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Feeding potential of *Coccinella septempunctata* Linn. on mustard aphid, *Lipaphis erysimi* Kalt.

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ABSTRACT

Mustard is an important *Rabi* season oilseed crop. In India, mustard is one of the most important oil seed crops after groundnut. The oil content in mustard seed ranges from 32 - 40 per cent. On the basis of economic losses, mustard aphid is considered to be a key pest. The exploitation of biocontrol agents is considered as a suitable alternative to the use of chemical pesticides. Coccinellid beetles, among the various predators, play a crucial role in controlling harmful insect pests in the natural environment. A widely distributed species of coccinellid beetle, Coccinella septempunctata, has been found to be highly effective in combating different insect pests. The feeding potential of mustard aphid predator, *C. septempunctata* was studied in ambient conditions by ensuring food supply to them in the form of varying number of aphids, *i.e.*, 50 to I instar, 75 to II instar, 100 to III instar, 125 to IV instar and 150 to adult daily in morning hours (8-10 AM). The observations on number of aphids consumed were recorded after 24 hours of food provided to the predator. A separate jar containing 100 aphids without predator was kept as control. The first instar larva (grub) of *C. septempunctata* consumed 20.30 aphids, second instar 31.10 aphids, third instar 84.20 aphids and fourth instar 119.30 aphids per day ranging from 20 - 28, 25 - 35, 43 - 159, 112 - 133 aphids per day, respectively. The highest number of aphids per day was consumed by fourth instar grub *i.e.*, 119.30 aphids/day. During the total grub period a single grub consumed on an average of 254.90 mustard aphids. The non-starved adult of *C. septempunctata* consumed 94.20 aphids and 24 hours starved adult consumed 110.20 aphids in 24 hours ranging from 90 - 101 and 99 - 118, respectively.

Key words: *Mustard, Oilseed, Mustard aphid, Biocontrol, Coccinellid beetles, Predator*

Introduction

Mustard, *Brassica juncea* (Linn.) Czern and Coss belongs to family Brassicaceae, is an important *Rabi* season oilseed crop. Its fruit is a peculiar kind of capsule called siliqua. In India, mustard is one of the most important oil seed crops after groundnut accounting around 25 per cent of total oilseed production. Mustard seed is a good source of minerals like calcium, phosporous and magnesium. The oil content in mustard seed ranges from 32 - 40 per cent. It also contains adequate amount of two essential fatty acids, linolenic and linoleic. Owing to such a nutritional value mustard occupy an important place in Indian kitchens for culinary purposes, used in medicine's and cosmetic's sector. The mustard oil is also used for making soap and detergent, softening of leather and lubrication purposes. The leaves of

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young plants are used as green vegetable. Mustard cakes appear to be a potential source of protein replacing groundnut and soybean cakes in fish and poultry rations as it has comparatively less anti-nutritional factors. Being a rich source of carbohydrate, it is used to feed cattles. The mustard cake is widely used to enrich soil fertility and reclamation of salt affected soils as it contains 5.2 per cent Nitrogen, 1.8 per cent Phosphorus and 1.2 per cent Potasium.It is widely used to improve soil fertility and restore salt-damaged soils. In India, there are 62.30 lakh hectares of land planted with this crop, yielding 93.39 million tonnes annually with an average yield of 1499 kg ha^{-1}. It covers 25.00 lakh hectares in Rajasthan and produces 41.96 million tonnes annually (Anonymous, 2018-19). In India, it is mostly grown in the states of Rajasthan, Uttar Pradesh, Madhya Pradesh, West Bengal, Haryana and Punjab (Anonymous, 2020).

Insect pests *viz*., aphid, *Lipaphis erysimi* (Kalt.), mustard sawfly, *Athalia lugens proxima* Klug., painted bug, *Bagrada cruciferarum* Kirk., cabbage leaf webber, *Crocidolomia binotalis* Zeller, flea beetle, *Phyllotreta cruciferae* Geoze, diamond back moth, *Plutella xylostella* Linn. and leaf miner, *Phytomyza horticola* Meign are major threat to mustard production(Rai, 1976; Khan, Nagraj and Reddy, 1991; Pradhan, Borkakati and Saikia, 2020). According to Dhaliwal *et al*., (2004), rapeseed-mustard in India generally suffers 30.0 per cent yield loss due to insect pests. Among them mustard aphid, *L. erysimi* was reported to be a regular and major insect pest in Rajasthan and other parts of the country (Rai, 1976; Bakhetia and Sekhon, 1986) caused 9.0 - 95.0 per cent loss in seed yield. Mustard aphid may cause 66.0 per cent to 99.0 per cent loss in *B. campestris* and 27.0 - 28.0 per cent in *B. juncea* (Bakhetia, 1979) with a 15.0 per cent reduction in oil content (Rohilla *et al*., 1987; Verma and Singh, 1987; Singh and Sachan, 1994). Both nymph and adults suck the sap from tender leaves, buds and pods. Curling may occur in infested leaves and at advanced stage, plants may wither and die. Their infestation causes wilting, yellowing and stunting of plants (Khan *et al*., 2015). The plants covered by honeydew excreted by the aphid favour sooty mould growth which affects the photosynthesis process (VB, 2002). The infected field looks sick and blighted in appearance and finally affect the yield of the crop adversely. An avoidable loss of 41.14 percent was registered due to insect pests of Indian mustard (Dotasara *et al*., 2018). On the basis of economic losses, mustard aphid is considered to be a key pest (Bakhetia and Sekhon, 1989).

