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FUNCTIONAL RESPONSE ON FEEDING BARLEY APHIDS BY DOMINANT COCCINELLIDS SPECIES

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ABSTRACT

The prey preference and predator prey relationship manifested by functional response of three dominant coccinellids were studied under conditions of atmospheric temperature and relative humidity in the laboratory of Department of Entomology, Rajasthan College of Agriculture, Udaipur during 2007–08. The three dominant coccinellids viz– *C. septempunctata, C. sexmaculata* and *A.variegata* showed a varied functional response while feeding on barley aphids. The materials used and methodology adopted during the present investigation on, " *Funtional response of feeding barley aphids by dominant coccinellids species* ", conducted at the Agronomy Farm and in the laboratory of the Department of Agricultural Zoology & Entomology, Rajasthan College of Agriculture, Udaipur during the crop seasons in 2007–08. The adult of *C. septempunctata* had a marginal increasing rate of prey killing for a gradual increase in the prey numbers from 25 to 100; thereafter, it evinced a constant rate of prey killing; thus a response between *Type II* and *Type III* became evident. The other two coccinellids *i.e.*, *C. sexmaculata*, and *A. variegata* recorded almost a constant rate of prey killing depicting a *Type I* response. The relative preference of aphids (barley aphid, mustard aphid winter maize aphid) by the three dominant coccinellids *i.e.*, *C. septempunctata*, *C. sexmaculata* and *A. variegata* was evaluated by the choice test. It became evident that *C. septempunctata* preferred to feed on mustard aphid (61.17%) though it did feed the other aphids; *C. sexmaculata* showed an equal preference for both the mustard aphid (52.05%) and the winter maize aphid (57.77%); whereas, *A. variegata* preferred to feed on the barley aphid(81.73%) than the other two aphids the preference was significantly higher.

Key words: Feeding, Coccinellids, Aphid, Prey Preference

INTRODUCTION

Coccinellids exhibits a key role in the suppression of aphid populations in diverse agro–ecosystems; some of their being euryphagous (like *Coccinella undecimpuntata* L.) (Raimando and Alves, 1986; Hodek and Honek, 1996). They accept a wide range of food and the larvae eat the some prey as adults; however, for the completion of larval development to reach adulthood and produce viable progeny they consume their "essential food" (Hodek, 1973). Aphidiphagous coccinellids,though indicate prey preference, often have generalist tendencies to feed on alternate prey species (Hodek and Honek, 1996; Dixon, 2000). Obrycki and Kring (1998), opined that emphasis on biodiversity studies, evaluation, predation specificity, colonization in a new environment and assessment of community level interventions is necessary to maximize the use of coccinellids in bio–control programs. The present investigation was conducted with a view to establish the trophic specificity of the more dominant aphidiphagous coccinellids maize/sorghum– wheat/ barley agro ecosystems.

MATERIALS AND METHODS

The comparative feeding propensity of major aphidiphagous coccinellids was studied under laboratory conditions.

Maintenance of laboratory culture: Adult coccinellids were collected from the untreated crop fields at the Agronomy Farm of the College and a stock culture was maintained in the laboratory under ambient conditions of temperature and humidity. The mean atmospheric temperature ranged from 17.5 to 21.5^{o} C with 40 to 52 percent relative humidity. Mating pairs were kept in glass jars (500 ml capacity) covered with muslin cloth fastened with rubber bands. Adult *Coccinella septempunctata* Linneaus, *Cheilomenes sexmaculata* (Fabricius) and *Adonia variegata* (Goeze) were reared on the barely aphid (unidentified) as prey, collected from the untreated barley fields. The left over aphids and dried shoots were replaced daily with fresh ones to avoid contamination and consequent mortality.

Prey preference and predation potential: With a view to record the prey preference, choice and no choice tests were carried out. The number of aphids consumed was recorded 24 hours after their release and such an observation was continued up to 20 days providing fresh food daily. To determine the predation potential of the three common aphidiphagous coccinellids, *C. septempuntata, C. sexmaculat and A. variegata* were starved for 24 hours before starting the experiment and later caged individually in wire–gauge aluminum cages (20cm×15cm×15cm). For the choice test aphids infesting barley, mustard and winter maize were provided as food. The test was carried out in glass desiccators (15cm mouth diameter) in which 5cm layer of oven sterilized (40°C for 48 hr) sand was put at the base. Using card board pieces three partitions were made within each of the desiccators. Three different aphids as prey for each coccinellid species under study were collected fresh from the field along with infested shoot/twig, counted and placed in the three separate compartments in each of the desiccators. From the stock culture of coccinellids as described above newly emerged adult females were released individually into the desiccators. The entire experiment was replicated five times.

