RESEARCH ARTICLE

Species Complex of Coccinellids on Major Tropical Fruits in Different Agro Climatic Zones of Tamil Nadu state of India

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DOI: 10.18811/ijpen.v7i04.8

Abstract

Studies were undertaken on the occurrence of coccinellids on various hosts of fruit crops in different zones of Tamil Nadu, bio-ecology of *Cryptolaemus montrouzieri* and *Scymnus coccivora*, behavioural response of *C. montrouzieri* to different species of mealybugs, toxicity of insecticides to the grubs and adults of *C. montrouzieri* and field efficacy of *C. montrouzieri* on guava mealybugs. Survey made in various zones of Tamil Nadu revealed that eight species of coccinellids *viz*., *Chielomenes sexmaculatus, S. coccivora, C. montrouzieri, Scymnus nubilus, Scymnus lateomaculatus, Calvia sykesii, Anegleis cardoni* and *Chilochorus melas* were found to feed on different species of mealybugs and aphids. *C. montrouzieri* followed by *S. coccivora* and *C. sexmaculatus* were recorded as predominant predators. Aphids species *viz*., *Aphis gossypii*, *Aphis punicae*, *Toxoptera citricidus*, *T. aurantii* and *T. odinae* and mealybug species *viz*., *Planococcus citri*, *P. lilacinus*, *Ferrisia virgata*, *Rastrococcus iceryoides* and *Maconellicoccus hirsutus* were observed in the surveyed locations. Among the different mealybug and aphid species, *P. citri* and *A. gossypii* were found to be the dominant prey for the coccinellids.

Keywords: Aphid species, Coccinellids, Tropical Fruits.

International Journal of Plant and Environment (2021); **ISSN:** 2454-1117 (Print), 2455-202X (Online)

Introduction

Among the various groups of insect predators, coccinellids are well known for their predation on injurious insects like aphids, scales, mealybugs and phytophagous mites. In recent years, the mealybug *Planococcus citri* have become serious pest on guava (Mani, 1986). In 1990s severe infestation of *P. citri* in guava orchard was found to bring under check by *Cryptolaemus montrouzieri* and *Spalgius epius* (Mani and Krishnamoorthy, 1990). Hence, exploitation of indigenous coccinellids as biocontrol agent of guava mealybugs are worthwhile. The study aimed to know the status of species complex of coccinellids from Tirunelveli district of Tamil Nadu.

Materials and Methods

Survey

An extensive survey was made on the diversity of coccinellids on different fruit crops in different zones of Tamil Nadu. Coccinellids were collected from orchards to catalogue species of coccinellids. The details of the surveyed zones and locations of Tamil Nadu are presented in Fig.1 and Table 1. The surveyed areas include Southern zone, High Rainfall zone, Western zone, North Eastern zone, North Western zone and Cauvery Delta zone.

Sampling

The collection of coccinellid predators and its population assessment were made as one time survey in the selected orchards during 2005 to 2007. The coccinellids were collected by slowly walking around the trees. Direct counts of predators were made for population assessment and expressed as nos/tree, while prey density was expressed as nos/cm of a shoot.

The specimens thus collected were killed and got identified using the catalogue given by Project Directorate of Biological Control, Bangalore. Finally, the dominant species of aphidophagous and coccidophagous coccinellids were identified. Mealybugs and aphid species were identified by following the keys given by Williams and Watson (1988) and Bei-Bienko (1967) respectively.

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How to cite this article: Allwin, L., & Durairaj, C. (2021). Species Complex of Coccinellids on Major Tropical Fruits in Different Agro Climatic Zones of Tamil Nadu state of India. International Journal of Plant and Environment. 7(4), 287-292.

Conflict of interest: None

Submitted: 02/11/2021 **Accepted:** 10/12/2021 **Published:** 31/12/2021

Results

Surveys were made in different zones of Tamil Nadu (Southern, High Rainfall, Western, North Eastern, North Western and Cauvery Delta zone) on the prevalence of coccinellids with their prey on major tropical fruits.

