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Research Aticle

Population dynamics and feeding potential of *Cheilomenes sexmaculata* (F.) (Coleoptera: Coccinellidae) on certain citrus insect pests

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ABSTRACT: A study was carried out on the population dynamics and predatory potential of *Cheilomenes sexmaculata* (F.) on various citrus insect pests at National Research Centre for Citrus, Nagpur, during 2006-10. Visual observation of 3-5 minutes/tree during 2006-08 showed that the population of *C. sexmaculata* was significantly higher in February (3.5 / tree) and January (2.8 / tree) than other months. The population of *C. sexmaculata* was significantly negatively correlated with wind velocity. Predatory potential studies revealed that each larva of *C. sexmaculata* consumed a total of 186.1 blackfly (*Aleurocanthus woglumi* Ashby) nymphs; 208.9 psylla (*Diaphosis citri* Kuwayama) nymphs and 252.8 aphids (*Aphis spiraecola* Patch) during 2008; a total of 189.0 blackfly nymphs/ 206.7 *D. citri* nymphs and 242.0 aphids during 2009 and a total of 184.8 A. nymphs/ 198.5 psylla nymphs and 260.2 aphids during 2010. Similarly, each adult of *C. sexmaculata* consumed a total of 540.5 blackfly nymphs; 660.2 psylla nymphs; 720.6 aphids and 210.3 leaf miner (*Phyllocnistis citrella* Stainton) pupae during 2008; a total of 538.3 blackfly nymphs, 651.8 psylla nymphs, 708.4 aphids and 216.1 leaf miner pupae during 2009 and a total of 519.5 blackfly nymphs, 634.1 psylla nymphs, 695.7 aphids and 201.2 leaf miner pupae during 2010. The results showed the preference of *C. sexmaculata* larvae and adults to *A. spiraecola* to other insect pests.

KEY WORDS: *Cheilomenes sexmaculata*, Coccinellidae, predatory potential, citrus insect pests

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INTRODUCTION

In recent years, use of predatory lady bird beetles are recommended for integrated pest management in different crops. In citrus ecosystem, *Cheilomenes sexmaculata* (F.) (Coleoptera: Coccinellidae) is found to be associated with the infestation of citrus blackfly (*Aleurocanthus woglumi* Ashby), psylla (*Diaphorina citri* Kuwayama), leaf miner (*Phyllocnistis citrella* Stainton), aphids (*Aphis spiraecola* Patch), etc. which cause considerable loss of normal growth of plant affecting fruit yield and quality (Rao and Shivankar, 2003). However, the population dynamics and predatory potential of *C. sexmaculata* on major citrus insect pests have not been critically studied. Therefore, systematic studies were undertaken at National Research Centre for Citrus, Nagpur, on the population dynamics and predatory potential of *C. sexmaculata* on various citrus insect pests with an objective of using it as a potent bioagent for the suppression of citrus insect pests.

MATERIALS AND METHODS

Rearing of citrus blackfly, psylla, leaf miner and aphids

Nagpur mandarin (*Citrus reticulata* Blanco) twigs (10-15 cm) infested with blackfly, psylla, leaf miner and aphids were collected from orchards in Nagpur area and the same were released on rough lemon (*Citrus jambhiri* Lust) seedlings with new flush separately in cages. In case of psylla, seedlings of *Murraya koenigii* (L.) were also used for establishing the citrus psylla culture. These seedlings were pruned at staggered intervals so that new flush was available to perpetuate the respective insect pest population round the year.

Rearing of *Cheilomenes sexmaculata*

The eggs and pupae of *C. sexmaculata* were collected from Nagpur mandarin orchards in Nagpur area and kept in a BOD (Programmable Environmental test chamber, Remi Instruments Ltd., Mumbai, India) maintained at 26°± 2°C and 65± 5% RH with a 14:10 light:dark photoperiod for larval and adult emergence, respectively. The emerged first instar larvae and adults were released on rough lemon seedlings infested with blackfly, psylla, leaf miner and aphids reared in cage house. The first instar larvae and adults from the cage house colony were used for experimental purpose.

Population dynamics

Seasonal incidence was recorded at fortnightly intervals during winter and spring flushing seasons in a

15-year-old *C. reticulata*) orchard (Block No. 20) with 64 trees at a spacing of 6mx6m at NRCC Research farm during 2006-07 and 07-08. Four fresh twigs each 15 cm long were observed from each tree. Visual observation on various stages (egg, larva, pupa and adult) of the predator was taken per tree for a fixed period of 3-5 minutes covering all four sides of the tree. Twenty trees were selected randomly in a diagonal manner for taking visual observations. The data were subjected to analysis of variance. The data on weather parameters such as temperature (maximum, minimum), RH, wind velocity, rain fall and sunshine hours during the experimental period were collected from the meteorological observatory of NRCC farm and correlated with the incidence of the predator.