Observations were recorded every day on the number of aphid–prey individuals consumed by the predatory adults. The weight of the adult beetle was taken before and after provision of known quantum of prey every 24 hrs for two days in order to get the biomass equivalent consumed. The populations of prey and predator were maintained daily after each observation. The functional response to the prey was also estimated using the method described by Holling (1959).

$$Ne = \frac{a\ TNo}{1 + a\ Th}$$

Where,

Ne = the number of prey attacked per predator

No = the initial prey density

a = predators rate of successful search

Th = the handling time per prey

T = the length of time the predator and prey are exposed

RESULTS AND DISCUSSION

Functional responses: After analyzing the continuum of feeding patterns the number of prey killed by the three dominant coccinellids differed significantly when plotted against the number of aphid prey provided. The coccinellid, *C. septempunctata* had a marginal increasing rate of prey killing for a gradual increase in the prey numbers from 25 to 100; thereafter, it evinced a constant rate of prey killing; thus a response between *Type II* and *Type III* became evident. The other two coccinellids *i.e.*, *C. sexmaculata* and *A. variegata* recorded almost a constant rate of prey killing depicting a *Type I* response. The reciprocal transformation of the functional response of coccinellids feeding barley aphids had a linear relationship (Table 1).

Table 1. Functional response parameters for coccinellids feeding barley aphid

Prey per cage (No: s) (H_1)	Replications (No: s)	Total Prey Provided	Total prey killed	Average prey killed (Ha)	1/Ha	1/(HT)
C.septempunctata						
25	5	125	114	28.0	0.044	0.04
50	5	250	138	27.6	0.036	0.02
75	5	375	148	29.6	0.034	0.013
100	5	500	150	30.0	0.033	0.01
125	5	625	142	28.4	0.035	0.008
C. sexmaculata						
25	5	125	104	20.8	0.048	0.04
50	5	250	102	20.4	0.049	0.02
75	5	375	112	22.6	0.044	0.013
100	5	500	106	21.2	0.047	0.01
125	5	625	109	21.8	0.046	0.008
A. variegata						
25	5	125	72	14.4	0.069	0.04
50	5	250	75	15.0	0.066	0.02
75	5	375	78	15.6	0.064	0.013
100	5	500	77	15.4	0.064	0.01
125	5	625	76	15.2	0.065	0.008

Table 1(a). Observed coccinellid feeding of barley aphid in one–hour

Coccinellid species	Handling		Aphids		
	Min.	Sec.	Provided	Consumed	Leftover
C. septempunctata	0	50	10	2	08
	0	50	20	2	18
	1	00	30	1	29
C. sexmaculata	2	00	10	2	08
	2	10	20	2	18
	2	30	30	3	27
A. variegata	2	15	10	2	08
	2	48	20	2	18
	2	50	30	3	27

Observations on the feeding behaviour of the 3 coccinellids (*C. septempunctata*, *C. sexmaculata* and *A. variegata*) for a one–hour period indicated that the handling time was the lowest (50 to 60 seconds) for *C. septempunctata*, while it was the highest (2 minutes 15 seconds to 2 minutes 50 seconds) for *A. variegata* [Table 1(a)]. It was also notable that *A. variegata* and *C. sexmaculata* could feed relatively more aphids at higher prey density than *C. septempunctata*; therefore, *A. variegata* consumed more aphids than the other two coccinellids and had a higher inverse value for average prey killed irrespective of the aphid–prey density.

The biomass equivalent of the aphid–prey consumed 24–hours after the experiment, estimated for the coccinellids after deducting the pre–feeding weight from the post–feeding weight, showed that it was the maximum for *C. septempunctata* (27.9 – 25.9 = 2.0mg), having consumed 25 aphids; followed by that for *A. variegata* (6.8 – 5.4 = 1.4mg), having consumed 21 aphids and *C. sexmaculata* (7.6 – 6.2 = 1.4mg) having consumed 19 aphids.

Feeding responses: The three coccinellids collected during the study showed effective predation at low aphid densities and the respective maximum percent feeding of aphids was 91.2 (*C. septempunctata*); 83.2 (*C. sexmaculata*) and 57.6 (*A. variegata*). It was notable that the coccinellids showed a decline in their feeding capacity (expressed as percent feeding) with an increase in prey density (Table 1).

Choice tests: The relative preference of aphids (barley aphid, mustard aphid winter maize aphid) by the three

