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Occurrence of common aphidophagous natural enemies on blackgram

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Abstract
Investigation on, "management of major insect pest of blackgram under organic farming" was carried out at the Instructional Farm, Rajasthan College of Agriculture, Udaipur during monsoon (July, 2013) and (July, 2014) seasons with the objectives to study the qualitative and quantitative abundance of major insect pests of blackgram and their associated natural enemies. The aphid pest recorded on blackgram was *Aphis craccivora* (Koch). Among the aphidophagous predatory guild, the major insect groups included, coccinellids, *Coccinella septempunctata* (L); *Cheilomenes sexmaculata* (Fab.) and syrphid flies, *Ischiodon sp.* were recorded feeding aphids on blackgram; the carabid, *Chlaenius aspericollis* (Bates); spiders; reduviid predatory bugs and wasps were also collected from the crop area. The seasonal mean population of aphids was higher during 1st week of September (36th SMW) during 2013 and 2nd week of September (37th SMW) during 2014 with mean population of 42.33 and 37.33 aphids/5 plants in the respective years. The mean density and relative density values were the maximum (8.0 & 78.27 %) for coccinellids during 2013, followed by that for syrphid fly (2.78 & 21.73 %) and relatively more as compared to 2014.

Keywords: blackgram, aphid, aerial, ground dwelling aphidophagous predators

1. Introduction
Black gram originated in India, where it has been in cultivation from ancient times and is one of the most highly prized pulses of India and Pakistan. Black gram has also been introduced to other tropical areas such as the Caribbean, Fiji, Mauritius, and Africa mainly by Indian immigrants. Black gram is very nutritious as it contains high levels of protein (25g/100g), potassium (983 mg/100g), calcium (138 mg/100g), iron (7.57 mg/100g), niacin (1.447 mg/100g), Thiamine (0.273 mg/100g), and riboflavin (0.254 mg/100g).[1] Black gram complements the essential amino acids provided in most cereals and plays an important role in the diets of the people of India and Nepal. [2] Black gram has been shown to be useful in mitigating elevated cholesterol levels [3, 4].

Agro-ecosystems under intensive agriculture often present unfavourable environments for natural enemies due to high levels of anthropological disturbance, particularly through intensive agriculture. Organic farming that aims at utilizing practices to favour natural enemies, especially, predators and parasitoids towards achieving conservation biological control has been often advocated. A higher natural enemy abundance [5] or diversity [6]) may not often lead to improved biological control, because prey other than the pest species may be preferred. The aphid, *Aphis crassivora* (Koch) is one of the important pests of blackgram and covered on leaves, inflorescence stalk and young pods and honey dew secretion with black ant movements. It was observed that infestation from 10-leaf stage to tasseling caused 28.14 per cent yield losses (average aphid density 818 aphids/plant); while, infestation through ripening stages caused 16.28 per cent yield losses (average aphid density 1038 aphids per plant). [7] studied the population dynamics of major insect pests of greengram. The aphid, *A. craccivora*, jassid, *E. kerri* and whitefly, *B. Tabaci* infested the crop in the last week of July 2013; The population of aphid, attained its peak during second week of August (36.75/5 plants) during 2013. [8] recorded an avoidable loss due to insect pests infestation in sole blackgram to be 55.20 per cent when exposed to insect infestation. The management of sap sucking insect pests through bio-intensive methods renders it important to record the diversity of natural enemies of aphids, both generalist and specific, commonly occurring in any crop ecosystem to exploit them in favour.

The aphidophagous arthropod guild can be divided broadly into specialists that include Braconidae and Aphidiinae parasitoids; predatory coccinellids, lacewings and hoverflies [9] or generalists that include euryphagous predators like ground beetles and spiders [10]. Intra-guild competition is often reported among aphidophagous natural enemies due to their foraging activity when they frequently encounter hetero-specific aphid predators, which may disrupt biological control efforts against aphids where more than one predator species is present; hence, this necessitates carefully choosing a combination of predators for success in biological control of aphids [11.]. The present investigation thus envisages working out the occurrence of aphidophagous arthropod natural enemies in blackgram cultivated during monsoon season.