In Tirunelveli district of southern zone, fruit trees such as guava, mango, citrus and pomegranate were surveyed for coccinellids. Guava trees were severely infested with aphid, *Aphis gossypii* and mealybug, *Planococcus lilacinus* with a mean population of 25 to 35 and 31 nos/cm of the shoot respectively. In mango orchards, the mealybug *Rastrococcus iceryiodes* and the aphids *Toxoptera odinae* were found to be dominant with a mean density of 12 to 23 and 12 nos/cm of the shoot respectively, while citrus orchards were infested with *T. citricidus*, *T. aurantii* and *P. citri* with a density of 18, 28 and 3 to 16 nos/cm of the shoot respectively. In pomegranate, the fruits were infested

Table 1: Surveyed locations of Tamil Nadu

Zones and fruit crop surveyed	*Block*		
I. Southern zone - Tirunelveli Dt. Mango, guava, citrus and pomegranate (March 2005)	*Kadayanallur*	*Sivagiri*	*Thenkasi*
	i. Idaikal ii. Velayuthapuram iii. Mangalapuram	i. Puliangudi ii. Vasudevanallur iii. Cinthamani	i. Ayikudi ii. Vallam iii. Illanji
II. High Rainfall Zone - Kanyakumari Dt. Mango, guava, citrus and amla (April 2005)	*Nagerkoil*	*Marthandam*	*Aralvaimozhi*
	i. Parakai ii. North thamaraikulam iii. Putheri	i. Karungal ii.Thickanamkodu iii. Mondaymarket	i. Theroor ii. Vellamadam ii. Navalkadu
III. Western Zone - Coimbatore Dt. Mango, guava, citrus, pomegranate and grapes (March 2006)	*Thondamuthur*	*Kovilpalayam*	*Alandurai*
	i. TNAU ii. Dhinampalayam	i. Vellakinaru ii. Kalapatti iii. Idikarai	i. Mathampatti ii. Nathaekoundan Puthur iii. Alandurai
IV. North Eastern Zone - Vellore Dt. Mango, guava, citrus and pomegranate (April 2006)	*Kalavai*	*Arcot*	*Virinjipuram*
	i. Kalavai college ii. Mulluvadi	i. Navolop farm ii. Christian farm	i. Virinjipuram
V. North Western Zone - SalemDt. Mango, guava and citrus (February 2007)	*Pethanaickanpalayam*	*Thalaivasal*	*Thamampatti*
	i. Thamaiyanur ii. Singipuram iii. Rajapalayam	i. Navakurichi ii. Siruvachur iii. Nathakarai	i. Koodamalai ii. Nankanpatti iii. Sentharapatti
VI. Cauvery Delta Zone - Perambalur Dt. Mango, guava and citrus (January 2007)	*Perembalur*	*Alattur*	*Veppanthattai*
	i. Thirupaiyur ii. Palaiyoor iii. Venbavoor	i. Ankoor ii. Vadakumadevi iii. Elamanoor	i. Thesanai ii. Koneripalayam iii. Alambadi

