



FEEDING POTENTIAL OF DOMINANT COCCINELLID PREDATORS OF THE CORIANDER APHID

D. K. MEENA AND R. SWAMINATHAN

Department of Entomology, Rajasthan College of Agriculture, Udaipur, Rajasthan India – 313 001

Email: udaiswami57@gmail.com

ABSTRACT

The predation efficiency of two coccinellid predators of the coriander aphid, *Hyadaphis coriandri* (Das), was evaluated under ambient conditions of temperature and humidity in laboratory studies at the Department of Entomology, Rajasthan College of Agriculture, MPUAT, Udaipur-313001, during *rabi* 2008-09. Adults of *Coccinella septempunctata* (L.) and *Menochilus sexmaculata* (F.) showed an increasing trend in the average prey consumption per day. The coccinellid, *C. septempunctata* recorded higher percentage feeding at lower aphid densities that gradually reduced with increased aphid-prey density being the highest (91.4%) at an aphid density of 20 and the lowest (36.52%) at an aphid density of 320. However, the other coccinellid, *M. sexmaculata* registered a near-uniform feeding at aphid densities of 20, 40, 80 and 160; whereas, as at the aphid density of 320 the feeding response was the lowest (45.77%). With an increase in the aphid density provided the percentage feeding values dropped down subsequently, which had a more marked difference for *C. septempunctata*, whereas for *M. sexmaculata* the difference was less marked. On the basis of prey biomass equivalent (mg) consumed by both coccinellids, an increasing trend was recorded, which had slightly changed for *C. septempunctata*. The biomass equivalent consumed at different aphid prey densities varied significantly.

Key words: Coccinellids, coriander aphid, *Hyadaphis coriandri*, predation efficiency

INTRODUCTION

Coriander, *Coriandrum sativum* (L) commonly known as “*dhania*” is a winter season seed spice crop that belongs to family Apiaceae. Rajasthan, Madhya Pradesh, Karnataka, Tamil Nadu and Uttar Pradesh are the leading states in the production of this crop. Rajasthan contributes about 70 percent of the total production of coriander in India, cultivated mainly for the dried fruit as well as for the tender leaves. Insect-pests are one of the major limiting factors for higher production of good quality coriander leaves and seeds; among which the coriander aphid, [*Hyadaphis coriandri* (Das.): Aphididae: Hemiptera], has been reported as a regular and major pest in Rajasthan and other parts of the country (Hameed *et al.*, 1975; Jain, 1984, Jain and Yadava, 1988). Aphids cause both quantitative and qualitative loss in the seed yield and deteriorate the green leaves by sucking cell sap; besides secreting honey dew. Due to their rapid multiplication aphids cover the entire surface of apical shoots; resultantly yellowing, curling and subsequent drying of leaves occurs. Aphids cause yield losses up to 50 per cent in fennel and coriander in Rajasthan (Kanwat, 1988 and Lekha, 2002). Coccinellids are potential biocontrol agents for coccids, mites, scale insects as well as aphids. They are the most effective bio-control agents for managing some of the

soft bodied insects to minimize insecticidal applicatais in pest management programmes. Therefore, a study was planned to study the feeding potential of major coccinellid predators of coriander aphid in the Rajasthan.

MATERIALS AND METHODS

The study on feeding potential of aphidophagous coccinellids was carried out in the Department of Entomology, Rajasthan College of Agriculture, Udaipur (Raj.) during *rabi* season 2008-09. Coriander was cultivated at the Horticulture Farm of the College, where the experimental field was ploughed twice with desi plough and leveled with heavy plank 15 days before sowing the crop. Half of the recommended dose of nitrogenous fertilizers (60 kg/ha) and full dose of phosphatic (40 kg/ha) and potassic (25 kg/ha) fertilizers were applied at the time of last ploughing and the rest half of the nitrogenous fertilizer was applied through top dressing at the time of flowering. Before sowing, the seeds were gently crushed into halves by rubbing with hands and were treated with Thiram and Bavistin (1:1 proportion) at 2 g/kg seed. Sowing was done manually maintaining a row to row distance of 30 cm with the seed rate of 10 kg/ha. First irrigation was applied just after sowing; thereafter, the crop was irrigated five times at an interval of 20 – 25 days. Thinning was done 30

days after sowing keeping the plant to plant distance at 10 cm. Likewise and other recommended cultivation practices were followed.

