



## Natural enemy complex associated with insect pests of acid lime, *Citrus aurantifolia*

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**ABSTARCT:** A fixed plot survey was carried out at College of Agriculture, Vijayapura, Karnataka, India during November 2020 to June 2022 to record the natural enemy fauna associated with insect pests of acid lime, *Citrus aurantifolia* Swingle. During the study, a neuropteran predator green lacewing, *Chrysoperla zastrowi sillemi*, three species of coccinellids viz., *Cheilomenes sexmaculata* (F.), *Coccinella transversalis* F. and *Illeis cincta* (F.) and several species of spiders viz., *Carrhotus viduus* (Koch), *Telamonia dimidiata* (Simon), *Thyene imperialis* (Rossi), *Phintelloides* sp. *Phintella* sp. and *Telamonia* sp. were noticed to be associated with insect pests of acid lime. In addition, a braconid parasitoid, *Distatrix papilionis* was found parasitizing the larvae of citrus butterfly in acid lime orchards. The efforts can be made to utilize these identified natural enemies in biological control of insect pests of acid lime.

**Keywords:** Acid lime, natural enemy complex, green lacewings, coccinellids, spiders, *Distatrix papilionis*, parasitization, biological control

### INTRODUCTION

Citrus fruits are third most important fruit crops after mango and banana. Globally, citrus fruits are grown over an area of 11.42 million ha with 179.0 million tonnes of production (Anonymous, 2020). Acid lime, *Citrus aurantiifolia* Swingle is one of the important citrus crops grown extensively in Karnataka. As many as 250 species of insect and mite pests have been reported to infest citrus plants in both the nurseries and orchards and inflicting heavy economic losses (Nayar *et al.*, 1976; Butani, 1979; Shivashankar and Singh, 2005). The natural enemies such as predators, parasitoids and entomopathogenic organisms assume paramount importance in natural and human induced biological control programmes. Although different natural enemies reported in citrus ecosystem (Narayanamma *et al.*, 2004; Deka *et al.*, 2016; Kattebennuru, 2017), comprehensive information regarding the relationship between incidence of insect pests and natural enemies is lacking. Hence present study was carried out to identify the natural enemy complex associated and their relationship with insect pests of acid lime.

### MATERIALS AND METHODS

A fixed plot survey was carried out at College of Agriculture, Vijayapura, Karnataka, India (16°49'39.1620" N 75°43'31.1772" E) to record the natural enemy complex associated with insect pests of acid lime. The population

of different natural enemies were recorded at fortnightly interval starting from November 2020 to June 2022 to assess the seasonal fluctuation in population in relation to pest densities. The observations on incidence of insect pests and different natural enemies were recorded on ten randomly selected plants of three replications in the acid lime orchard. In case of parasitoid, *Distatrix papilionis* (Viereck), the larvae of citrus butterfly *Papilio demoleus* L. were collected from the field at fortnightly interval starting from November 2020 to June 2022. The collected larvae were observed for parasitoid emergence under laboratory condition, later per cent parasitization was worked out.

### Correlation studies

The data on natural enemy population was correlated with insect pest populations that occurred on acid lime plants to know the relationship between same parameters by using SPSS statistical software. The extent of influence of insect pest population on natural enemies was studied by performing multiple linear regression using SPSS statistical software.

### RESULTS AND DISCUSSION

**Coccinellids:** The coccinellids were the major insect predators found in acid lime ecosystem. During the study, three species of coccinellids viz., *Cheilomenes sexmaculata* (F.), *Coccinella transversalis* F. and *Illeis*

