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Survey and Records of Mealy Bugs Species on Cotton and Alternate Host of Key Mealy Bug *Phenacoccus solenopsis* Tinsley and its Natural Enemies Complex in Major Cotton Growing Areas of South Tamil Nadu, India

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A B S T R A C T

Survey were conducted to document the mealy bug species, alternate hosts and natural enemies complexes of mealy bug, *Phenacoccus solenopsis* (Psuedococcidae: Hemiptera) in cotton ecosystem of Madurai, Theni, Sivaganga, Virudhunagar and Ramnad Districts of South Tamil Nadu, India. From the frequent survey 5 species of mealy bugs identified on different cotton cultivars. Among the mealy bug species existed in cotton ecosystem *P. solenopsis* scored most important species in cotton. A total of 24 weed species were identified as alternate hosts for *P. solenopsis*. Predators such as coccinellids, Green lace wing *Chrysoperla carnea*, Lepidopteran Predator *Spalgius apius* and parasitoids of Encyrtids and unidentified Eulophid were recorded as natural enemies against *P. solenopsis* in cotton ecosystem of surveyed areas.

Introduction

About 5000 species of mealy bugs have been recorded from 246 families of plants throughout the world. Among these, 56 species have been reported from 15 genera of the family Malvaceae, including cotton and many other plants of economic importance (Ben-Dov, 1994). Mealy bug, *Phenacoccus solenopsis* Tinsley was described originally from the USA (Tinsley, 1898) and prevalent till 1992 (Ben-Dov, 2004). *P. solenopsis* has been recorded from 154 plant species including field crops, vegetables, ornamentals, weeds, bushes and trees. Most of these plants belong to the families Malvaceae, Solanaceae, Asteraceae, Euphorbiaceae, Amaranthaceae and Cucurbitaceae. Fuchs *et al.*, (1991) provided the first report of *P. solenopsis* infesting cultivated cotton in USA. Moreover, mealy bugs were never considered as major pests on cotton in India (APCoAB, 2006). Mealy bugs, *P. solenopsis* caused severe economic damage to *Gossypium* sp and reduced the yield up to 40-50 per cent in several parts of Gujarat (Dhawan, 2008). The unforeseen occurrence of mealy bug *P. solenopsis* in cotton and weed hosts create a new problem in cotton cultivation and pest management. There are very limited information on this pest and associated biotic factors. However, the present investigation

was under taken during 2007 -2009 in major cotton growing areas of South Tamil Nadu, India.

Materials and Methods

Intensive surveys were conducted to collect and record the different species of mealy bugs and Alternate hosts and Natural enemies of Mealy bug, *P. solenopsis* on cotton plants during the year 2007 – 2009 that existed in the cotton ecosystem in Madurai, Theni, Sivaganga, Virudhunagar and Ramnad Districts of Tamil Nadu, India. Population of crawlers and adults of mealy bugs per 5 cm apical shoot was recorded from 10 randomly selected cotton plants in a field and three fields in a place. Per cent infested cotton plants due to mealy bugs (either on leaves, shoots and bolls separately or together) were estimated from 100 randomly selected plants in a field and three fields in a place.

Intensity grading was also estimated based on National Centre for Integrated Pest Management (NCIPM) grade of description of symptom (0 for no mealy bug, 1 for scattered appearance of few mealy bugs in the plant, 2 for severe incidence of mealy bug on any one branch of the plant, 3 for severe incidence of mealy bug on more than one branch or half portion of the plant, and 4 for severe incidence of mealy bug on the whole plant) from 10 randomly selected plants (Anon., 2007).

Collection and Identification of mealy bugs species

Field collected mealy bugs from cotton plants were brought to the laboratory, preserved in 70 per cent ethyl alcohol and mounted on slides (Borror *et al.,* 1992)**.** The specimens were identified by taxonomic keys (Williams and Watson, 1988) and with the repository collection of coccids kept in Department of Agricultural Entomology, Tamil Nadu Agricultural University, Coimbatore.

