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Biological suppression of the mealybugs *Planococcus citri* (Risso), *Ferrisia virgata* (Cockerell) and *Nipaecoccus viridis* (Newstead) on pummelo with *Cryptolaemus montrouzieri* Mulsant in India

M. MANI* and A. KRISHNAMOORTHY
Division of Entomology and Nematology, Indian Institute of Horticultural Research, Bangalore - 560 089, Karnataka, India.
E-mail: mmani1949@yahoo.co.in

ABSTRACT: A field study was carried out to determine the efficacy of the Australian ladybird beetle, *Cryptolaemus montrouzieri* Mulsant, in the suppression of three mealybug species, namely, citrus mealybug, *Planococcus citri* (Risso), striped mealybug, *Ferrisia virgata* (Cockerell), and the spherical mealybug, *Nipaecoccus viridis* (Newstead), on pummelo (*Citrus grandis* Swingle). *C. montrouzieri* was released @ 30 larvae / plant in August 2005 in the pummelo orchard. The population of *P. citri* declined from 313.84 / plant in August 2005 to 2.63 / plant in October 2005, that of *F.virgata* from 248.85 to 7.57 / plant and *N. viridis* from 165.48 to 6.85 / plant in the same period. In the present investigation, a mean of 97.74%, 90.17% and 82.37% reduction in the population of *P. citri*, *F. virgata* and *N. viridis*, respectively, was recorded 60 days after *Cryptolaemus* release on pummelo.

KEY WORDS: Biological suppression, *Citrus grandis*, *Cryptolaemus montrouzieri*, *Ferrisia virgata*, ladybird beetle, *Nipaecoccus viridis*, *Planococcus citri*, pummelo

INTRODUCTION

In recent years, mealybugs have become an increasing threat to the cultivation of pummelo *Citrus grandis* (Swingle), causing serious losses in India. Nymphs and adult mealybugs suck the sap from shoot, leaf, bark, stem, flowers and fruits. In addition, the sticky honeydew excreted by the mealybugs serves as a substrate for the growth of sooty mold interfering with photosynthesis. Fruits covered with mealybugs and sooty mould lose their market value. Shrewsbury *et al.* (2004) reported that pesticides were frequently used, often unsuccessfully to control the mealybugs. But the mealybugs are more amenable for control with the use of parasitoids and predators. Severe infestation of citrus mealybug, *Planococcus citri* (Risso), striped mealybug, *Ferrisia virgata* (Cockerell), and the spherical mealybug, *Nipaecoccus viridis* (Newstead), was observed on pummelo in August 2005 at IIHR Farm. Though the performance of the Australian ladybird beetle, *Cryptolaemus montrouzieri* Mulsant, against mealybugs infesting several cultivars of citrus was reported, no work has been carried out the control of mealybugs in pummelo orchards in India and elsewhere. The

* Present address: National Research Centre for Grapes, Pune – 412307, Maharashtra.

present investigation was carried out to document the impact of release of *C. montrouzieri* in the suppression of mealybugs on pummelo.

MATERIALS AND METHODS

Culturing of *Cryptolaemus montrouzieri*

Cryptolaemus montrouzieri was multiplied on mealybug-infested pumpkin fruits (*Cucurbita moschata* Linn.) as described by Chacko *et al.* (1978) at 26.0 ± 2.0°C and 60-70% RH in the laboratory.

Selection of orchard

Mealybug infestation in the current season was the criterion for selecting the orchards to conduct the studies. A pummelo orchard infested with mealybugs at IIHR Farm was selected to release and study the field efficacy of *C. montrouzieri* in the suppression of the mealybugs. In this pummelo orchard, mealybug damage was observed in severe form on leaves, trunk and fruits in August 2005. There were 60 plants of which 34 plants were found infested with the mealybugs in August 2005. Among them, 25 were found infested with *P.citri*, 6 with *F.virgata* and 3 with *N. viridis*.

Field release of *Cryptolaemus montrouzieri*

Since ants are known to interfere with the activity of natural enemies of the mealybugs, they were checked by applying chlorpyriphos 0.05% in the ant holes located in the orchards 15 days prior to the predator release. Application of insecticides on pummelo plants was suspended a fortnight before the releases of *C. montrouzieri* and also during the study period. Five-day-old larvae of *C. montrouzieri* were released @30 larvae / pummelo plant in August 2005.

Sampling and evaluation

Prior and subsequent to the release of the predator, the populations of the mealybugs, *C. montrouzieri* and other natural enemies, if any, were observed at about 15 day intervals on 10 randomly selected infested trees in case of *P. citri* and all the plants infested with *F. virgata* and *N. viridis* since there were only limited pummelo plants infested with *F. virgata* and *N. viridis*. Four shoots of 30cm length were removed from each tree and brought to the laboratory. After counting the live mealybugs (all stages) and predators, the samples were kept on pumpkins in wooden cages to record the emergence of parasitoids and predators. Weather parameters like minimum and maximum temperature, morning and evening relative humidity and rainfall were recorded during the study period to determine their influence, if any, in the suppression of the mealybugs.