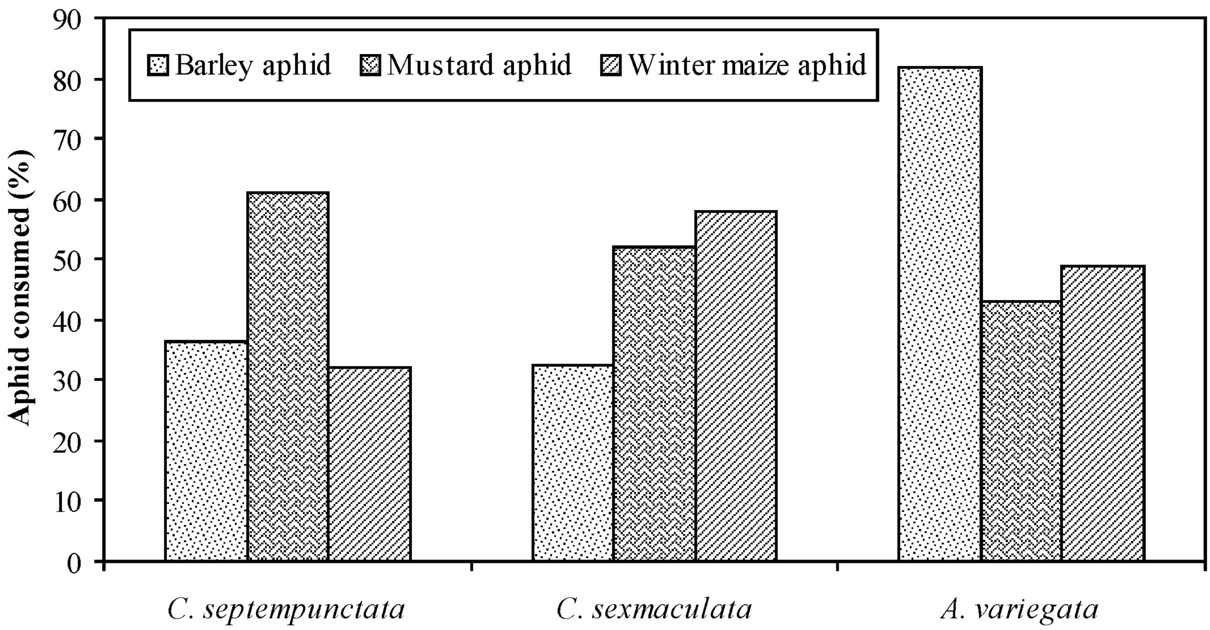

Figure 1. Aphid preference by coccinellids on choice feeding

Table 2. Aphid preference by coccinellids on choice feeding

Coccinellids	Barley aphids			Mustard aphids			Rabi Maize aphids		
	Av. Provided	Av. Consumed	%	Av. Provided	Av. Consumed	%	Av Provided	Av. Consumed	%
C.septempunctata	115	42	36.52	85	52	61.17	50	16	32
C. sexmaculata	105	34	32.38	73	38	52.05	90	52	57.77
A. variegata	115	94	81.73	70	30	42.85	43	21	48.83

dominant coccinellids *i.e*., *C. septempunctata*, *C. sexmaculata* and *A. variegata* was evaluated by the choice test. It became evident that *C. septempunctata* preferred to feed on mustard aphid (61.17%) though it did feed the other aphids; *C. sexmaculata* showed an equal preference for both the mustard aphid (52.05%) and the winter maize aphid (57.77%); whereas, *A. variegata* preferred to feed on the barley aphid (81.73%) than the other two aphids, moreover, the preference was significantly higher (Table 2; Fig. 1).

Recently, Sarmento *et al.* (2007) studied the functional response of adult coccinellid female of *Eriopis connexa* to different densities of *Macrosiphum euphorbiae* and *Tetranychus evansi* and observed that when preying upon aphid, *E. connexa* presented a sigmoidal functional response (Type III); and the behaviour changed drastically to an exponential (Type II) functional response when mites (*T. evansi*) were offered to *E. connexa.*

The present work indicated that these dominant coccinellids evinced effective predation at low aphid densities. They also showed a decline in their feeding capacity with an increase in prey density. In similar situations, Kriz *et al.* (2006) recorded that *Hippodamia parenthesis* Say was encountered more frequently in fields with lower aphid abundances (2002); and *Hippodamia convergens* Guerin–Meneville, *Coccinella septempunctata* L., and *Nabis americoferus* Carayon were encountered more frequently in fields with higher aphid abundances. In 2003, *Coleomegilla maculata* DeGeer was encountered more frequently in fields with higher aphid abundance. The remaining two species of coccinellids and *Chryoperla* spp. did not exhibit significant correlations with aphid abundance in either year. Omkar and Pervez reference to be added.

From the literature it has become increasingly clear that coccinellids accept a wide range of food and the larvae eat the same prey as adults. However, they complete larval development and produce viable progeny only if they consume their ‘essential food’ (Hodek, 1973). In contrast, adults can survive on ‘alternative food’ which may consist almost wholly of spores of the lower cryptogams, pollen grains, and plant aphids and varying but little from one genus to another, as observed by Forbes (1876–1883) in his early studies of coccinellid feeding habits (1876–1883). On the basis of overall performance of *Cheilomenes sexmaculata* (Fab.), Omkar and Bind (2004) recorded the order of suitability of prey species as *A. craccivora* > *A. gossypii* > *R. maidis* > *M. persicae* > *U. compositate* > *L. erysimi* > *A. nerii.* Similarly, Lucas *et al.* (2004) observed that for *Coccinella septempunctata* (L.) and *Hormonia axyridis* (Pallas) the total number of prey killed (total prey species pooled) and the total biomass were significantly higher when both prey (*Aphis pomi* and *Choristoneura rosaceana*) were present than in single prey treatment. The voracity of *C. septempunctata* on *C. rosaceana* larvae was not affected by adding the aphid, *A. pomi*; whereas that of *H. axyridis* declined; the voracity of both predators on *A. pomi* increased when *C. rosaceane* larvae were added. The preference for the aphids over *C. rosaceana* was confirmed for both coccinellid species.

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