2. Materials and Methods

A. Experimental site

The experimental site was located at the Instructional Farm, Rajasthan College of Agriculture, Udaipur, situated at 75.40 E Latitude and 23.40 N Longitude at an elevation of 582.17 MSL in the sub-humid southern region of Rajasthan, India. The zone has a typical sub-tropical climatic condition characterized by moderate winter and hot summer associated with high humidity especially during months of August and September. The average rainfall of this tract ranges between 450-650mm, contributed by South-West monsoon from July to September with occasional rains during the winter season. During summers, the atmospheric temperature may go as high as 45.5 ^{0}C, while in winters, it may fall as low as 3.5 ^{0}C occasionally.

B. Field preparation and sowing of blackgram crop

The experimental field was prepared in the first week of July during both the years of study (2013 & 2014) by proper ploughing followed by cross harrowing and planking. The blackgram variety PU-31 was sown on 12th July during 2013 and on 15th July during 2014; maintaining a row to row and plant to plant spacing of 30 cm x 10 cm, respectively. All other recommended agronomic practices were followed as per the package of practices to raise a good crop.

C. Natural enemy collections

The associated natural enemies including syrphid flies, coccinellids, predatory bugs and spiders were recorded by visual count from the same five plants per replication. For the estimation of the population of soil dwelling predators, especially carabids, pit fall traps were laid out in each replication with three traps placed randomly in each plot of 25 sq. m.

D. Arthropod monitoring

a) Pest aphids count

Visual counting method was used to record the population of aphids on 5 randomly selected plants from 5 cm floral twigs in each replicate. Aspirator was used to collect necessary sample insects for further identification. A hand-held magnifying lens (6x) with LED illumination was used to count the insects in the field.

b) Aphidophagous natural enemy count

i. Specific and generalist predator count

The predator abundance was recorded as per stage of development:

a) First, larvae of coccinellids and hoverflies were counted on the same shoots used to count the aphids.
b) Second, adult aerial predators, mainly coccinellids, were recorded visually.
c) Third, the ground-dwelling predators were collected using pitfall traps. Three pitfall traps (500ml glass jar with ethylene glycol) were positioned diagonally within each replicate. The traps were dug down to ground level. Transparent plastic covers were placed above the traps to prevent flooding by rain during the monsoon season.
d) Aphids and aerial predator transects were inspected between 7:00 and 9:00 a. m.
e) Ambient atmospheric temperature (^{0}C) and relative humidity (%) was measured prior to sampling. Sampling was carried out as soon as aphid infestation began.

Statistical analyses

The following mathematical analysis was made towards estimating the species richness of aphidophagous natural enemies and their diversity indices:

Mean density

$$\text{Mean density} = \frac{\sum Xi}{N} \times 100$$

Where,

Xi = Numbers of insects or natural enemies
N = Total numbers of plants sampled

Relative density (R.D. %)

$$RD\% = \frac{\text{Number of individuals of one species x 100}}{\text{Total number of individuals of all species}}$$

Shannon-Weiner diversity index

Shannon-Weiner diversity index (H') = - $\sum$ p*i ln p*

Where, p*i* = the decimal fraction of individuals belonging to ith species.

3. Results and Discussion

Aphid incidence and their natural enemies

The aphids collected from blackgram were *Aphis crassivora* (Koch) [Aphididae: Hemiptera]. The associated natural enemies of aphids on blackgram included coccinellids [*Coccinella septempunctata* Linneau,s *Cheilomenes sexmaculata* (Fabricius), Coccinellidae: Coleoptera] and syrphid flies [major being Ischiodon sp., Syrphidae: Diptera] were being dominant and carabid, *Chlaenius aspericollis* (Bates); spiders; reduviid predatory bugs and wasps were also recorded from crop area in trace number. The seasonal incidence of the blackgram aphid during the both year, as presented in Tables 1 and 2 respectively, indicate that the seasonal mean aphid abundance on blackgram during 2013 was relatively more than that during 2014. The mean population ranged from 5.00 aphids per five plants to 42.33 aphids per five plants with the seasonal mean being 19.66 aphids per five plants during 2013 (Table 1). Likewise, the mean population ranged from 6.00 aphids per five plants to 37.33 aphids per five plants with the seasonal mean being 18.83 aphids per five plants during 2014 (Table 2). From the observations taken during both the years it could be noted that the aphid population was 1.13 times more in 2013 as compared to that during 2014, It could be inferred that an increase in total rainfall and enhanced relative humidity during 2014 caused a reduction in aphid numbers.