In order to prevent infestation of *L. erysimi* and to produce a quality crop, it is essential to manage the pest population at appropriate time with suitable control measures. The conventional method of insect management by insecticidal spray is a good way to avoid insect pest damage to crops. But their injudicious and indiscriminate use offers a lot of problems such as environmental pollution, increased cost of production, food poisoning and pest resurgence which does not support sustainable agricultural production. Therefore, it became inevitable to device new insect pest management techniques, as conventional methods of insect management are neither economical nor ecological approach for pest management. The worldwide research support this idea and recommend to adopt alternatives of insecticidal spray for insect pest management. Such potential alternatives include use of bio-control agents, plant products, newer safe insecticide molecules and IPM based strategies which entails all possible means of pest management in an economic and ecological way. The exploitation of biocontrol agents is considered as a suitable alternative to the use of chemical pesticides (Sandhu *et al*., 2012). Among the various biocontrol agents, predators and entomopathogenic fungi being a major component of an integrated approach can provide significant and selective insect control. Coccinellid beetles are the important entomophagous predators against many species of aphids and observed as an efficient and mightiest predator of *L. erysimi* in field conditions (Singh and Singh, 2013). Ladybirds, also known as ladybug beetles, are part of the Coleoptera order and the Coccinellidae family. They are highly effective predators of a variety of insect pests, particularly aphids, scale insects, mealy bugs, thrips, and other soft-bodied insects as well as mites. This family of insects has gained attention as an important group in the biological control of crop-damaging insect pests (BahyEl-Din, 2006). There is ample information available regarding the potential use of ladybirds in biological control (Gospodarek, 2012). The use of ladybirds in biological control has significantly reduced pest populations below the level of economic damage (Hoy and R., 2000). Furthermore, ladybird predators are tolerant to many insecticides, giving them an advantage over other predators (Banken and Stark, 1998). A widely distributed species of coccinellid beetle, *Coccinella septempunctata*, has been found to be highly effective in combating

different insect pests. Coccinellid beetles can be reared in laboratories and can be exploited in insect pests infested field without any ecological drawback. Feeding efficacy of biocontrol agent has a impact on the extent of control that it will provide against a specific pest. However, Coccinellid beetles are voracious feeder of aphid yet, a well planned scientific study regarding their feeding potential is prerequisite to actuaaly assess their role and impact in pest management programmes. Therefore, considering all the pros and cons of available pest management approach, reseach focus is to devise a noble, eco-friendly pest management strategy which would prove ecologically safe, economically feasible and field applicale. Considering these facts the investigation on "feeding potential of *Coccinella septempunctata* Linn. on mustard aphid, *Lipaphis erysimi* Kalt." was proposed and carried out.

Materials and Method

The materials used and methodologies adopted during the course of investigation on "feeding potential of *Coccinella septempunctata* Linn. on mustard aphid, *Lipaphis erysimi* Kalt." as envisaged in the plan of work has been described here under. The experiment was carried out in completely randomized design with six treatments and three replications under controlled environmental conditions.

Details of treatments used

S.No.	Treatments
1.	I instar grub of *C. septempunctata*
2.	II instar grub of *C. septempunctata*
3.	III instar grub of *C. septempunctata*
4.	IV instar grub of *C. septempunctata*
5.	Adult (non-starved) of *C. septempunctata*
6.	Adult (24 hours starved) of *C. septempunctata*

Method of observations

The feeding potential of mustard aphid predator, *C. septempunctata* was studied in ambient conditions. For this different grub instars and beetles of *C. septempunctata* were taken in separate petri dishes, each replicating three times. Each instar was provided with varying number of aphids, *i.e.*, 50 to I instar, 75 to II instar, 100 to III instar, 125 to IV instar and 150 to adult daily in morning hours (8-10 AM). The number of aphids consumed by coccinellid predators was observed daily in morning hours (Choudhary and Kanwat, 2004). The I instar nymphs of aphid were not provided as food to the coccinellid predators. The number of aphids consumed per day by different larval instars, 24 hours starved and non-starved adult coccinellid were worked out to find out the feeding potential and its deviations. The observations on number of aphids consumed were recorded after 24 hours of food provided to the predator. A separate jar containing 100 aphids without predator was kept as control. Since, the numbers of aphids provided as food to the predator were always in excess, the actual number of aphids consumed in 24 hours was calculated by counting the number of remaining aphids and subtracting them from the total number of aphids provided.