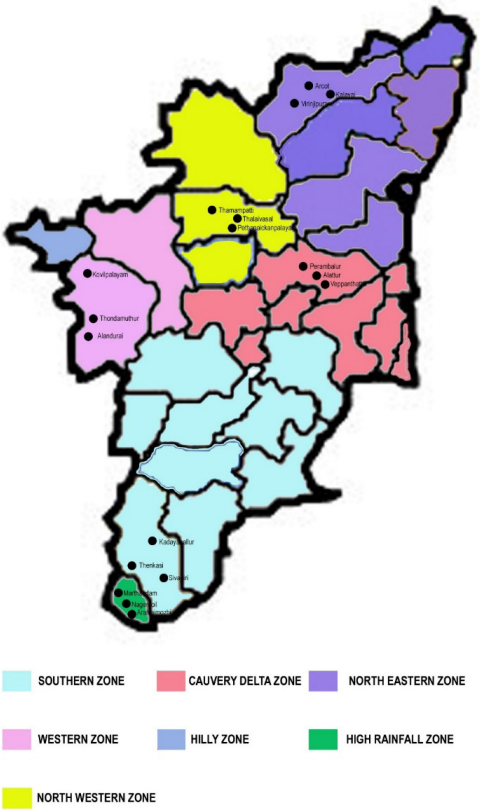

Fig. 1: Tamil Nadu map showing surveyed zones and locations

Fig. 2: Mealybug Infested Fruits Of guavo, mango, pomegranate and grapes

with only *Ferrisia virgata* with a density of 15 to 22 nos/cm of the shoot (Table 2). Some of the mealybug infested fruit crops are depicted in Fig. 2.

Eight species of coccinellids *viz*., *Chielomenes sexmaculatus, Scymnus coccivora, Cryptolaemus montrouzieri, S. nubilus, S. lateomaculatus, Calvia sykesii, Anegleis cardoni* and *Chilochorus melas* were found to feed on different species of mealybugs

Table 2: Status of coccinellids and its prey in various fruit crops of Tamil Nadu

Place	*Tree*	*Prey*	*Prey density* (Nos/cm/shoot)*	*Species*	*Predator density (Nos/tree)*
I. Southern zone - Tirunelveli District (March 2005)					
1. Kadayanallur block					
i. Idaikal	Mango	*Rastrococcus iceryoides*	18.0	Cheilomenes sexmaculatus	4.0
	Guava	*Aphis gossypii*	30.0	C. sexmaculatus	2.0
	Mango	*R. iceryoides*	23.0	Scymnus coccivora	3.0
				C. sexmaculatus	5.0
ii. Velayuthapuram	Citrus	*Toxoptera citricidus*	18.0	Cryptolaemus montrouzieri	13.0
	Pomegranate	Ferrisia virgata	22.0	S. nubilus	2.0
iii. Mangalapuram	Citrus	*Planococcus citri*	3.0	C. sexmaculatus	1.0
2. Sivagiri block					
i. Puliangudi	Citrus	*T. aurantii*	28.0	C. sexmaculatus	2.0
		P. citri	16.0	S. coccivora	7.0
ii. Vasudevanallur	Mango	*R. iceryoides*	12.0	C. montrouzieri	7.0
iii. Cinthamani	Guava	*P. lilacinus*	31.0	S. latemaculatus	8.0
	Pomegranate	*F. virgata*	15.0	C. sexmaculatus	5.0
3. Thenkasi Block					
i. Ayikudi	Guava	*A. gossypii*	25.0	C. montrouzieri	16.0
				S. coccivora	2.0
ii. Vallam	Mango	*T. odinae*	12.0	*Chilocorus melas* Weise	3.0
				C. sexmaculatus	1.0
iii. Illanji	Guava	*A. gossypii*	35.0	S. coccivora	1.0
II. High Rainfall zone - Kanyakumari district (April 2005)					
1. Nagerkoil block					
i. Parakai	Mango	*T. odinae*	13.0	*Anegleis cardoni* (Weise)	6.0
ii. North thamaraikulam	Mango	*T. odinae*	6.0	C. sexmaculatus	8.0
iii. Putheri	Citrus	*T. citricidis*	16.00	C. montrozieri	12.00
2. Marthandam block					
i. Karungal	Amla	*P. citri*	21.0	C. montrouzieri	2.0
ii. Thickanamkodu	Mango	*R. iceryoides*	16.0	C. sexmaculatus	1.0
iii. Monday market	Guava	*P. citri*	27.0	C. montrouzieri	6.0
3. Aralvaimozhi block					
i. Theroor	Guava	Maconellicoccus hirsutus	19.0	C. montrouzieri	2.0
ii. Vellamadam	Mango	*T. odinae*	16.0	S. nubilus	5.0
iii. Navalkadu	Citrus	*T. citricidus*	26.0	*C. melas*	2.0
III. Western zone - Coimbatore District (March 2005)					
1.Thondamuthur Block					
i. TNAU, Coimbatore	Guava	*A. gossypii*	16.0	S. nubilus	2.0
ii. Dhinampalayam	Grapes	*M. hirsutus*	10.0	C. montrouzieri	12.0
	Citrus	*P. citri*	15.0	S. coccivora	1.0
2. Kovilpalayam Block					
i. Vellakinaru	Guava	*A. gossypii*	13.0	S. latemaculatus	1.0
				S. nubilus	2.0
ii. Kalapatti	Pomegranate	*F. virgata*	20.0	C. montrouzieri	8.0
iii. Idikarai	Mango	*T. odinae*	26.0	C. sexmaculatus	7.0