In accordance to the aphid numerical abundance and being

density-dependent, the associated aphidophagous natural enemies were relatively a little more during 2013 as compared to that during 2014. The mean coccinellid population (inclusive both grub and adult) ranged from 3.00 to 10.33 per five plants with the seasonal mean of 6.00 per five plants during 2013; while the corresponding values for 2014 crop were 2.33 to 9.33 per five plants with the seasonal mean of 4.40 per five plant. The syrphids had a seasonal mean population of 1.93 and 1.53 per five plants during kharif 2013 and 2014, respectively. It could be observed the populations of the aphidophagous natural enemies were more during 2013 than in 2014, possibly being favoured by the environmental conditions. The population trend of the blackgram aphid and the associated natural enemies has been depicted in the Figures 1 and 2. Among the aphidophagous natural enemy guild recorded during both year, coccinellids dominated with 78.27 and 77.66 per cent relative density, respectively. [Table 1 & 2]. Earlier, Nampala [12] observed coccinellids, syrphid larvae, spiders, *Orius sp*. and earwigs on cowpea cropping systems (sole crop and intercrops). Similar to our observation, among coccinellids, *C. septempunctata*, *C. transversalis*, *Brumoides suturalis* and *Cheilomenes sexmaculata* are the most widespread (Singh and Brar [13]). Similarly, the abundance of predators (Coccinellidae, Staphylinidae, Syrphidae, Anthocoridae, Mantidae, Dermaptera, ground beetles, predatory mites, lygaeid bugs, dragonflies and spiders) was observed to be associated with cowpea/greengram cropping systems (Munyulia [14]). Among aphid predators, the coccinellids, *Coleomegilla maculata* lengi and *Hippodamia tredecimpunctata* were significantly more abundant in the monoculture than in the maize intercropped with beans, but *Coccinella septempunctata* and spiders were not (Coderre [15]). Thus, it can be inferred that coccinellids happen to be the most dominant aphidophagous predators of aphids as recorded during the present investigation. (Swaminathan *et. al* [16] studied the aphidophagous predatory guild, the major insect groups included coccinellids (*Coccinella septempunctata* Linnaeus, *Cheilomenes sexmaculatus* (Fabricius) and *Brumoides suturalis* (Fabricius): Coccinellidae, Coleoptera); lygaeid bug (*Geocoris* sp.: Lygaeidae, Hemiptera,); rove beetle [*Paederus fuscipes* Curtis: Staphylindae, Coleoptera] and syrphid flies (*Ischiodon* sp.: Syrphidae, Diptera; being dominant). The seasonal mean population of aphids was higher during monsoon season crop (369.09/plant) than during the summer season (291.26/plant). Likewise, the seasonal mean population of the aphidophagous predators per plant was relatively more during monsoon season being 8.56 (coccinellids), 3.76 (Geocoris sp.), 3.14 (P. fuscipes) and 2.41 (syrphid flies); whereas, in summer season the corresponding values were 7.78 (coccinellids), 3.60 (Geocoris sp.), 2.87 (P. fuscipes) and 1.89 (syrphid flies).

Table 1: Occurrence of common aphidophagous natural enemies on blackgram during *kharif* 2013

			Abiotic factors		Mean population per five plants		
SMW	**Date and month**	**Mean Atm.**	**Mean R.H.**	**Total Rainfall**	**Aphids**	**Syrphid fly**	**Coccinellids**
		Temp (°C)	**(%)**	**(mm)**			
31	July 30-Aug 5	26.10	84.90	63.60	0.00	0.00	0.00
32	Aug 6- Aug 12	26.55	82.10	85.20	0.00	0.00	0.00
33	Aug 13- Aug 19	26.80	81.80	25.60	5.00	0.00	0.00
34	Aug 20 – Aug 26	26.35	75.50	16.80	11.67	1.33	3.00
35	Aug 27-Sept 2	26.20	71.10	0.00	26.00	2.00	6.33
36	Sept 3-Sept 9	25.10	63.50	0.00	42.33	3.00	10.33
37	Sept 10- Sept 16	23.90	65.50	51.20	21.67	2.33	7.67
38	Sept 17- Sept 23	27.10	70.30	17.20	11.33	1.00	2.67
Seasonal mean					19.66	1.93	6.00
Mean Density (%)					(23.70)	(2.78)	(8.00)
Relative density [%]					[30.65]	[21.73]	[78.27]
Coefficient of correlation (r) between aphid population and the natural enemy					---	0.93*	0.95*
*Significant at 5% level of significance							
Figure in parentheses are mean density (%) values							

