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Population dynamics of coccinellid, *Cheilomenes sexmaculata* (Fab.) on cowpea aphid

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Abstract
Studies on the population dynamics were conducted during *Rabi* 2017 in the main campus of UAHS, Shivamogga. The study revealed that cowpea aphid and coccinellid prevailed throughout the cropping period of cowpea. The peak incidence of aphids was noticed in 46th SMW (125.35 aphids/2.5cm pod length) with a population ranged from 25.70 aphids/3 leaves to 125.35 aphids/2.5cm pod length. The population of coccinellids followed the trend of cowpea aphid. The mean number of aphids and coccinellid adults showed positive correlation with maximum temperature and negative correlation with remaining weather parameters such as minimum temperature, morning, evening relative humidity and rainfall. The coccinellid grubs showed significant positive correlation with maximum temperature and negatively significant correlation with evening relative humidity. Whereas, negatively correlated with the remaining parameters such as minimum temperature, morning relative humidity and rainfall. And it was found that the coccinellid population were highly significant and positively correlated with aphid population.

Keywords: Cowpea aphid, *Aphis craccivora* and predator, *Chilomenes sexmaculata*

Introduction
Among the various grain legumes, Cowpea (*Vigna unguiculata* (L.) Walp.) is one of the most important pulse crops, native to central Africa, belongs to family Fabaceae. Cowpea grain contains an average of 23- 25 per cent protein. It is extremely valuable where many people cannot afford high protein foods such as meat and fish [1]. It is an essential component of cropping systems in the drier regions of the tropics covering parts of Asia and Oceania, the Middle East, Southern Europe, Africa, Southern USA and Central and South America [2]. Cowpea is usually preferred by farmers because of its role in maintaining soil fertility through nitrogen-fixing and production of nutritious fodder for livestock.
The major constraint for cowpea grain production is insect damage [3]. It was reported that *Aphis craccivora* (Koch) is one of the key pests of cowpea [4] affecting 90% of plants according to the field study. Cowpea is known to have a rich natural enemy complex and the coccinellid, *Chilomenes sexmaculata* is major one among them. Field studies conducted so far revealed strong correlations between the aphid and predator populations on cowpea [5]. The data available on the feeding capacity of *Chilomenes sexmaculata* an important predatory coccinellid of this pest, suggest that this predator possesses the potential to substantially reduce aphid populations on cowpea [6, 7]. So it is necessary to know the population trends of coccinellid in relation to the aphid population. Information regarding this work further will be useful to manage population of aphids.

Materials and Methods
Field trial was conducted to study the population dynamics of predators and aphid population during the crop growth period, *Rabi* 2017. Population trend of the aphids and its coccinellid predators were compared with the weather parameters.
The field experiment was carried out in the main campus of UAHS Shivamogga was raised by recommended package of practices except plant protection measures. In the bulk plot of 500 m^2 the cowpea genotype, C-152 was grown with spacing of 30 cm x 10 cm.

The sample procedure
Observations on coccinellid populations were commenced from 14 days after sowing and

aphids population 21 days after sowing. Observations were recorded at weekly interval till maturity of the crop. In the vegetative stage of crop growth, number of aphids per 3 leaves was counted and in reproductive stage the aphid count was taken as 2.5cm pod length.

For coccinellids, both grubs and adults were counted from 10 randomly selected plants and expressed as number of grubs and adults per plant.

Data obtained was correlated with various weather parameters using software Statistical Package for the Social Sciences (SPSS). Regression analysis was performed to find out the extent of influence of weather parameters on the population dynamics of predators and aphid population.

Results and Discussion

Cowpea aphids

The cowpea aphid incidence on *Rabi* sown cowpea crop at UAHS campus, Shivamogga was observed from 4th week of September (39th SMW) to 4th week of November (48th MW) and the population ranged from 25.70 aphids/3 leaves to 125.35 aphids/2.5cm pod length (Table 1). Initially the aphid population was increasing from 4th week of September (39th SMW) to 2nd week of October (41st SMW) *i.e.,* 25.70 to 80.935 aphids/3 leaves. Further the population of aphids did not show any increasing or decreasing trend because of intermittent rain fall.