Collection and identification of alternate hosts

Mealy bug infested weed plants in cotton ecosystem were also collected and their identification was accomplished with the help of weed scientists of the Department of Agronomy, Agricultural College and Research Institute, Madurai.

Collection and identification of natural enemies

Predators

Coccinellid predators collected from mealy bug infested cotton plants were killed using ethyl acetate and preserved. They were identified by using standard taxonomic keys of common species of Coccinellidae (Poorani, 2004) and with the repository collection of Department of Agricultural Entomology, AC&RI, Madurai.

Parasites

The field collected mealy bug species from cotton plants were brought to the laboratory and kept in emergence cages. The parasitoids emerged from the mealy bug colonies samples were properly preserved and sent to the Insect Systematic Laboratory, Department of Entomology, Faculty of Agriculture, Annamalai University, Chidambaram, Tamil Nadu.

Results and Discussion

Mealy bug management is one of the greatest challenges to the farmers due to diversity of species. Careful identification and documentation of the mealy bug species are essential before control practices can be used.

During the survey and surveillance, solenopsis mealy bug, *Phenacoccus solenopsis* Tinsley; two tailed mealy bug, *Ferrisia virgata* Ckll. and Pink Hibiscus mealy bug, *Maconellicoccus hirsutus* Green and Papaya mealy bug, *Paracoccus mariginatus* Williams and Granara de Willink were recorded on cotton cultivars at various locations of Madurai, Theni, Sivaganga, Viruthunagar and Ramnad districts of Tamil Nadu (Table 1). Among the mealy bug species identified *P. solenopsis* was the major species on cotton from the areas surveyed.

In Madurai District, Agricultural College and Research Institute (AC&RI), Madurai, Pannikundu, Thirumangalam and Karumathur locations were surveyed for the incidence of mealy bug species. Table 1 elucidated that *P. solenopsis* was observed in AC&RI Madurai, Pannikundu, Thirumangalam and Karumathur locations on MCU 7, *Bt* bunny and SVPR 2 cultivars with a population range of 27.2 (on MCU 7 in Thirumangalam) to 38.9 (on *Bt* bunny in AC&RI, Madurai) per 5 cm apical shoot. *P. solenopsis* was also noted on MCU 7 with a population of 36.9 per 5 cm apical shoot in AC&RI, Madurai, and SVPR 2 in Pannikundu (31.8 per 5 cm apical shoot) and Karumathur (36.3 per 5 cm apical shoot). *F. virgata* was recorded on *Bt* bunny in AC&RI, Madurai (35.4 per 5 cm apical shoot) and on SVPR 2 in Karumathur (29.3 per 5 cm apical shoot). *M. hirsutus* was seen only on SVPR 2 (37.3 per 5 cm apical shoot) in Pannikundu areas.

Infestation due to *P. solenopsis* varied from 67.5 to 77.5 per cent on all the three varieties in all the four locations in Madurai District. Maximum infestation was observed on MCU 7 in Thirumangalam followed by SVPR 2 (73.5%) in Karumathur, and *Bt* bunny (72.3%) and MCU 7 (69.5%) in AC&RI, Madurai. However, *P. solenopsis* registered minimum infestation on SVPR 2 in Pannikundu. Infestation due to *F. virgata* was maximum on SVPR 2 (76.3%) in Karumathur and on *Bt* bunny (72.3%) in AC&RI, Madurai. But, *M. hirsutus* registered only 54.6 per cent infestation on SVPR 2 in Pannikundu.