The feeding potential of dominant coccinellids on coriander aphid *H. coriandri* was studied under laboratory conditions at ambient room temperature and relative humidity during February, 2009. Adult coccinellids were field collected from of coriander and reared in the laboratory. Field collected adults and laboratory reared grubs were taken for the experiment. Coriander umbels with aphids were provisioned as food. The coccinellid grubs and adults were starved for 24 hours before starting the feeding experiment and then caged individually with provision of known numbers of the prey. The numbers of aphids consumed were recorded 24 hours after their release and such observations were continued up to 14 days for the adults, while up to 4 days for grubs and were repeated thrice to work out the sequential feeding. The feeding response at different aphid densities was recorded analyzing the data under Completely Randomized Block Design. In all, there were five treatments each replicated 3 times and were 20, 40, 80, 160 and 320 coriander aphids. Known numbers of coriander aphids were provided to the 3rd instar grubs and adult beetles of *Coccinella septempunctata* (Linnaeus) and *Menochilus (=Cheilomenes) sexmaculata* (Fabricius). Later on, when the adults and grubs of both coccinellid species were released, umbels with known number of aphids were transferred to glass jars (1000 ml capacity, 10.5 cm diameter and 15.5 cm height), which were covered with muslin cloth fastened in place with rubber bands. The eat ends of umbels were kept moistener in a swab of cotton. Observations were recorded every 24 hours on the number of prey individuals consumed by the coccinellid grubs and adults after counting the aphids remaining alive in each jar. These observations were continued for fourteen days. The weight of the adult and grub was taken before and after provision of known quantum of prey (food) every day in order to get the biomass equivalent consumed. Fresh aphids as prey were provided daily in each replicate and the numbers of aphids were replenished and maintained as per treatment requirement.

RESULTS AND DISCUSSION

The feeding potential of adults of *C. septempunctata* and *M. sexmaculata* showed an increasing trend in the average prey consumption per day. In case of *C. septempunctata*, when 20 aphids were provided the average number of prey consumed was 18.28; similarly, when 40, 80, 160 and 320 aphids were provided as prey, the consumption was 25.27, 46.81 and 116.85 aphids per day. For the coccinellid *M. sexmaculata*, when 20 aphids were provided, the average prey consumed was 12.81;

whereas, when 40, 80, 160 and 320 aphids were provided as prey, the consumption was 26.35, 44.88, 109.50 and 146.45 aphids per day. Based on the percent feeding per day (Table-1) for the coccinellids *C. septempunctata*, it was observed that at lowest aphid density (20 aphids per day) the percent feeding was highest (91.40) and for *M. sexmaculata* the feeding was more or less uniform (mean 63.61) at aphid densities of 20 to 160 per day. With an increase in the aphid density provided the percent feeding values dropped down subsequently being the lowest (36.52 for *C. septempunctata* and 45.77 for *M. sexmaculata*) at the highest aphid density (320 aphids/day).

On the basis of biomass equivalent (mg) for both coccinellids, an increasing trend was recorded, which had slightly changed for *C. septempunctata*. A gradual increase in the equivalent biomass consumed was recorded for both species. However, little difference in the biomass equivalent could be observed between 20 & 40, and 80 & 160 aphids as prey provisions made for *C. septempunctata*; whereas, it was just the reverse for *M. sexmaculata*. The biomass equivalent consumed at different aphid prey densities varied significantly. (Table-2) The feeding potential of grubs of *C. septempunctata* and *M. sexmaculata* as indicated in Table-3 showed that at low aphid densities (20 & 40 per day) the mean consumption rate was at par; whereas, the mean consumption rate was significantly different at higher aphid densities (80, 160 & 320 aphids per day). It is clear that at higher aphid densities (320 & 160 aphids/day) the daily mean consumption by *C. septempunctata* followed a decreasing trend (Fig. 1); whereas, at lower aphid densities (80, 40 & 20) the mean

Table 1. Aphid feeding response (%) of dominant coccinellids in coriander

S.No.	Aphid prey density	Feeding Response (%)	
		<i>C. septempunctata</i>	<i>M. sexmaculata</i>
1	20	91.40	64.05
2	40	63.68	65.88
3	80	58.51	56.10
4	160	53.87	68.44
5	320	36.52	45.77