Place	*Tree*	*Prey*	*Prey density* (Nos/cm/shoot)*	*Species*	*Predator density (Nos/tree)*
3. Alandurai block					
i. Mathampatti	Grapes	*M. hirsutus*	15.0	C. montrouzieri	2.0
ii. Nathaekoundan Puthur	Mango	*T. odinae*	11.0	C. sexmaculatus	5.0
				S. nubilus	1.0
iii. Alandurai	Guava	*A. gossypii*	35.0	S. coccivora	2.0
				C. montrozieri	12.0
IV. North Eastern zone - Vellore District (April 2006)					
1.Kalavai block					
i. Kalavai college	Mango	*R. iceryoides*	25.0	C. montrouzieri	6.0
	Citrus	*T. aurantii*	23.0	C. sexmaculatus	2.0
ii. Mulluvadi	Guava	*A. gossypii*	15.0	S. coccivora	3.0
2. Arcot block					
i. Navolop farm	Pomegranate	*A. punicae*	17.0	S. coccivora	3.0
				C. sexmaculatus	5.0
				S. latemaculatus	1.0
ii. Christian farm	Guava	*F. virgata*	25.00	C. sexmaculatus	3.0
3. Virinjipuram block					
i. Virinjipuram	Guava	*A. gossypii*	16.0	C. montrouzieri	8.0
				S. coccivora	2.0
V. North Western zone - Salem District (February 2007)					
1. Pethanaickanpalayam block					
i. Thamaiyanur	Mango	*R. iceryoides*	13.0	C. montrouzieri	2.0
ii. Singipuram	Guava	*P. lilacinus*	23.0	*Calvia sykesii* (Crotch)	5.0
iii. Rajapalayam	Mango	*R. iceryoides*	9.00	*C. melas*	9.00
2. Thalaivasal block					
i. Navakurichi	Citrus	*P. citri*	16.0	*C. sykesii*	6.0
ii. Siruvachur	Mango	*R. iceryoides*	24.0	S. coccivora	4.0
iii. Nathakarai	Mango	*A. gossypii*	32.0	*C. sykesii*	1.0
3. Thamampatti block					
i. Koodamalai	Guava	*A. gossypii*	21.0	*C. sykesii*	1.0
ii. Nankanpatti	Guava	*A. gossypii*	36.0	S. coccivora	3.0
iii. Sentharapatti	Citrus	*P. citri*	11.0	*C. sykesii*	7.0
VI. Cauvery Delta zone - Perambalur district (January 2007)					
1.Perembalur block					
i. Thirupaiyur	Guava	*P. citri*	12.0	C. montrouzieri	9.0
ii. Palaiyoor	Citrus	*P. citri*	7.0	C. montrouzieri	3.0
iii. Venbavoor	Citrus	*P. citri*	17.0	C. sexmaculatus	4.0
2. Alattur block					
i. Ankoor	Mango	*T. odinae*	13.0	C. sexmaculatus	7.0
ii. Vadakumadevi	Guava	*P. citri*	16.0	C. montrouzieri	11.0
iii. Elamanoor	Mango	*F. virgata*	9.0	*C. melas*	3.0
3. Veppanthattai block					
i. Thesanai	Citrus	*P. citri*	32.0	S. coccivora	2.0
ii. Koneripalayam	Citrus	*T. citricidis*	25.0	C. montrouzieri	8.0
iii. Alambadi	Mango	*R. iceryoides*	14.0	C. montrouzieri	4.0