During the cropping period of cowpea *i.e.,* 2nd week of September (37st SMW) to 4th week of November (48st SMW), the aphid population reached its peak (125.35 aphids/2.5cm pod length) during 46th SMW and lowest in 4th week of September (25.70 aphids/3 leaves). This is in confirmation with findings of Srikanth and Lakkundi (1990) [8]

Aphids infestation in vegetative and reproductive stages of cowpea

The incidence of cowpea aphid was observed throughout the cropping period, so the count of aphids varied during vegetative and reproductive stages of cowpea. It is indicated in the table 1.

Vegetative stage

In this stage the infestation of aphid was noticed on the leaves, which was taken as mean no. of aphids/3 leaves and it starts from 39 to 42nd SMW. During vegetative stage the population increased from 25.70 (39th SMW) to 80.90 (41st SMW) aphids/3 leaves.

Reproductive stages

The infestation of aphids on pod starts from 43rd SMW (48.50 aphids/2.5cm pod length) and reached its peak in 46th SMW (125.35 aphids/2.5cm pod length) thereafter the population decreased. Infestation of aphids on pod continued till the maturity of pod *i.e.,* in 48 SMW.

Coccinellid grubs (*Cheilomenes sexmaculata*)

The activity of coccinellid grubs started from 41st SMW and observed till end of crop (48th SMW) (Table 1). However, the grubs were recorded 3 weeks after appearance of beetles and population of coccinellid grubs ranged from 0.20 to 5.20 grubs/plant. First the population trend was increasing from 2nd week of October (41st SMW) to 4th week of October (43rd SMW) *i.e.,* 0.70 to 1.90 grubs/plant. After that there was no increasing or decreasing trend of coccinellid grubs due to population fluctuation of prey (aphids). Here the highest number of coccinellid grubs were recorded in 46th SMW (5.20 grubs/plant) and lowest during 44th SMW (0.20 grubs/plant).

Coccinellid adults (*Cheilomenes sexmaculata*)

The population of adult coccinellid beetles were observed before incidence of cowpea aphid during 38th SMW which may be due to availability of aphids on other hosts in and around the experimental plot. It was ranged from 0.20-1.90 adults/plant. The highest population was recorded during both 47th and 48th SMW (1.90 adults/plant) and lowest during 38th SMW (0.20 adults/plant) (Table 1). Formerly the trend observed was increasing from 3rd week of September to 2nd week of October (0.20 to 1.60 adults/plant) and there after its population changed as like cowpea aphids.

In order to know the role of different weather parameters on population dynamics of cowpea aphid and coccinellids, data was subjected to correlation analysis. The maximum, minimum temperature, morning, evening relative humidity and rainfall were correlated with aphid and coccinellid population and correlation values are presented in the table 2.

Table 1: Population dynamics of cowpea aphid, *Aphis craccivora* Koch and Coccinellid, *Cheilomenes sexmaculata* (Fab.) during *Rabi* 2017

SMW	Date of observation	Aphid count*	Mean number of Coccinellids	
			Grubs/ plant	Adults/ plant
37	09/09/2017	0.00	0.00	0.0
38	16/09/2017	0.00	0.00	0.2
39	23/09/2017	25.70	0.00	0.3
40	30/09/2017	72.60	0.00	0.6
41	07/10/2017	80.90	0.70	1.6
42	14/10/2017	69.10	1.50	0.9
43	21/10/2017	90.20	1.90	1.7
44	28/10/2017	33.70	0.20	0.6
45	04/11/2017	48.50	1.30	0.9
46	11/11/2017	125.35	5.20	1.1
47	18/11/2017	102.48	2.52	1.9
48	25/11/2017	97.80	1.50	1.9

SMW: Standard Meteorological Week

*Aphid count in vegetative stage taken as mean no. of aphids/3 leaves (39 to 42ndSMW) and in reproductive stage, mean no. of aphids/2.5cm pod length (43 to 48thSMW)

