Preying Capacity of Different Established Predators of the Aphid *Lipaphis erysimi* (Kalt.) Infesting Rapeseed-Mustard Crop in Laboratory Conditions

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Abstract

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Experiments on the preying capability of different stages of larvae of coccinellid and syrphid flies on the mustard aphid, *Lipaphis erysimi* (Kalt.), were conducted in a laboratory during the winter cropping seasons of 2009–2010 and 2010–2011. Results revealed that grubs of the *Coccinella septempunctata* Linn. preyed the highest number of mustard aphids (average 61.42 aphids/day) followed by *Syrphus confrater* Wied (34.81 aphids/day), *Syrphus balteatus* Deg. (32.26 aphids/day) and *Ischiodon scutellaris* Fab. (27.76 aphids/day) during their larval span. Among the larval stages of the coccinellid and syrphid predators, it was also analysed that the last juvenile stage of the predators was proved the mightiest devourer against the aphid *L. erysimi*. These predators could be used effectively for the management of *L. erysimi* on rapeseed-mustard crop.

Keywords: preying efficiency; coccinellid larvae; syrphid larvae

Rapeseed-mustard (*Brassica juncea* L.) is a very important oilseed crop and constitutes the major source of edible oil in the country. It ranks as the second in area and production among all the oilseed crops only after groundnut. With demand for oilseed running ahead of supplies, the production trends have been unsatisfactory due to the attack of various insect pests. It is prone to the attack of a number of insect pests (Rai 1976). More than three dozen of pests are known to be associated with various phenological stages of rapeseed and mustard crops in India (Bakhetia *et al.* 1989). Among the insect pests attacking rapeseed and mustard, the "mustard aphid", *Lipaphis erysimi* (Kalt.), is a serious insect pest, infesting the crop right from seedling stage to maturity that ravages the crop during the reproductive phase and acts as a limiting factor in the production. Due to sap sucking, leaves become curled and discoloured, spots appear on the foliage, and plants may gradually wilt, turn yellowish or brownish and die. Besides, aphids secrete honeydew which encourages the growth of sooty moulds, giving the stem and leaves black appearance and interfering in the photosynthesis. The losses in yield caused by mustard aphid ranged from 9% to 95% (Singh *et al.* 1980), 35.4% to 72.3% (Bakhetia *et al.* 1986), 24.0% to 96.0% (Phadke 1985), up to 96% (Verma 2000) at different places of India such as Haryana, Delhi, and Kanpur, respectively. The infestation by pests not only results in reduced yield of the seeds but also reduces the oil content up to 66.87% (Singhvi *et al.*1973).

The use of insecticides for controlling this pest causes several adverse side-effects, i.e. toxic effects on non-target species, secondary pest outbreak, residual effects on the food chain, non-biodegradable pollution hazard, and problems of residue hazard to man, animals and environment. These adverse effects of synthetic insecticides can be overcome by the use of biological control agents. Among several bio-agents, syrphid flies (Diptera:

Syrphidae) as *Syrphus confrater* (Weid.), *Syrphus balteatus* (Deg.) and *Ischiodon scutellaris* (Fab.) and lady bird beetle *Coccinella septempunctata* (L.) (Coleoptera: Coccinellidae) are the important entomophagous predators upon many species of aphids that were observed as efficient and mightiest predators of *L. erysimi* in field conditions. The bio-control agents like coccinellids and others have been reported to be effective for controlling the mustard aphid *L. erysimi* (Shukla *et al.* 1990).

Keeping this in mind, the present studies were undertaken in order to make the quantitative estimates of preying capacity of different larval instars of *C. septempunctata*, *S. confrater*, *S. balteatus,* and *I. scutellaris* on the mustard aphid *L. erysimi*, reared on mustard plants under laboratory conditions.

MATERIAL AND METHODS

The predation potential of the larvae of different predators on mustard aphids, *L. erysimi*, was investigated by feeding the grubs with aphids. The experiment was carried out in a completely randomised design and replicated ten times in a laboratory of the Department of Agricultural Entomology, Udai Pratap Autonomous College, Varanasi (U.P.) during the *rabi* cropping seasons of 2009–2010 and 2010–2011.

To evaluate the preying capacity of different predators, pupae were collected in the field in mustard crop in the locality (25°2'N and 83°1'E, 77.12 m a.s.l.) almost in the centre of Indo-Gangetic belt and reared in the laboratory for different larval instars. The stock culture of *S. confrater*, *S. balteatus*, *I. scutellaris*, and *C. septempunctata* was maintained at 22 ± 2°C and relative humidity of 65 ± 5% on the leaves of the mustard plant (variety T-59) in the laboratory. The leaves/twigs of host plants infested with mustard aphids were collected from plants after counting the number of aphids on leaves/twigs. They were placed over a thin layer of moist soil and wet blotting paper in plastic containers so as to keep the leaf turgid.