The data obtained were converted into the actual number of aphids consumed by predator, by using the formula.

$$X = R - (T + C)$$

Where,

X = Actual number of aphids consumed by predator

R = Total number of aphids released in treatment

T = Number of live aphids in treatment

C = Number of aphids dead in control

Results and Discussion

Result

The observations of feeding potential of ladybird beetle, *C. septempunctata* were recorded under laboratory at ambient room temperature. The average temperature was 23.6 - 31.8 °C maximum and 1.4 - 11.1 °C minimum and relative humidity was 71.0 - 88.0 per cent in morning and 22.0 - 31.0 per cent in evening during the present investigation.

To find out the feeding potential, both larvae (first, second, third and fourth instar) and adults (non-starved and 24 hours starved) of ladybird beetle, *C. septempunctata* were allowed to feed on counted number of mustard aphids per day along with a control to consider natural mortality factor. The feeding potential of different stages of predator varied greatly. The 24 hours starved adult of *C. septempunctata* consumed more aphids (110.20 aphids/ day) than non-starved adult (94.20 aphids/ day).

The first instar larva (grub) of *C. septempunctata* consumed 20.30 aphids, second instar 31.10 aphids,

third instar 84.20 aphids and fourth instar 119.30 aphids per day ranging from 20 - 28, 25 - 35, 43 - 159, 112 - 133 aphids per day, respectively. The highest number of aphids per day was consumed by fourth instar grub *i.e.*, 119.30 aphids/ day. During the total grub period a single grub consumed on an average of 254.90 mustard aphids.

The non-starved adult of *C. septempunctata* consumed 94.20 aphids and 24 hours starved adult consumed 110.20 aphids in 24 hours ranging from 90 - 101 and 99 - 118, respectively.

Discussion

It was revealed that feeding potential of ladybird beetle, *C. septempunctata* increased gradually with the advancement of grub instar. The first, second, third, fourth instar grubs, adult (non-starved) and adult (24 hours starved) consumed on an average 20.30, 31.10, 84.20, 119.30, 94.20 and 110.20 of aphids, respectively. It was evident from the results that 24 hours starved adult of *C. septempunctata* and forth instar grub of *C. septempunctata* consumed more individuals of aphids than non-starved adults. The present findings are corroborating with the result of Singh and Singh (1994) who observed similar feeding behavior. The present results also get support from the findings of (Shenhmar and Brar, 1995) who reported that *C. septempunctata* consumed 380.4 aphids during its larval development. Similarly, (Singh *et al.*, 2011) reported that the grub of *C. septempunctata* consumed 549.11 aphids in its total developmental period. (Varshney, Rachana and Bisht, 2016) reported that *C. septempunctata* feeds 424.4±2.78 aphids during its entire larval period. (Mishra and Kanwat, 2017) observed that the grub of *C. septempunctata* required 610.25 aphids for completion of larval development.

Table. Feeding potential of *Coccinella septempunctata* Linn. on mustard aphid, *Lipaphiserysimi* Kalt. under laboratory conditions during 2020-21

S. No.	Stages of *Coccinella septempunctata*	Mean aphid population consumed in 24 hrs.	Range
1.	Grub (I instar)	20.30 (4.56)	20-28
2.	Grub (II instar)	31.10 (5.62)	25-35
3.	Grub (III instar)	84.20 (9.20)	63-95
4.	Grub (IV instar)	119.30 (10.95)	112-124
5.	Adult (non-starved)	94.20 (9.73)	90-101
6.	Adult (24 hr. starved)	110.20 (10.52)	99-118
	S.Em. ±	0.48	
	CD (P=0.05)	1.51	
	CV%	3.94	

*Figures in parenthesis are square root transformed values

The fourth instar grub of *C. septempunctata* consumed the highest number of mustard aphid, *L. erysimi* (119.30 aphids per day). This finding was supported by the findings of Singh *et al.* (1994) who stated that grub of *C. septempunctata* consumed more aphid than adult beetle. The results also indicated that 24 hours starved adult of *C. septempunctata* (110.20 aphids) consumed more aphids per day than non-starved adult (94.20 aphids). The finding was supported by (Choudhary and Kanwat, 2004) who reported that 24 hours starved adults of *C. septempunctata* consumed more individuals of aphid (64.46 aphids in 24 hours) as compared to non-starved adult (49.20 aphids in 24 hours).

However, the present findings were contrasting with the findings of (Dixon *et al.*, 1997; Gour and Pareek, 2003; Choudhary and Kanwat, 2004; Bunker and Ameta, 2009) who reported that the adult of *C. septempunctata* feed a greater number of aphids per day than its grub.

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Conflict of interest

The authors have declared that no conflict of interest exists.

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