Correlation of cowpea aphid and Coccinellid with weather parameters

From table 2, it was observed that mean number of aphids and coccinellid adults showed positive correlation with maximum temperature (r = 0.550 and r = 0.486, respectively) and negative correlation with remaining weather parameters such

as minimum temperature (r = 0.386 and r = 0.381, respectively), morning relative humidity (r = 0.250 and r = 0.217, respectively) evening relative humidity (r = 0.438 and r = 0.434, respectively) and rainfall (r = 0.409 and r = 0.557, respectively). When the data was subjected to multiple linear regression analysis, the equation obtained was Y= -643.707 + 24.371 X_1 - 17.831 X_2 + 0.834 X_3 + 3.417 X_4 - 0.403 X_5 + 39.778 and Y= -10.03 + 0.349 X_1 - 0.220 X_2 + 0.016 X_3 + 0.056 X_4 - 0.012 X_5 + 0.632, with an R^2 value of 0.475 and 0.512, which implicated that 47.5 and 51.2 per cent of total variation in aphid and coccinellid adult count could be explained by above five parameters.

The coccinellid grubs/plant showed significant positive correlation with maximum temperature (r = 0.586) and significantly negative correlation with evening relative humidity (r = 0.638). Whereas the remaining parameters such as minimum temperature (r = 543), morning relative humidity (r = 0.346) and rainfall (r = 0.543) were negatively correlated. When the data was subjected to multiple linear regression analysis, the equation obtained was Y= -15.041 + 0.647 X_1 - 0.58 X_2 + 0.063 X_3 + 0.037 X_4 - 0.01 X_5 + 1.32, with an R^2 value of 0.58, which implicated that 58 percent of total variation in coccinellid grub count per plant could be explained by above five parameters.

Correlation of coccinellid, *Cheilomenes sexmaculata* with cowpea aphid, *Aphis craccivora*

It was confirmed that, both grub (0.788**) and adult (0.836**) coccinellid population were highly significant and positively correlated with aphid population (Table 2).

The present findings are in agreement with Tank (2006) [9] who reported that the larval and adult population of *C. sexmaculata* on cowpea crop showed negative correlation with minimum temperature, evening relative humidity and rainfall. And also supported by the findings of Megha (2013) [10] and Gauns *et al.* (2014) [11] who found the lady bird beetle population was negatively correlated with minimum temperature and evening relative humidity and positively correlated with cowpea aphids. But the results are contrary with the findings of Mantesh (2017) [12] who found coccinellid grub population was negatively correlated with maximum temperature and positively correlated with morning and evening relative humidity and rainfall.

Table 2: Correlation coefficient (r) and Coefficient of determination (R^2) between weather parameters with Coccinellid, *Cheilomenes sexmaculata* (Fab.) and cowpea aphid, *Aphis craccivora* Koch during *Rabi* 2017

Variable	Cowpea aphids	Coccinellid grub	Coccinellid adult	Correlation coefficient (r)					Coefficient of determination (R^2)
				Meteorological parameters					
				Temperature (^{0}C)		Relative humidity (%)		Rainfall (mm) (X_5)	
				Max (X_1)	Min (X_2)	I (X_3)	II (X_4)		
Cowpea aphids	-	0.788**	0.836**	0.550^{NS}	-0.386^{NS}	-0.250^{NS}	-0.438^{NS}	-0.409^{NS}	0.475
Coccinellid grub	0.788**	-	-	0.586*	-0.543^{NS}	-0.346^{NS}	-0.638*	-0.543^{NS}	0.580
Coccinellid adult	0.836**	-	-	0.486^{NS}	-0.381^{NS}	-0.217^{NS}	-0.434^{NS}	-0.557^{NS}	0.512

n= 12, r= 0.576 NS: Non-Significant * Correlation is significant at the 0.05 level (2-tailed) ** Correlation is significant at the 0.01 level (2-tailed)

Conclusion

Population dynamics of aphids and coccinellids in cowpea crop revealed that higher population was observed during pod development period. The population of coccinellid followed the trend of cowpea aphid.

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