Feeding potential

Tender twigs (15 cm) of rough lemon with nymphs (second and third instars) of blackfly, psylla and aphids were held separately in conical flasks (25 ml capacity) filled with water. Such conical flasks were kept in plastic jars (21 cm x 9.5 cm) covered with muslin cloth. In case of leaf miner, opened pupae were provided to the adult predator in plastic disposable sterilized Petri dishes (13 cm diameter, Tarsons®, India). Five larvae and adults of *C. sexmaculata* were released in each jar, after 24 hours, each jar was examined and the number of unconsumed nymphal stages was counted and removed. A new set of 80-100 nymphs (II and III instars) / pupae of respective insect pest was provided in each jar containing larvae/adults of *C. sexmaculata*. This procedure was continued till the transformation of nymphs to pupae and death of the last adult. Number of nymphs of *A. woglumi, D. citri, A. spiraecola* and pupae of *P. citrella* consumed for completion of development were recorded at 24h interval. The biological parameters like larval period, pupal period and adult period were also recorded.

The study on feeding potential of *C. sexmaculata* was conducted during 2008-10 at 26±2°C temperature and 60±5% relative humidity in the laboratory. The experiments were laid in completely randomized design with 4 replications and the data were subjected to analysis of variance.

RESULTS AND DISCUSSION

The population of *C. sexmaculata* was significantly higher in February II FN (fortnight) (3.66-3.86 / tree) than other months but, was on par with February I FN (3.32/ tree) and January II FN (2.92/ tree) during 2006-07 and with February I FN (3.16/tree) and January I (3.02/tree) and II FN (2.62/ tree) during 2007-08 with respect to visual observations. The data on pooled means also showed that the population of the predator was significantly higher in February II FN followed by February I FN and January I and II FN (Table 1). The population of *C. sexmaculata* was negatively correlated with maximum and minimum temperature, relative humidity (R.H.), wind velocity and rain fall whereas, it was positively correlated with sunshine hours. However, the correlation between *C. sexmaculata* population with relative humidity and wind velocity was significant (Table 2). These results corroborate the earlier reports of Parikh (2001), Patel (2002) and Bhatt (2005) who established negative relation between RH and the coccinellid population on lucerne, isabgol and gallardia, respectively. Further, Tank and Korat (2007) reported the negative influence of R.H. on *C. sexmaculata* population on cotton, cowpea, maize, wheat and pearl millet. Parikh (2001) also reported the negative influence of wind speed on the activity of coccinellid beetles. Probably, relative humidity (71.8-80.3%) that prevailed during January and February 2007 and 2008 favoured the multiplication of *C. sexmaculata* and the average minimum wind velocity (0.4-3.0 kmph) during the same period minimized the adverse effect, if any, on the dispersal of the predator.

Each larva of *C. sexmaculata* consumed a total of 186.1 blackfly nymphs, 208.9 psylla nymphs (Fig. 3) and 252.8 aphid nymphs during 2008; a total of 189.5 blackfly nymphs, 206.7 psyllid nymphs and 242.0 aphid nymphs during 2009; and a total of 184.8 blackfly nymphs, 198.5 psyllid nymphs and 260.2 aphids nymphs during 2010. However, the larvae of *C. sexmaculata* did not feed on leaf miner larvae inside the mine as well as outside.

Similarly, each adult of *C. sexmaculata* consumed a total of 540.5 blackfly nymphs, 660.2 psylla nymphs, 720.6 aphid nymphs (Fig. 4) and 210.3 leaf miner pupae during 2008; a total of 538.3 blackfly nymphs, 651.8 psylla nymphs, 708.4 aphid nymphs and 216.1 leaf miner pupae during 2009 and a total of 519.5 blackfly nymphs, 634.1 psylla nymphs, 695.7 aphid nymphs and 201.2 leaf miner pupae during 2010 (Table 3). The larval period of *C. sexmaculata* was 7.1-7.8 days, 8.2 -8.6 days and 10.8-11.9 days while feeding on nymphs of blackfly, psylla and aphids, respectively. The pupal period was 6.2-6.4 days, 6.5 -6.9 days and 7.5-7.8 days for *C. sexmaculata* larvae fed on nymphs of blackfly, psylla and aphids, respectively. The adult period of *C. sexmaculata* was 25.4-26.8 days, 26.3-27.3 days, 30.6-32.1 days and 21.2-22.7 days while feeding on nymphs of blackfly, psylla, aphids and pupae of leaf miner, respectively (Table 4). The pooled mean data showed that *C. sexmaculata* larvae and adults preferred *A. spiraecola* to other insect pests (Table 3, 4).