The newly hatched larvae (1–4 h) of different predators maintained in separate jars were released. After every 24 h period, such aphid infested host leaves or twigs were changed. Preying propensity/efficiency of different predators was evaluated by releasing 100 aphids per larva per day to the 1^{st} and 2^{nd} instar grubs, while it was 150 aphids per individual per day for the 3^{rd} and 4^{th} instar grubs. The counting of preyed aphids was made 24 h after release by counting living individuals. The number of aphids consumed per day during the period of study was recorded in each treatment by counting the number of remaining aphids and subtracting them from the total number of aphids provided. Natural mortality of aphids was also observed in a separate jar containing 100 aphids kept as control. The first instar nymphs and adults of the prey (*L. erysimi*) were not included (due to minute size and delicacy of the first instar nymphs was not accurate in the study so similarity as the aphid reproduces parthenogenetically, hence adults were not included) in feeding efficiency tests and the prey population was maintained after 24 h again. Cleaning and sterilising the Petri dishes were done with 70% ethanol after every 24 hours. The fresh leaves were provided with every change.

The actual number of aphids consumed by predators was calculated by using the following formula and these corrected values were analysed statistically: $X = R - (T - C)$, where: X – actual number of aphids consumed by predator, R – total number of aphids released in Petri dishes, T – number of live aphids in Petri dishes, and C – number of dead aphids in control.

RESULTS

Experimental data on the predation efficiency of larvae of different predators *C. septempunctata*, *S. confrater*, *S. balteatus,* and *I. scutellaris* on the mustard aphid *L. erysimi* are presented in Tables 1–2.

Preying efficiency of *C. septempunctata*

The lady bird beetle, *C. septempunctata*, 1^{st}, 2^{nd}, 3^{rd}, and 4^{th} instar larvae efficiently consumed 21.43, 46.90, 72.61, and 102.60 aphids per day, respectively, during the years 2009–2010 (Table 1). The corresponding consumption values during the years 2010–2011 were 21.80, 49.15, 74.13, and 102.68 aphids per day, respectively (Table 1). The average feeding capability of the larvae during their different instars was observed 60.89–61.94 aphids per day. The total and per day devouring capacity of different instar grubs greatly varied during both years of investigation.

Table 1. Feeding potential of *C. septempunctata*, *S. confrater*, *S. balteatus*, and *I. scutellaris* on *L. erysimi* during the winter cropping seasons of 2009–2010 and 2010–2011 in the laboratory

Nymphal stage	Average number of aphids consumed by different nymphal instars							
	2009–2010				2010–2011			
	range	total	per day	SE ±	range	total	per day	SE ±
C. septempunctata								
1st instar	30–45	42.86	21.43	0.09	30–40	43.60	21.80	0.11
2nd instar	80–100	93.80	46.90	0.27	80–110	98.30	49.15	0.26
3rd instar	125–160	145.22	72.61	0.91	120–160	148.26	74.13	0.94
4th instar	180–210	205.20	102.60	0.64	175–210	205.36	102.68	0.67
Total	415–515	487.08	243.54	1.91	405–520	495.52	247.76	1.98
Mean	103.75–128.75	121.77	60.89	0.48	101.25–130.00	123.88	61.94	0. 50
S. confrater								
1st instar	15–30	23.20	7.73	0.08	15–30	21.10	7.03	0.07
2nd instar	100–150	122.70	40.90	0.33	110–150	125.20	41.73	0.35
3rd instar	150–200	165.80	55.27	0.46	140–200	168.60	56.20	0.48
Total	265–380	311.70	103.90	0.87	265–380	314.90	104.96	0.90
Mean	88.33–126.67	103.90	34.63	0.29	88.33–126.67	104.97	34.99	0.30
S. balteatus								
1st instar	20–30	26.75	8.92	0.09	20–30	24.68	8.23	0.08
2nd instar	50–90	75.49	25.16	0.21	60–90	77.20	25.73	0.31
3rd instar	160–200	183.23	61.08	0.38	280–310	193.25	64.42	0.46
Total	230–320	285.47	95.16	0.68	360–430	295.13	98.38	0.85
Mean	76.67–106.67	95.16	31.72	0.23	120.00–143.33	98.38	32.79	0.28
I. scutellaris								
1st instar	15–30	22.88	7.63	0.10	15–25	20.87	6.96	0.09
2nd instar	90–110	98.10	32.70	0.17	85–120	101.40	33.80	0.36
3rd instar	100–150	124.70	41.57	0.49	110–160	131.65	43.88	0.49
Total	205–290	245.68	81.90	0.76	210–305	253.92	84.64	0.94
Mean	68.33–96.67	81.89	27.30	0.25	70.00–101.67	84.64	28.21	0.31

Preying efficiency of *S. confrater*

The maximum predation was observed by the 3rd instar of the *S. confrater* followed by the 2nd and 1st instar during both years of study. The first instar larvae of *S. confrater* could feed up to 7.73 and 7.03 aphids per day during 2009–2010 and 2010–2011, respectively. Whereas the corresponding values for the second instar larvae were 40.90 and 41.73 aphids per day, respectively. The 3rd instar larvae could devour 55.27 and 56.20 aphids per day during the first and second year of investigation, respectively. The average feeding capability of the larvae during their life span was 34.63 to 34.99 aphids per day. The differences in the aphid consumption by the different instars of *S. confrater* varied greatly during both years of investigation.