Intensity grade of *P. solenopsis* arrayed from 2.8 to 3.7 on cotton cultivars in Madurai District. This was maximum on *Bt* bunny in AC&RI and on SVPR 2 in Karumathur. The grade was 3.6 and 3.3 on MCU 7 in Thirumangalam and AC&RI respectively. However, the grade was minimum on SVPR 2 in Pannikundu. *F. virgata* registered maximum grade of 3.6 on *Bt* bunny in AC&RI, and 3.4 on SVPR 2 in Karumathur. SVPR 2 in Pannikundu however registered lowest intensity grade of 2.0. In Theni District, the surveyed locations were Agricultural Research Station Vaigai Dam and Jayamangalam. *P. solenopsis* alone was recorded in both surveyed areas. The population of *P. solenopsis* varied from 35.6 to 27.9 per 5 cm shoot. The population was maximum on MCU 7 and minimum on Supriya in ARS Vaigai Dam. However, the population was 33.3 per 5 cm shoot on Supriya in Jayamangalam village. A range of 23.5 to 52.0 per cent *P. solenopsis* infestation was observed. Maximum infestation was recorded on Supriya in Jayamangalam followed by on MCU 7 (45.7%) in ARS Vaigai Dam. However, Supriya in ARS Vaigai Dam registered minimum infestation. The intensity grade was 2.3 on MCU 7 (ARS Vaigai Dam) and Supriya (Jayamangalam). It was 1.8 on Supriya in ARS Vaigai Dam.

In Sivaganga District, survey was conducted only in Illayankudi, where in *P. solenopsis* alone and not any other mealy bug species was observed. In Illayankudi, population was higher (40.2/ 5 cm shoot), infestation was maximum (76.5%) and the intensity grade was also more (3.6).

Table.1 Survey and surveillance of mealy bug species on cotton

Locations	Variety/ Hybrid	Observed mealy bug spp.	No of mealy bugs per 5 cm apical shoot *	Infested plants (%) **	Intensity grade ***
1. Madurai					
AC&RI	MCU 7	*Phenacoccus solenopsis* Tinsley	36.9	69.5	3.3
	Bt Bunny	*P. solenopsis*	38.9	72.3	3.7
		Ferrisia virgata Ckll.	35.4	72.3	3.6
Thirumangalam	MCU 7	*P. solenopsis*	27.2	77.5	3.6
Pannikundu	SVPR 2	*P. solenopsis*	31.8	67.5	2.8
		Maconellicoccus hirsutus Green	37.3	54.6	2.0
Karumathur	SVPR 2	*P. solenopsis*	36.3	73.5	3.7
		F. virgata	29.3	76.3	3.4
2. Theni					
ARS (Vaigai Dam)	Supriya	*P. solenopsis*	27.9	23.5	1.8
	MCU 7	*P. solenopsis*	35.6	45.7	2.3
Jayamangalam	Supriya	*P. solenopsis*	33.3	52.0	2.3
3. Sivaganga					
Illayankudi	SVPR 2	*Paracoccus mariginatus* Williams	40.2	76.5	3.6
4. Virudhunagar					
Aruppukottai	LRA 5166	*P. solenopsis*	30.8	40.5	2.1
Thadampatti	MCU 7	*P. solenopsis*	28.6	57.5	2.6
Kattangudi	MCU 7	*P. solenopsis*	32.8	45.0	2.2
Yerampatti	SVPR 2	*P. solenopsis*	33.4	68.5	2.5
P. N. Pudhupatti	SVPR 2	*P. solenopsis*	28.4	42.5	2.0
Kallikudi	SVPR 2	*P. solenopsis*	30.9	61.5	3.0
ARS Srivilliputhur	SVPR 2	*P. solenopsis*	28.9	70.5	3.3
5. Ramnad					
Saligramum	MCU 7	*P. solenopsis*	43.1	82.0	3.8