Table 2. Biomass equivalent of coriander aphid consumed by adult coccinellids

Aphid prey provided	Biomass Equivalent (mg) over 24 hours	
	<i>C. septempunctata</i>	<i>M. sexmaculata</i>
20	2.03	1.43
40	2.82	2.94
80	5.19	5.01
160	5.57	12.22
320	12.97	16.35

Table 3. Comparative aphid feeding response by grubs of dominant coccinellids

Coriander aphid density	Mean Aphid Consumption (Numbers)*	
	<i>C. septempunctata</i>	<i>M. sexmaculata</i>
20	10.86 ^a	11.97 ^a
40	15.67 ^a	18.63 ^a
80	25.75 ^b	37.16 ^b
160	43.50 ^c	63.19 ^c
320	93.27 ^d	113.33 ^d
S. Em. ±	± 3.099	± 4.268
CD at 5%	9.764	12.9485

* Data presented are mean of three replications

consumption followed a specific pattern showing neither a rising nor a declining trend. Similarly, for the adults of *M. sexmaculata* (Fig. 2) at higher aphid densities (320 aphids/day) the daily mean consumption followed an increasing trend; whereas, at lower aphid densities (160, 80, 40 & 20) the mean consumption rate neither showed an increasing trend nor a decline. The feeding behaviour of grubs clearly indicated that at higher aphid densities (320, 160 and 80) the consumption rate was the maximum for *C. septempunctata* grub; whereas, the consumption rate at lower aphid densities (40 & 20) happened to be almost equal. Similarly, in case of *M.*

sexmaculata at higher aphid densities the consumption rate was the maximum; whereas, the consumption rate at lower aphid densities happened to be almost equal. The functional response of adult coccinellids (*C. septempunctata* & *M. sexmaculata*) showed a gradual increase in the rate of prey consumption at the different prey densities from 20 to 160 aphids per day; thereafter, the increase in aphid consumption rate was marginal. A comparison of the feeding response for the coccinellids *C. septempunctata* and *M. sexmaculata*, expressed as a percentage, indicated a gradual declining trend with the increase in aphid prey densities (Fig. 3). When the inverse values of aphid prey density and coccinellid consumption rates were compared the predator-prey functional response evinced a linear expression (Fig. 4).

Prey-predation is largely density dependent and ladybirds exhibit definite patterns of predation in response to various prey densities. This can be well-explained in terms of functional and numerical responses (Solomon, 1949). The functional response by ladybirds is a key factor regulating the population dynamics of prey-predator systems describing the rate at which a predator kills its prey at different prey densities and can thus determine the efficiency of a predator in regulating prey population (Omkar and Pervez, 2003, 2004). This is further supported by plotting the number of prey consumed against the number of prey available and