Perusal of the literature reveals that *C. sexmaculata* is aphidophagous and the larvae and adults of *C. sexmaculata* have been reported to feed on a host of insects including mealybugs, psyllids, leaf and plant hoppers, tingids, whiteflies, early instar lepidopteran larvae, spiders and mites (www.aphidweb.com, Agarwala and Yasuda, 2000). *C. sexmaculata* larva fed on 350 to 400 nymphs of *Aphis*

Table 1. Population dynamics of *Cheilomenes sexmaculata* during 2006-08

Month	*C. sexmaculata* (cumulative no./15cm twig)		
	2006-07	2007-08	Mean
October I FN	0.34 (0.58)^{f}	0.38 (0.61)^{f}	0.36 (0.60)^{e}
October II FN	0.57 (0.75)^{ef}	0.43 (0.65)^{ef}	0.50 (0.71)^{e}
November I FN	1.05 (1.02)^{de}	1.33 (1.15)^{cd}	1.12 (1.06)^{d}
November II FN	1.38 (1.17)^{d}	1.10 (1.05)^{de}	1.24 (1.11)^{d}
December I FN	2.74 (1.65)^{bc}	2.42 (1.55)^{ab}	2.58 (1.60)^{bc}
December II FN	2.81 (1.67)^{bc}	2.43 (1.56)^{ab}	2.62 (1.62)^{bc}
January I FN	2.80 (1.67)^{bc}	2.62 (1.62)^{ab}	2.71 (1.65)^{abc}
January II FN	2.92 (1.71)^{abc}	3.02 (1.74)^{ab}	2.97 (1.72)^{abc}
February I FN	3.32 (1.82)^{ab}	3.16 (1.77)^{ab}	3.24 (1.80)^{ab}
February II FN	3.86 (1.96)^{a}	3.66 (1.91)^{a}	3.76 (1.94)^{a}
March I FN	2.51 (1.58)^{bc}	2.29 (1.51)^{bc}	2.40 (1.55)^{bc}
March II FN	2.17 (1.47)^{c}	1.99 (1.41)^{bcd}	2.08 (1.44)^{c}
SED+	0.139	0.183	0.154
CD (*P*=0.05)	0.28	0.37	0.31

Figures in parentheses are square root transformed values
I FN: First fortnight, II FN: Second fortnight,
In a column means followed by a common letter do not differ significantly at P <0.05 by Duncan's Multiple Range Test

Table 2. Correlation of weather parameters with the population of *Cheilomenes sexmaculata*

Weather parameter	*C. sexmaculata*		
	2006–07	2007–08	Mean
Max.Temperature	–0.145	–0.221	–0.214
Min.Temperature	–0.549	–0.558	–0.553
Relative Humidity	–0.724*	–0.768*	–0.800*
Wind Velocity	–0.699*	–0.835*	–0.879*
Rainfall	–0.035	–0.492	–0.440
Sunshine hours	0.495	0.427	0.482

*Significant at P <0.05

craccivora Koch during its development while adult fed on 12.5 nymphs/day (Gautam, 1994). Predation of *C. sexmaculata* adults on *P. citrella* pupae was reported by Rao *et al.* (2003). The foregoing results revealed that *C. sexmaculata* larvae and adults preferred *A. spiraecola* which can be taken into account in the multiplication and field release of *C. sexmaculata* which can further help in formulating biological suppression programmes for the management of citrus insect pests.

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Table 4. Larval, pupal and adult period of *Cheilomenes sexmaculata* on different citrus insect pests during 2008-10.

Host insect	*C. sexmaculata*											
	Larval period (days)				Pupal period (days)				Adult period (days)			
	2008	2009	2010	Pooled Mean	2008	2009	2010	Pooled Mean	2008	2009	2010	Pooled Mean
A. woglumi	7.8	7.6	7.1	7.5	6.2	6.4	6.2	6.3	25.4	26.1	26.8	26.1
D. citri	8.3	8.6	8.2	8.4	6.5	6.9	6.7	6.7	26.3	26.9	27.3	26.8
A. spiraecola	11.5	11.9	10.8	11.4	7.8	7.6	7.5	7.6	30.6	31.4	32.1	31.3
P. citrella	–	–	–	–	–	–	–	–	22.7	22.0	21.2	21.9
SED+	1.56	1.88	1.41	–	–	–	–	–	2.26	1.79	1.88	–
CD (*P*=0.05)	3.4	4.1	3.2	–	NS	NS	NS	–	4.8	3.8	4.1	–

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