* Mean no of mealy bugs/10 plants

** Mean per cent values of 100 plants of surveyed field

Table.2 Alternate host of mealy bug *P. solenopsis* in cotton ecosystem

S. No.	Scientific Name of the Weeds	English/Vernacular Name	Family
1.	*Abutilon indicum* L.	Kakai, Thutthi	Malvaceae
2.	*Parthenium hysterophorus* L.	Whitetop Weed, Congress grass, Feverfew	Asteraceae
3.	*Trianthema protulacastrum*.L.	horse purslane	Aizoaceae
4.	*Pavonia zeylanica* (L.) Cav.	Senegal	Malvaceae
5.	*Acalypha indica* L.	Kuppi, Kuppaimeni	Euphorbiaceae
6.	*Cleome viscosa* L.	Asian spider flower	Capparaceae
7.	*Tridax procumbens* L.	Coat Buttons	Asteraceae
8.	*Euphorbia hirta,*	Asthma Weed	Euphorbiaceae
9.	*Achyranthes aspera* L.	Latjeera, Prikly Chaff flower	Amaranthaceae
10.	*Boerhaavia diffusa* L.	Tar vine, Punarnava	Nyctaginaceae
11.	*Corchorus trilocularis* L.	Wild Jute	Tiliaceae
12.	*Commelina benghalensis* L.	Benghal dayflower, Tropical Spiderwort	Commelinaceae
13.	*Phyllanthus amarus* Webster	Niruri, Kizha Nelli	Phyllanthaceae
14.	*Phyllanthus maderaspatensis* L.	Stonebreaker, Keela Nelli	Phyllanthaceae
15.	*Vernonia cinerea* (L.) Less.	Little Ironweed, Ash-Coloured Fleabane, Goat-Weed	Asteraceae
16.	*Portulaca oleracea* L.	Purslane little, hogweed	Portulacaceae
17.	*Sida spinosa* L.	Prickly Fanpetals	Malvaceae
18.	*Digera arvensis* Forsk	Diagra, Tandla	Amaranthaceae
19.	*Eclipta prostrata* L.	False Daisy, karisalankanni	Asteraceae
20.	*Euphorbia geniculata* L.	Mexican fireplant	Euphorbiaceae
21.	*Corchorus capsularis* L.	Tossa jute	Tiliaceae
22.	*Cyanotis axillaris* Roem and Sch.	Spreading dayflower, Neer-pulli	Commelinaceae
23.	*Cyanotis cuculata* Kunth		Commelinaceae
24.	*Ageratum conyzoides* L.	Ageratum	Asteraceae
25.	*Cynodon dactylon* Pres.	Bermuda Grass, Ghass	Gramineae
26.	*Cyperus rotundus* Linn.	Sedge grass, Nut rass, Korai,	Cyperaceae

In Virudhunagar District, survey was conducted in six places like Aruppukottai, Thadampatti, Kattangudi, Yerampatti, P. N. Pudhupatti, Kallikudi and ARS Srivilliputhur. In all the surveyed cotton cultivars (LRA 5166, MCU 7 and SVPR 2) of Virudhunagar District, only *P. solenopsis* was recorded and not any other mealy bug species.

The population varied from 28.4 to 33.4 per 5 cm shoot. Maximum population was observed on SVPR 2 in Yerampatti followed by on MCU 7 (32.8/5 cm shoot) in Kattangudi, on SVPR 2 (30.9/5 cm shoot) in Kallikudi and on LRA 5166 (30.8/5 cm shoot) in Aruppukottai. Minimum population of 28.9 per 5 cm shoot was seen on SVPR 2 in ARS Srivilliputhur followed on MCU 7 (28.6/5 cm shoot) in Thadampatti and on SVPR 2 (28.4/5 cm shoot) in P.N. Pudhupatti.

Infestation of *P. solenopsis* in Virudhunagar District arrayed from 40.5 to 70.5 per cent. Maximum infestation was noticed on SVPR 2 in ARS Srivilliputhur followed by on the same cultivar in Yerampatti (68.5%) and Kallikudi (61.5%); and on MCU 7 (57.5%) in Thadampatti. Minimum infestation however was observed on LRA 5166 in Aruppukottai. This was followed by on SVPR 2 (42.5%) in P.N. Pudhupatti and on MCU 7 (45.0%) in Kattangudi (Table 1).

A range of 2.0 to 3.2 intensity grade was recorded due to *P. solenopsis*. Cultivar SVPR 2 registered intensity grade of 2.0, 2.5, 3.0 and 3.3 in P.N. Pudhupatti, Yerampatti, Kallikudi and ARS Srivilliputhur respectively. Lesser intensity grade of 2.2 and 2.6 was noticed on MCU 7 in Kattangudi and Thadampatti. Minimum grade of 2.1 was recorded on LRA 5166 in Aruppukottai.