RESULTS AND DISCUSSION

The results on the population trend of the citrus mealybug *P.citri* on pummelo are presented in Table1. A mean of 313.84 citrus mealybugs / plant was observed on 5th August 2005. Following the release of *C. montrouzieri*, the mealybug population declined to 180.60 / plant on 20th August 2005. The plants were completely cleared of the mealybugs in the third week of October 2005 (Table 1). In case of *F.virgata*, a mean of 248.85 mealybugs / plant was observed on 3rd August 2005.The population of striped mealybug declined from 248.85 / plant on 3rd August to 1.48/plant on 2nd November 2005. The mean number of spherical mealybugs was 165.48 / plant when the study was initiated on 5th August 2005 and declined to 0.65 / plant on 2nd November 2005.

C. montrouzieri was the only natural enemy found feeding on all the three species of mealybugs throughout the study period. The minimum temperature ranged from18.8 to 19.2°C, maximum temperature from 27.2 to 28.0°C, relative humidity from 69–71% and rainfall from 25 to 63 mm in the study period. Statistical analysis revealed that there was no significant influence of these weather factors on the population of all the mealybug species. Hence the reduction of mealybugs was attributed mainly to predation by *C. montrouzieri*.

In general, *C. montrouzieri* takes 60 days after release to give effective control of mealybugs on different fruit crops. In the present investigation, a mean of 97.74, 90.17and 82.37% reduction in the

Table 1. Population of citrus mealybug *Planococcus citri* and *C. montrouzieri* on pummelo

Date of observation	Population/plant (4 shoots)		% reduction in mealybug population
	Mealybug	*C. montrouzieri*	
05-08-2005	313.84±20.58	0.00 ±0.00	—
20-08-2005	290.40±12.52	10.46±4.19	8.92
05-09-2005	180.60±8.38	12.80±2.86	42.46
19-09-2005	74.60±6.72	8.28±3.84	76.23
04-10-2005	12.40±2.30	4.26±0.75	97.74
19-10-2005	2.64±0.62	0.94±0.82	99.16

S.D. = Standard deviation

Table 2. Population of striped mealybug *Ferrisia virgata* and *C. montrouzieri* on pummelo

Date of observation	Population/plant (4 shoots)		% reduction in mealybug population
	Mealybug	*C. montrouzieri*	
05-08-2005	248.85±20.18	0.0 0±0.00	—
20-08-2005	206.34±15.64	11.45±4.96	17.08
05-09-2005	142.26±9.48	14.90±3.86	42.83
19-09-2005	70.84±5.92	9.38±3.62	71.53
04-10-2005	24.46±1.95	4.84±0.62	90.17
19-10-2005	7.57±1.46	2.58±0.80	96.95
02-11-2005	1.48±0.46	0.48±0.37	99.40

S.D. = Standard deviation

Table 3. Population of citrus mealybug *Planococcus citri* and *C. montrouzieri* on pummelo

Date of observation	Population/plant (4 shoots)		% reduction in mealybug population
	Mealybug	*C. montrouzieri*	
05-08-2005	165.48±20.64	0.0±0.00	—
20-08-2005	124.38±14.64	7.56±4.47	24.83
05-09-2005	88.83±7.26	10.34±3.43	46.31
19-09-2005	58.50±5.38	6.82±2.83	64.64
04-10-2005	29.25±1.85	4.92±1.84	82.37
19-10-2005	6.85±0.76	2.16±0.84	95.86
02-11-2005	0.65±0.36	0.64±0.53	99.60

S.D. = Standard deviation

population of *P.citri*, *F.virgata* and *N. viridis*, respectively, was recorded after 60 days of *Cryptolaemus* release on pummelo (Tables 1, 2 and 3). The control of citrus mealybug was observed with second generation of *Cryptolaemus* grubs (Singh, 1978). Similar results in the control of *F. virgata* on guava (Mani *et al.*, 1990), *Maconellicoccus hirsutus* (Green) on acid lime (Mani and Krishnamoorthy, 1999) and *N. viridis* on acid lime (Mani and Krishnamoorthy, 2002) with *C. montrouzieri* have been reported earlier in India.

C. montrouzieri gave partial to complete control of *P. citri* on citrus in different countries (Mani and Krishnamoorthy, 1997). Outstanding control of *P. citri* on citrus was achieved with the introduction of *C. montrouzieri* in Eastern Australia and South Africa (Wilson, 1960; Greathead, 1971). In the present investigation, a mean of 99.16% control of *P.citri* on pummelo was achieved by *C.montrouzieri* within three months of its release. Similar level of control of striped and spherical mealybugs was also observed in pummelo orchard during our study period.

Not many effective chemicals are available for the control of mealybugs on pummelo. Hence, there is good scope for using the proven natural enemies particularly *C. montrouzieri*, which can be multiplied and supplied by commercial insectaries to the citrus growers to manage *P. citri* and other species of mealybugs. According to Fronteddu *et al.* (1996), the use of bioagents including *C. montrouzieri*, led to a drastic reduction in the use of synthetic insecticides against citrus mealybugs.

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