* Mean of five shoots rounded to whole numbers

and aphids. Among them, *C. montrouzieri* density was more (16 nos/tree) while density of *S. nubilus* was found to be the least (2 nos/tree). Among the three blocks surveyed, Kadayanallur block had shown more coccinellid species complex than other blocks (Table 2) (Fig.3).

Kanyakumari district, a high rainfall zone includes the fruit trees mango, citrus, guava and amla. Mango orchards were highly infested with *T. odinae* and *R. iceryoides* with the mean density of 6 to 16 and 16 nos/cm of the shoot respectively, while citrus trees were infested with *T. citricidus* with the density of 16 to 26 nos/cm of the shoot. The other fruit crops such as guava and amla were infested with *P. citri* with the density of 27 and 21 nos/cm of the shoot respectively. The coccinellids *viz*., *Anegleis cardoni, C. sexmaculatus, C. montrouzieri, S. nubilus* and *C. melas* were found to prey on aphids and mealybugs. Among them *C. montrouzieri* was found to be more in citrus orchard of Nagerkoil block with a density of 12 nos/ tree followed by *C. sexmaculatus* in mango orchard (8 nos/tree). *A. cardoni* and *C. melas* were recorded with a density of 6 and 2 nos/tree respectively.

Fig. 3: Coccinellid species of fruit crops of Tamil Nadu

Coimbatore, one of the locations of western zone included grapes, guava, mango, citrus and pomegranate. Grapes were infested with *Maconellicoccus hirsutus* with a mean density of 10 to 15 nos/cm of the shoot and *P. citri* with a density of 15 nos/cm in citrus. The prey density of *T. odinae* in mango ranged from 11 to 26 nos/cm. The incidence of *A. gossypii* (35 nos/cm) was more in guava trees of Alandurai block (Table 2). Among the five species of coccinellids observed in Coimbatore district, complex of *Scymnus* spp. *viz*., *S. coccivora*, *S. lateomaculatus* and *S. nubilus* with less population and *C. montrouzieri* was found in Thondamuthur and Alandurai block with the density of 12 nos/ tree.

In Vellore district of north eastern zone, the surveyed crops include mango, guava, citrus and pomegranate. The prey density of *F. virgata* in guava was 25 nos/cm and *R. iceryoides* in mango was 25 nos/cm of the shoot. In guava, *A. gossypii* population ranged from 15 to 16 nos/cm. Among the four species of coccinellids reported from this district, the prevalence of *S. coccivora* was more (2 to 3 nos/tree) in all the orchards of guava and citrus followed by. *C. sexmaculatus*.

To represent north western zone, Salem district was surveyed. The mango trees were infested with *R. iceryoides* with a density of 9 to 24 nos/cm and *A. gossypii* with 32 nos/cm. Citrus crops were infested by *P. citri* with the density of 11 to 16 nos/cm. Guava tree was infested by *A. gossypii* with the highest population of 36 nos/cm. Among the four species of coccinellids reported in Salem district, *Calvia sykesii* distribution was more with the density of 1 to 7 nos/tree in all the blocks surveyed. But density of *C. melas* (9 nos/ tree) was more in mango of Pethanaickanpalayam block.

In Perambalur district, survey was made in orchards of citrus, guava and mango. The infestation of *P. citri* was more in citrus and guava orchards with the density of 7 to 32 nos/ cm and 12 to 16 nos/cm respectively. Among the coccinellids observed *C. montrouzieri* distribution and density was found to be more in all the blocks (3 to 11 nos/tree) than other coccinellids (Table 2).