In Ramnad District, MCU 7 cotton fields of Saligramum were surveyed for the mealy bug species. Only *P. solenopsis* was noticed. Population of 43.1 per 5 cm shoot, infestation of 82.0 per cent and intensity grade of 3.8 were observed (Table 1b.)

Present records are in accordance with earlier findings of Kaur *et al.,* (2008) who reported that in general, *P. solenopsis* is a common mealy bug species on cotton throughout India. The results of present survey confirmatory of the results of Suresh (2008) who also reported the occurrence of *P. solenopsis, M. hirsutus, F. virgata* and Malvastrum mealy bug, *Ferrisia malvastra* (Mc Daniel) in India and Tamil Nadu on various plants. Sporadic occurrence of *M. hirsutus* on cotton in Central Gujarat was also reported by Jhala and Bharpoda (2008).

Alternate hosts of mealy bug, *P. solenopsis* in cotton ecosystem

Mealy bug, *Phenacoccus solenopsis* was recorded on 26 weed plant species such as *Abutilon indicum* L., *Parthenium hysterophorus* L., *Trianthema protulacastrum.* L., *Pavonia zeylanica* (L.) Cav., *Acalypha indica* L. *Cleome viscosa* L., *Tridax procumbens* L., *Euphorbia hirta, Achyranthes aspera* L., *Boerhaavia diffusa* L., *Corchorus trilocularis* L., *Commelina benghalensis* L., *Phyllanthus amarus* Webster, *Phyllanthus maderaspatensis* L, *Vernonia cinerea* (L.) Less, *Portulaca oleracea* L, *Sida spinosa* L., *Digeria arvensis* Forsk, *Eclipta prostrata* L., *Euphorbia geniculata* L, *Corchorus capsularis* L., *Cyanotis axillaris* Roem & Sch., *Cyanotis cuculata* Kunth, *Ageratum conyzoides* L., *Cynodon dactylon* Pres. and *Cyperus rotundus* Linn., in cotton ecosystem. However, major occurrence of *P. solenopsis* was seen on *Trianthema protulacastrum, T. monogena* and *Parthenium hysterophorus* in all the surveyed locations. Nagrare *et al.,* (2009) also observed the multiplication of *P. solenopsis* on the weed, *P. hysterophorus*

growing on field bunds, water channels and wastelands and their movement on to the cotton plants during the cropping season. Arif *et al.,* (2009) recorded *P. solenopsis* from 154 plant species including field crops, vegetables, ornamentals, weeds, bushes and trees. Probably proper weed management and field sanitation practices may reduce the mealy bug occurrence and further flareup (Table 2).

Natural Enemies of cotton mealy bug *P. solenopsis*

Predators

From the survey following predators also recorded on *P. solenopsis* infested cotton ecosystem such as Coccinellids: *Scymnus coccivora* Ayyar, *Cryptolaemus montrouzieri* (Mulsant), *Cheilomenes sexmaculata* (Fabricius), *Brumoides suturalis* (Fabricius), *Coccinella transversalis* F., *Coccinella septempunctata* Linnaeus, *Harmonia* spp; Chrysopids: *Chrysoperla carnea* (Stephens) and Lepidopteran: *Spalgius epius* (Westwood). Population of coccinellids was maximum followed when compared to the chrysopids.

Parasitoids

During the survey period six different hymenopteran parasitoids *viz*., *Aenasius bambawalei* Hayat, *Promuscidea unfasciativentris* Girault, *Anagyrus kamali* Moursi, *Prochiloneurus* spp., *Leptomastix nigrocoxalis* Compere and one Eulophid were identified from the cotton mealy bug *P. Solenopsis*. The occurrence of these parasitoids had earlier been reported on various mealy bugs species (Sinha *et al.,* 1985 and Hayat, 1986). Recently these parasitoids had also been recorded from coccids on *Hibiscus rosasinensis* in Maharastra (Sureshan and Narendran, 2005).

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