**Table 1. Natural enemy complex associated with insect pests of acid lime, *Citrus aurantifolia***

Months		Green lacewings/ plant	Coccinellids/ shoot	Spiders/plant	Parasitization by <i>Distatrix papilionis</i> (%)
November	I FN	0.51	0.65	1.20	32.00
2020	II FN	0.64	0.70	1.30	40.00
December	I FN	0.73	0.60	1.35	33.33
2020	II FN	0.71	0.85	1.30	40.00
January	I FN	0.84	1.20	1.43	33.33
2021	II FN	0.86	1.00	1.50	32.00
February	I FN	0.81	1.10	1.50	35.00
2021	II FN	0.85	0.95	1.58	25.00
March	I FN	0.86	1.10	1.50	13.33
2021	II FN	0.88	1.05	1.55	0.00
April	I FN	0.96	0.90	1.65	0.00
2021	II FN	1.13	1.10	1.68	0.00
May	I FN	0.80	1.00	1.50	0.00
2021	II FN	0.75	1.15	1.40	0.00
June	I FN	0.93	0.90	1.10	0.00
2021	II FN	0.76	0.80	0.98	15.00
July	I FN	0.71	0.80	1.20	20.00
2021	II FN	0.76	0.95	1.08	44.00
August	I FN	0.61	1.00	1.05	40.00
2021	II FN	0.59	1.10	0.95	28.00
September	I FN	0.48	0.85	0.88	30.00
2021	II FN	0.45	0.80	0.85	20.00
October	I FN	0.56	0.65	0.60	33.33
2021	II FN	0.63	0.80	0.75	26.67
November	I FN	0.58	0.75	1.28	30.00
2021	II FN	0.59	0.65	1.13	36.00
December	I FN	0.66	0.65	1.33	44.00
2021	II FN	0.66	0.75	1.35	32.00
January	I FN	0.85	0.90	1.40	28.00
2022	II FN	0.83	0.85	1.45	20.00
February	I FN	0.78	1.15	1.40	25.00
2022	II FN	0.74	1.00	1.33	13.33
March	I FN	0.83	1.30	1.40	20.00
2022	II FN	0.88	1.05	1.38	0.00
April	I FN	0.99	1.00	1.35	0.00
2022	II FN	1.08	1.15	1.40	0.00
May	I FN	0.75	1.00	0.93	0.00
2022	II FN	0.76	1.05	1.05	0.00
June	I FN	0.78	0.80	1.03	13.33
2022	II FN	0.71	0.75	0.90	25.00

**Table 2. Relationship between of population of natural enemies with pest density in acid lime ecosystem**

Insect pests	Green lacewing	Coccinellid Correlation co-efficient	Spiders
Citrus leaf miner	-0.215 <sup>NS</sup>	-0.142 <sup>NS</sup>	0.121 <sup>NS</sup>
Citrus butterfly	-0.581 <sup>**</sup>	-0.565 <sup>**</sup>	-0.197 <sup>NS</sup>
Citrus psyllids	0.540 <sup>**</sup>	0.503 <sup>**</sup>	0.119 <sup>NS</sup>
Blackflies	0.782 <sup>**</sup>	0.456 <sup>**</sup>	0.341 <sup>**</sup>
Mealybug	0.480 <sup>**</sup>	0.429 <sup>**</sup>	0.659 <sup>**</sup>
Aphids	0.774 <sup>**</sup>	0.662 <sup>**</sup>	0.522 <sup>**</sup>
Multiple linear regression equation			
Regression analysis	$Y=0.34+0.06X_1+0.02X_2+0.05X_3+0.02X_4+0.11X_5-0.03X_6$	$Y=0.48+0.03X_1-0.01X_2+0.01X_3+0.04X_4+0.03X_5+0.01X_6$	$Y=0.18+0.04X_1+0.04X_2+0.03X_3+0.03X_4+0.32X_5-0.03X_6$
Coefficient of determination (R <sup>2</sup> )			
	0.852	0.651	0.654

*cincta* (F.) were recorded in acid lime ecosystem. The average population of coccinellids ranged from 0.60 to 1.30 grub and adults per shoot. The maximum population of coccinellids was recorded during first fortnight of March 2022 (1.30) and minimum population was recorded during first fortnight of December 2020 (0.60). The correlation of population of coccinellids with different insect pests found on acid lime crop revealed significantly positive correlation with citrus psyllids (r=0.503\*\*), blackflies (r=0.456\*\*), mealybug (r=0.429\*\*) and aphids (r=0.662\*\*). Whereas, significant negative correlation with larval population of citrus butterfly (r=-0.565\*\*). The multiple linear regression analysis indicated that population of different insect pests influenced the population dynamics of coccinellids to an extent of 65.10 per cent (Table 1).