Preying efficiency of *S. balteatus*

S. balteatus could consume 8.92, 25.16, and 61.08 aphids per day during their 1st, 2nd, and 3rd instar of the development, respectively, in the 1st year of investigation. The corresponding values for the second year of experiment were observed as 8.23, 25.73, and 64.42 aphids per day, respectively. The average feeding capability of the larvae during their life span was 31.72 to 32.79 aphids per day. Significant differences were also observed in the

Table 2. Feeding potential of the larvae of different predators on *L. erysimi* during the winter cropping seasons of both years (pooled)

Nymphal stage	Average number of aphids consumed by larvae of different Predators							
	C. septempunctata		*S. confrater*		*S. balteatus*		*I. scutellaris*	
	total	per day	total	per day	total	per day	total	per day
1st instar	43.23	21.62	22.15	7.38	25.72	8.57	21.88	7.29
2nd instar	96.05	48.03	123.95	41.32	76.35	25.45	99.75	33.25
3rd instar	146.74	73.37	167.20	55.73	188.24	62.75	128.18	42.73
4th instar	205.28	102.64	–	–	–	–	–	–
Total	491.30	245.66	313.30	104.43	290.31	96.77	249.81	83.27
Mean	122.83	61.42	104.43	34.81	96.77	32.26	83.27	27.76
SE ±	43.23	21.62	0.74	0.25	0.55	0.18	0.63	0.21

C.D. value (P = 0.05): between instars 8.73 and between predators 2.16

preying capacity of different instar grubs of the predators during both years of investigation.

Preying efficiency of *I. scutellaris*

The first instar larvae of *I. scutellaris* could consume 7.63 and 6.96 aphids/day during the first and second year of investigation, respectively. The 2nd instar larvae could devour 32.70 and 33.80 aphids per day during 2009–2010 and 2010–2011, respectively. Similarly the corresponding values for the 3rd instar larvae were observed as 41.57 and 43.88 aphids per day, respectively. The average feeding capability of the larvae during their different instars was 27.30 to 28.21 aphids per day. The total and per day consumption of the aphids by the different instars of this grub was found significant.

Comparative analysis

The average (pooled) data of both the years indicate that the maximum predation (61.42 aphids/day) was recorded for *C. septempunctata* during their larval life span followed by *S. confrater* (34.81 aphids/day), *S. balteatus* (32.26 aphids/day) and *I. scutellaris* (27.76 aphids/day). It was also observed that the last instar larvae of all the tested predators are the voracious feeders upon the *L. erysimi*. A statistically significant difference was observed in the consumption of aphids by the different instars of the predators during both years of investigation. The pooled data shows that in the case of *C. septempunctata*, the 1st, 2nd, 3rd, and 4th instar grubs consumed 21.62, 48.03, 73.37, and 102.64 aphids/day, respectively. *S. confrater* 1st, 2nd, and 3rd instar grubs consumed 7.38, 41.32, and 55.73 aphids/day, respectively, whereas it was 8.57, 25.45, and 62.75 for *S. balteatus* and 7.29, 33.25, and 42.73 for *I. scutellaris*.

Observations revealed that the grubs of all the tested predators became almost always active against the nymphs of *L. erysimi* during the entire period of the study. It was also analysed that the last instar larvae/grubs of the predators were proved the mightiest devourers against *L. erysimi*.

DISCUSSION

These findings are similar to the findings of several earlier researchers who studied the feeding potential of coccinellids on aphids and found large variations (Bunker & Ameta 2009). Coccinellids were found to prey upon all the life stages of prey available within their reach. Among the larval stages, the highest voracity was observed in 4st instar larvae by Bilashini and Singh (2009). The preying potential range between 39.00 and 161.30 aphids/coccinellids/day was observed by Saxena *et al.* (1970). The present investigations are also in conformity with the findings of some other authors like Lekha and Jat (2002), Meena and Bhargava (2002), and Pandey and Khan (2002). The feeding potential of *C. septempunctata* increased with an increase in the age of the larva. Studies by Jindal and Malik (2006) showed that the fourth larval instar of the predator consumed 69.40 and 61.50 aphids per day of *L. erysimi* and

M. persicae, respectively. The two-day-old grub, 2nd, 3rd, 4th instar and adult consumed 14.50, 15.75, 26.50, 51.25 and 40.75 aphids, respectively, within 24 h of release when 100 aphids were provided as food (Soni *et al.* 2008). Under present studies *C. septempunctata* adults consumed 78.26 and 78.96 aphids of *L. erysimi* per day during the 1st and 2nd year of investigation, respectively.

It is known that the last larval instar is the most consumed. Future studies should be proposed in which it would be determined which of the predators has increased cannibalism, as the efficiency was evaluated by placing only a single predator larvae per capsule. The presence of such species cannibalism in the predator efficiency decreases when in natural conditions.

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