Table 2: Occurrence of common aphidophagous natural enemies on blackgram during *kharif* 2014

S.M.W	**Date and month**		**Abiotic factors**		**Mean population per five plants**		
		Mean Atm.	**Mean R.H.**	**Total Rainfall**	**Aphids**	**Syrphid fly**	**Coccinellids**
		Temp (°C)	**(%)**	**(mm)**			
31	July 30-Aug 5	27.00	83.60	109.00	0.00	0.00	0.00
32	Aug 6- Aug 12	25.80	81.30	47.20	0.00	0.00	0.00
33	Aug 13- Aug 19	26.60	72.70	0.20	6.00	0.00	0.00
34	Aug 20 – Aug 26	28.10	76.40	40.80	14.00	1.00	2.33
35	Aug 27-Sept 2	27.40	77.40	31.60	28.00	1.33	4.00
36	Sept 3-Sept 9	25.90	82.70	165.20	11.67	1.33	4.67
37	Sept 10- Sept 16	25.10	87.60	94.80	37.33	2.67	9.33
38	Sept 17- Sept 23	26.20	68.10	0.00	16.00	1.33	1.67
Seasonal mean					18.83	1.53	4.40
Mean Density (%)					(25.11)	(2.11)	(5.87)
Relative density [%]					[34.31]	[22.34]	[77.66]
Coefficient of correlation (r) between aphid population and natural enemy					---	0.88*	0.85*
*Significant at 5% level of significance							
Figure in parentheses are mean density (%) values							

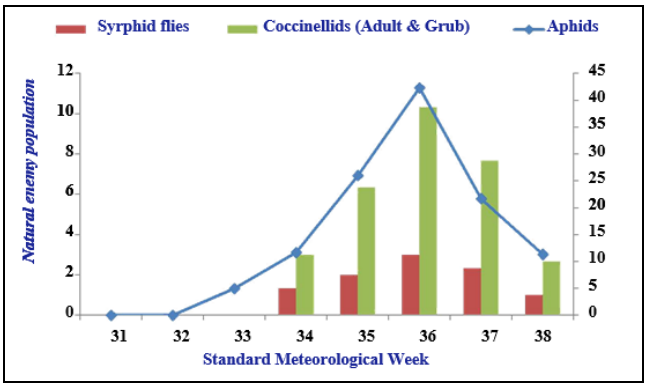

Fig 1: Occurrence of common aphidophagous natural enemies on blackgram during *kharif* 2013

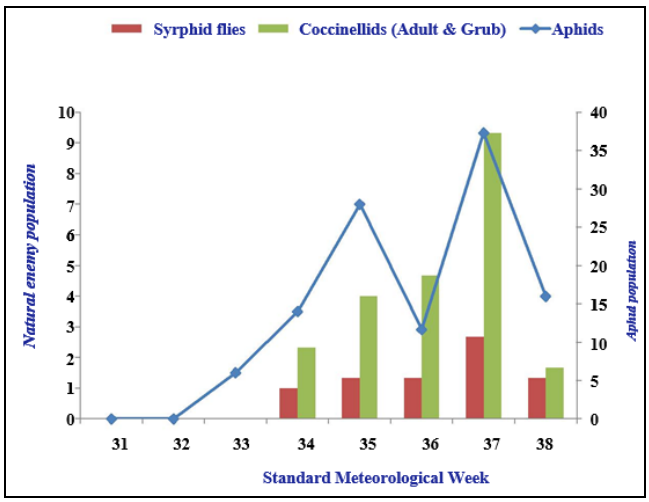

Fig 2: Occurrence of common aphidophagous natural enemies on blackgram during *kharif* 2014

4. Conclusion

Syrphid fly and coccinellid population exhibited a significant and positive correlation with the aphid population during both the years it indicating an increase in the syrphid fly and coccinellid population with an increase in aphid population.

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