**Green lacewing, *Chrysoperla zastrowi sillemi***

The average population of green lacewings ranged from 0.45 to 1.13 grubs and adults per plant. The maximum population of green lacewing were recorded during second fortnight of April 2021 (1.13) and minimum population was recorded during first second fortnight of September 2021 (0.45). The correlation studies revealed that green lacewings had significantly positive correlation with citrus psyllids (r=0.540\*\*), blackflies (r=0.782\*\*), mealybug (r=0.480\*\*) and aphids (r=0.774\*\*). Whereas significant negative correlation with larval population of citrus butterfly (r=-0.581\*\*). The multiple linear regression analysis indicated that population of different insect pests influenced the population dynamics of green lacewings to an extent of 85.20 per cent (Table 1).

**Spiders**

The spider fauna were major non-insect predators occurred in acid lime ecosystem. During the study spiders

*viz.*, *Carrhotus viduus* (Koch), *Telamonia dimidiata* (Simon), *Thyene imperialis* (Rossi), *Phintelloides* sp. *Phintella* sp. and *Telamonia* sp. were encountered in the experimental plot. The average population of spiders ranged from 0.60 to 1.68 spiders per plant. The maximum population of spiders noticed during second fortnight of April 2021 (1.68) and minimum population were observed during first fortnight of October 2020 (0.60). The correlation data revealed that spiders had significantly positive correlation with blackflies (r=0.341\*\*), mealybug (r=0.659\*\*) and aphids (r=0.522\*\*). The multiple linear regression analysis indicated that population of different insect pests influenced the population dynamics of spiders to an extent of 65.40 per cent (Table 1).

The present findings on natural enemies recorded in acid lime ecosystem are supported by Deka *et al.*, (2016) and Kattebennuru (2017) where they opined that coccinellids, green lacewings and spiders were the major predatory fauna found in citrus orchards. However, the species of natural enemy found in the current study differs compared to earlier reports.

**Parasitization of citrus butterfly by *D. papilionis* on acid lime**

An endo-larval parasitoid, *D. papilionis* (Braconidae: Hymenoptera) was found to parasitize citrus butterfly, *Papiliodemoleus* L. on acid lime. The parasitization of larval stage of citrus butterfly by *D. papilionis* ranged from 0.00 to 44.00 per cent. The peak per cent parasitization was recorded during second fortnight of July 2021 (44.00) and first fortnight of December 2021 (44.00) which was coincide with peak activity of pest. The overall data indicated 24.87 per cent parasitization of citrus butterfly larvae by *D. papilionis* (Table 1). Similarly, Narayanamma *et al.*, (2004) found maximum rate of parasitization of citrus butterfly by *Apanteles*





**Fig 1. *Coccinella transversalis* F**



**Fig 2. *Cheilomenes sexmaculata* (F.)**



**Fig 3. *Illeis cincta* (F.)**



**Fig. 4. *Carrhotus viduus***



**Fig. 5. *Telamonia dimidiata***



**Fig. 6. *Thyene imperialis***



**Fig. 7. *Phintella* sp.**



**Grubs**



**Pupae**



**Adult**

**Fig. 8. An endo-larval parasitoid, *Distatrix papilionis* on citrus butterfly larvae**

*papilionis* during first fortnight of November to January and rate of parasitism was synchronised with the pest activity. Recently, Bhoje and Charaple (2020) opined that *A. papilionis* can be efficiently used in biological control of citrus butterfly.

The present study through a light on natural enemy complex associated with the insect pests of acid lime. The efforts can be made to encourage the activity of these natural enemies in acid lime ecosystem, at the same time efficiently utilized for biological control of insect pests of acid lime.

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