Discussion

Among the districts surveyed, Coimbatore, Tirunelveli and Perambalur recorded comparatively more of coccinellid population than other districts. However, the lowest predator population was recorded in Salem district. It is also inferred that *C. montrouzieri* followed by *Scymnus* sp and *C. sexmaculatus* were the dominant species, feeding on aphids and mealybugs of fruit crops (Figs. 4 and 5).

During the survey, eight species of coccinellids were recorded and found to feed on mealybugs and aphids. Among the coccinellids, *C. montrouzieri* followed by *Scymnus coccivora* and *Cheilomenes sexmaculatus* were recorded as predominant species. Among the districts surveyed, Tirunelveli, Kanyakumari and Coimbatore were predominantly infested with aphids *Aphis gossypii* and *Toxoptera odinae* on guava, citrus and mango trees while Vellore, Salem and Perambalur with mealybugs *Rastrococcus iceryoides* and *Planococcus citri*. The infestation of aphids was found mostly on the shoots, leaves and twigs of fruit trees whereas mealybugs were on the fruits also. Hence, the mealybug infestation on fruit trees are considered to be more serious than aphid infestation.

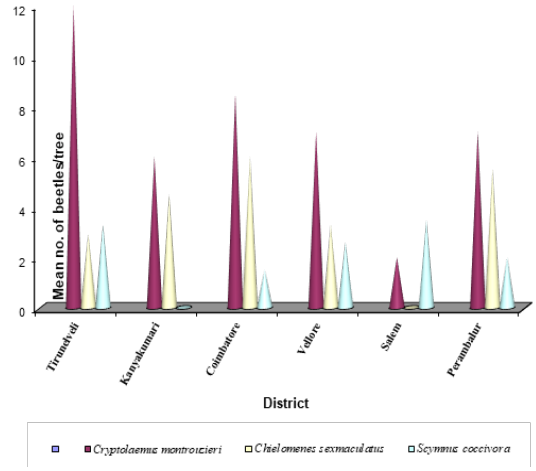

Fig 4: Distribution of potential coccinellid species in different districts of Tamil Nadu

Among the coccinellids, the *C. montrouzieri* population was comparatively more in all the districts except Salem where *S. coccivora* population reported to be more. The perusal of literature indicated that Subramanian (1923) listed coccinellids of South India which included *C. montrouzieri*, *S. coccivora* and *C. sexmaculatus* along with the description of hosts. Puttarudriah and Channabasavanna (1953) got identified a list of 29 beneficial coccinellids from Karnataka which included the predominant coccinellids reported from Tamil Nadu in this present study.

Conclusion

As a whole, *C. montrouzieri*, *S. coccivora* and *C. sexmaculatus* were the dominant coccinellids in fruit crops of Tamil Nadu and the use of these predators may be further exploited in the biocontrol for the management of mealybugs in fruit crops.

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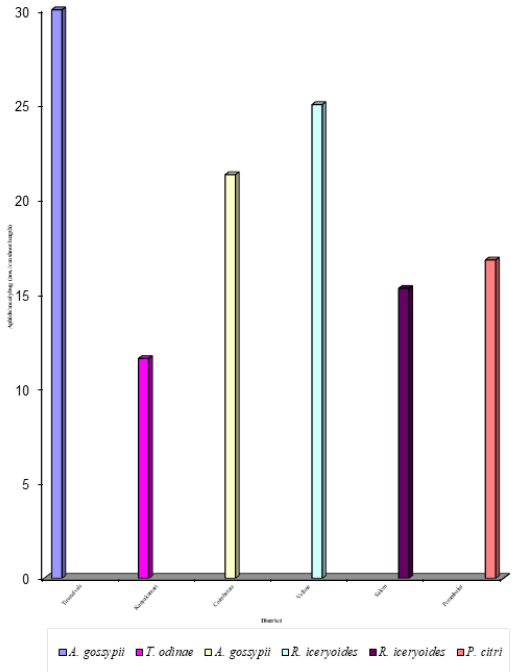

Fig. 5: District wise distribution of aphids and mealybug species

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