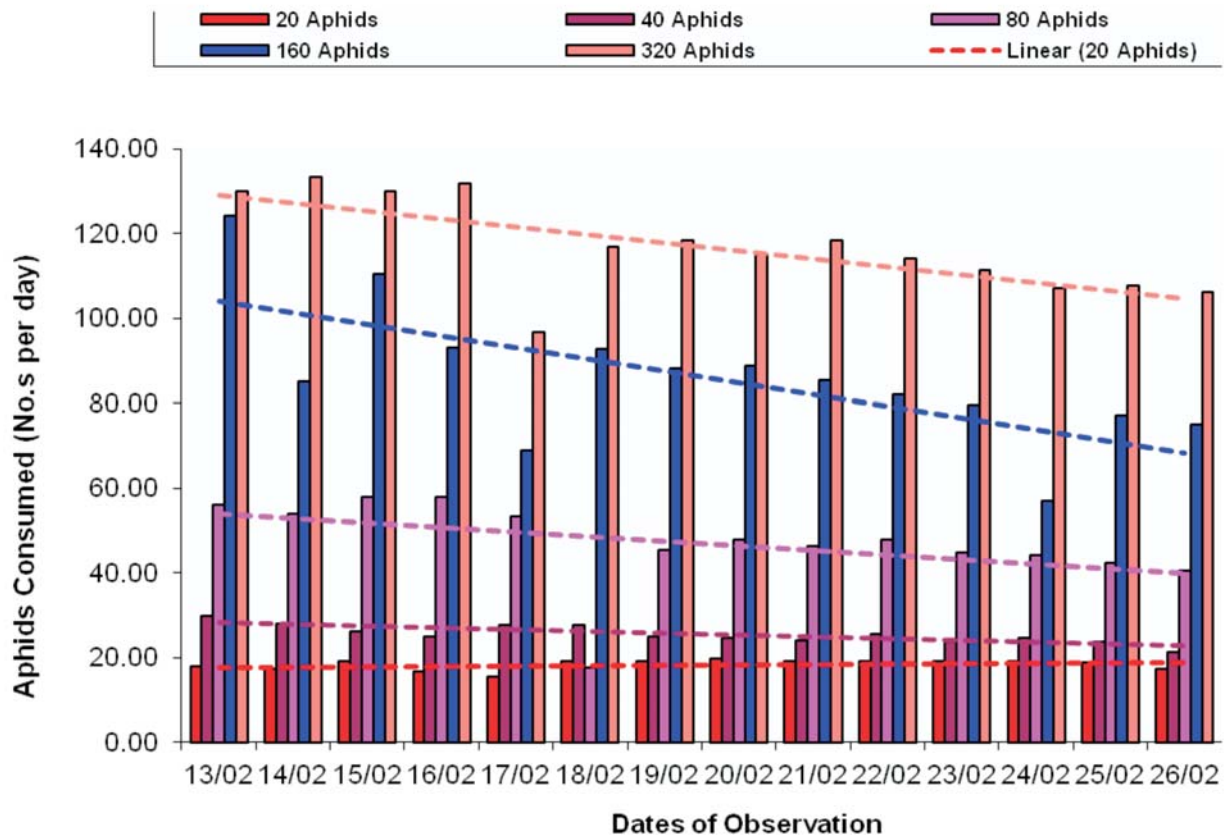


Figure 1. Daily mean prey consumption by adults of *C. septempunctata*

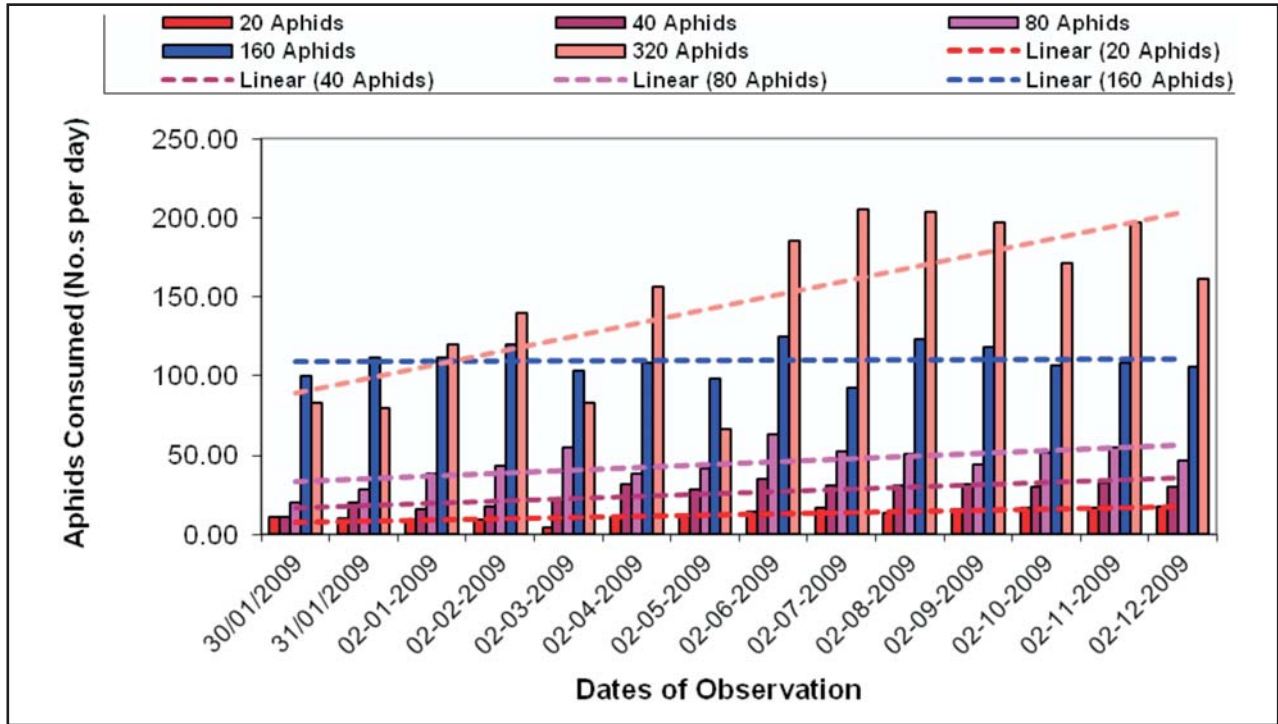


Figure 2. Daily mean prey consumption by adults of *M. sexmaculata*

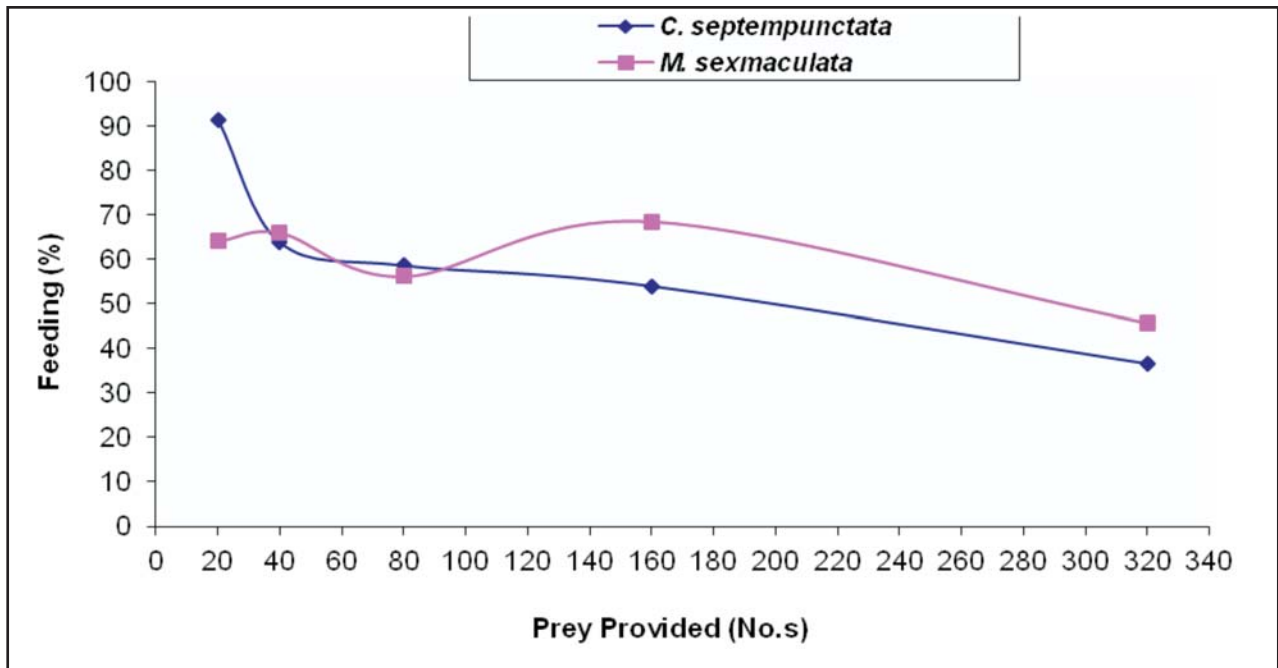


Figure 3. Consumption feeding response on coriander aphid

analyzing a continuum of patterns delimited into three types (Holling, 1959, 1965). These are linear (Type-I), curvilinear (Type II) and sigmoidal (Type III), which could further be simplified in terms of density-dependence. That is, they result in a constant (I) decreasing (II) and increasing (III) rate of prey killing and yield density- dependent, negatively density-dependent and positively density-dependent prey mortality, respectively. In the present study the feeding potential of adult coccinellids showed an increasing

trend in the average prey consumption per day; whereas, for both coccinellids, it was observed that at lower aphid density the percent feeding was highest and at higher aphid densities, the percent feeding values dropped down subsequently. It could be deduced that *M. sexmaculata* is relatively more reliable as a predator of the coriander aphid than *C. septempunctata*. On the basis of biomass equivalent (mg) for both coccinellids an increasing trend was recorded. From the literature it could be noted that ladybirds generally exhibit Type II response operated by

