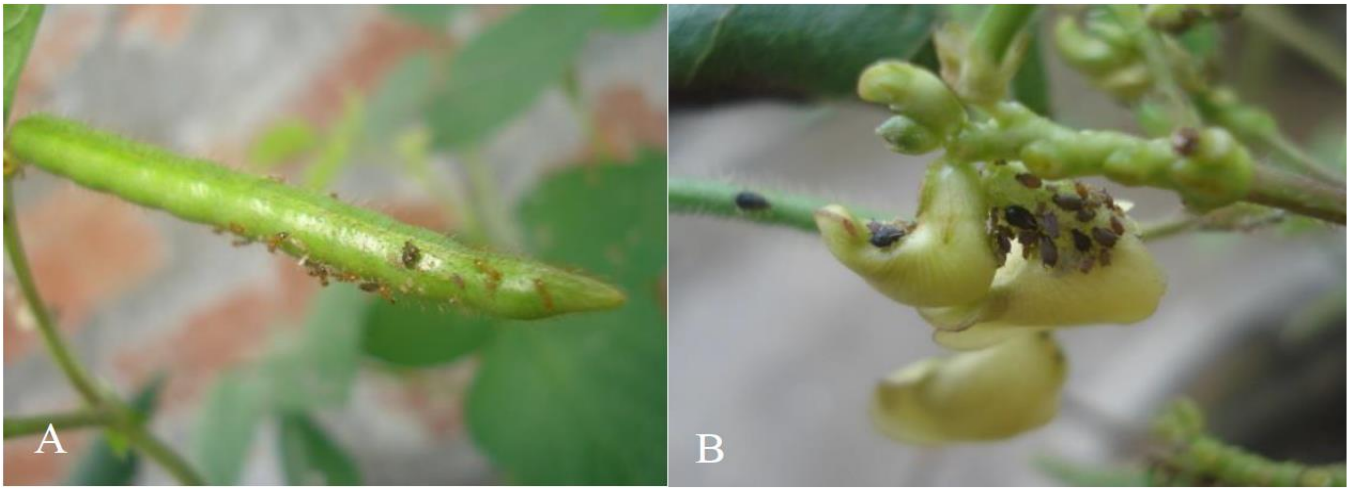

Figure 01. A, : Low infestation of *A. craccivora* on fruit of *V. radiate;* B, High infestation of *A. craccivora* on flower of *V. radiata*

Vigna radiata

In the 2012-2013, the appearance of predator was observed in field after 6 weeks from the date of appearance of aphid (16.9 ºC, 51% RH). The moderate association of predator was observed on moderate intensity of infestation of *A. craccivora* in the 4th week of November. Thereafter, aphid population increased upto peak level, during 3rd standard week of December (16.9 ºC, 61% RH). The population of predators was also observed very high due to increase of aphid population (Table 01).

During 2013-2014, the moderate population of predator was recorded after 5th week of appearance of aphids and no association of predator was recorded from 3rd week of November to 1st week of December. The low association of predator was observed in the 2nd week of December (17.5 ºC, 82% RH) (Table 02).

(i) *Vigna mungo*

In the year 2012-2013, no association of predator was observed with *A. craccivora* (Table 01). However, in the year 2013-2014, the first appearance of predator was observed in the field at 16.9 ºC, 80% RH, after 8 weeks of infestation of *A. craccivora* in the field. The association of aphid and its predator was observed from 3rd week of December to the end of mid January. Its first association was recorded in the field with high intensity of infestation of aphids with low population of predators in the 3rd week of December. The aphid infestation was observed high with moderate intensity of association of predator at 9.6 ºC; 81% RH. Thereafter, moderate intensity of association of predator was observed on very high infestation of aphids (7.8 ºC, 80 % RH). From the 2nd week of January to the mid February, no association of predator was recorded (Table 02).

Discussion

The appearance of aphids and growth of population in the present investigation were observed host plant and temperature/humidity dependent. *A. craccivora* first time appeared on *V. radiata* during first/third week of October in both years (2012-2013 & 2013-2014) at 26.6 ºC, 58% RH and 26.3 ºC, 56% RH respectively. However, *A. craccivora* appeared late on *V. mungo* during third/fourth week of October in both years at 22.4ºC, 60% RH and 24.9 ºC , 50% RH. The moderate to very high intensity of infestation was observed during October to January (4 months) on *V. radiata*. However, it moderate to high intensity of infestation was observed from November to January (3 months) on *V. mungo*. It revealed that early appearance of aphids and stay longer period on *V. radiata* than *V. mungo,* caused curling of leaves, retard the growth of flowers and development of fruits.

The present results were also observed temperature and humidity dependent. During study, it was observed that high temperature and low humidity lowered down the aphid population build up. However, Upadhyay *et al.,* (1980) reported that the rise in humidity declined the population of *Uroleucon compositae*. In the first week of November 2012, the aphid population declined drastically due to rainfall. Similar observation was also made by several workers (Atwal *et al.,* 1971; Bhatia and Verma, 1994; Vijay and Raj, 1999) which is in agreement with our present finding. During both the year, the aphid population persisted in the field until harvest. These results are in the conformity with Agarwal and Dedheech, (1990). The flowering stage of crop vulnerable to aphid infestation reported by (Brar *et al.,* 1976 and Sinha *et al.,* 1990) which is in the agreement of present finding. Verma *et al.,* (1987) also reported high temperature, above 31 ºC adversely affecting the population of aphid.

The population of *C. sexmaculata* was observed moderate to very high on *V. radiata* from November to January (2-3 months) in both years. The appearance of *C. sexmaculata* and its population buildup also depends on host plants in the present investigation. However, during 2012-2013 no association of *C. sexmaculata* was observed on *V. mungo*, but in the next year its appearance was observed during December and January (2 months). The present investigation shows that *V. radiata* are more suitable host plants than *V. mungo* in predator prey system. According to Tank and Korat (2008), good number of grubs and beetles of *C. sexmaculata* insects were found on cowpea crop from mid September to the end of October.

Rakhshan and Ahmad (2017) reported that when population of *A. craccivora* build up, the population of *C. sexmaculata* increased continuously to maximum even after decline of aphids from the field which is supported to present finding. The present investigations are also in the conformity with finding of Atwal *et al.,* (1971). Upadhyay *et al.,* (1983) reported that the activity of coccinellids increased with increase of *U. compositae* population on safflower and it indicates positive relationship between pest and predators.

In the present investigation, the appearance and population buildup of *A. craccivora* and *C. sexmaculata* were host plant, temperature and humidity dependent. *V. radiata* is more suitable host plant than *V. mungo*. Similarly, Rakhshan and Ahmad (2017) reported that the maximum intensity of infestation of *A. craccivora* and population of *C. sexmaculata.*was observed on *P. sinensis* than *L. purpureus.* They also reported that weather parameters are also responsible for early appearance of prey and predator on its favourable host plants.

Conclusion

An information based on population build up of predator would be useful to make sound eco-friendly strategy for managing *A. craccivora* population on host plants *V. radiata* and *V. mungo* in relation to abiotic factors.

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