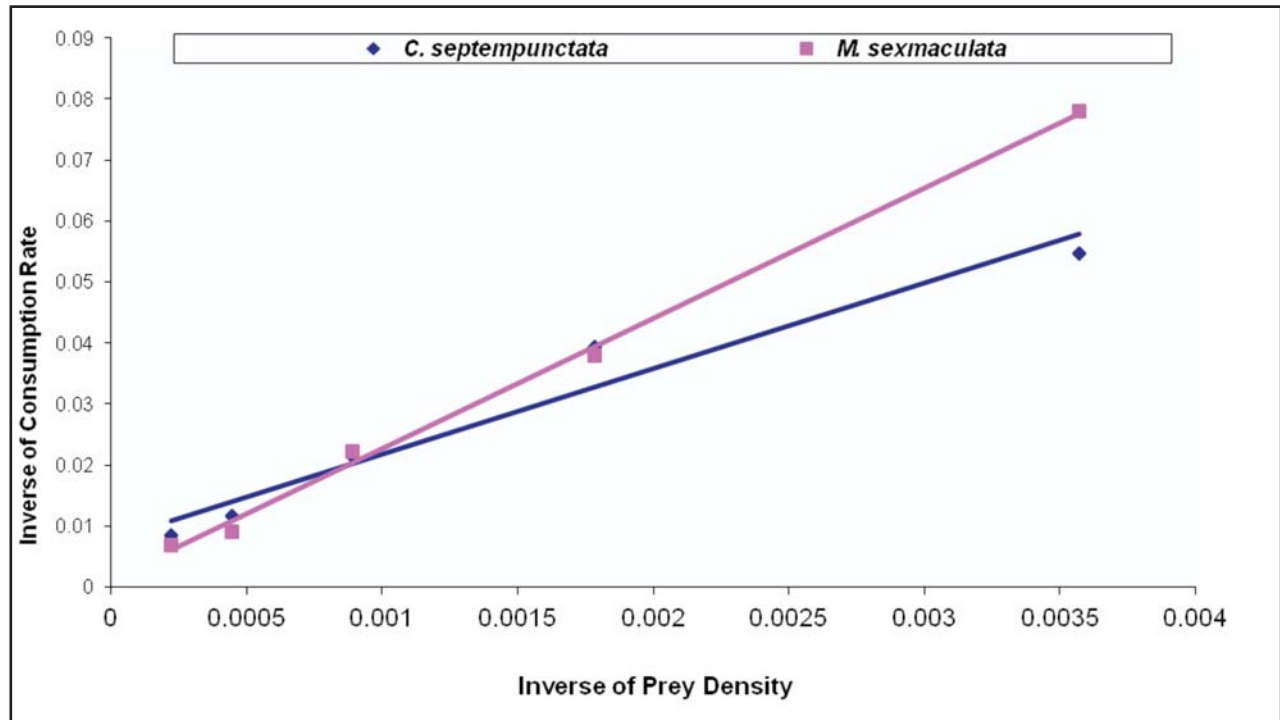


Figure 4. Linear expression to functional response of coccinellids feeding coriander aphid

satiation and handling time (Omkar and James, 2001; Omkar and Srivastava, 2001, 2003a, 2003b; Omkar and Pervez, 2004; Pervez and Omkar, 2003). There are only a few reports of Type I and III responses (Lou, 1987; Hu *et al.*, 1989; Haji-Zadeh *et al.*, 1994). The multi-colored Asian ladybird, *Harmonia axyridis* has been reported to exhibit all the three responses, *i.e.*, Type I on aphid, *Rhopalosiphum prunifoliae* (Lou, 1987); Type II on aphid *L. erysimi*; and Type III on aphid *Cinara sp.* (Hu *et al.* 1989). Interestingly on a single prey species, (eggs of Monarch butterfly, *Danaus plexippus*), third instar and adults of *H. axyridis* exhibited Type II and Type I response, respectively (Koch *et al.* 2003). A single predator thus can respond differentially to various prey as well as prey densities. The Type II functional response in most generalist ladybirds is considered a reason for their unsuccessful releases as bio-control agents of aphids. However, recent research reveals that besides the shape, the magnitude of functional response parameters (*i.e.* coefficient of attack rate and handling time) should also be considered for the prediction of bio-control success in the fields (Pervez and Omkar, unpublished data).

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