Karnataka J. Agric. Sci., 23(1) : (6-9) 2010

Invasive mealybugs of Tamil Nadu and their management

S. SURESH, R. JOTHIMANI, P. SIVASUBRMANIAN, P. KARUPPUCHAMY, R. SAMIYAPPAN AND E. I JONATHAN

Tamil Nadu Agricultural University, Coimbatore, India

Abstract: *Solenopsis mealybug, Phenacoccus solenopsis* Tinsley and papaya mealybug, Paracoccus marginatus Williams and Granara de Willink were recorded for the first time in India and considered to be invasive pests. Studies were made on the biology, seasonal incidence, alternate host plants and integrated management practices were developed for the above pests and discussed in detail.

Key words: Invasive, *Phenacoccus, Paracoccu*s , ecology, management

Introduction

Mealybugs once considered as minor pests have assumed the status of major status due to their polyphagous nature coupled with high reproductive capacity with short life cycle which is more favoured due to prolonged drought and quick dispersal through wind, seeds and planting materials. Earlier, two tailed mealybug, *Ferrissia virgata* (Ckll) and pink mealybug, *Maconellicoccus hirsutus* (Green) were considered as polyphagous major coccid pests in India. In addition, citus mealybug, *Planococcus citri*, (Risso) and long tailed mealybug, *Pseudococcus longispinus* (Tag-Tazz.) were also recorded on few fruit crops and on coconut. There was a severe incidence of mealybug in cotton at Haryana and subsequently in Punjab, Gujarat, Maharashtra and Karnataka during 2004-05. Initially it was considered as two species *viz.,* solanum mealybug, *Phenacoccus solani* and solenopsis mealybug, *Phenacoccus solenopsis* (Suresh and Kavitha, 2007). However detailed studies revealed that both of them are one and the same species (Hodgson *et al.*, 2008). In Tamil Nadu though it occurred three years back, its incidence was quite severe only during 2006-07 season attacking cotton, sunflower, many vegetable crops and weed hosts resulting in heavy yield loss. Last year, another species of mealybug, *Paracoccus marginatus* was recorded in papaya for the first time in Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India during July, 2008 which is considered to be invasive. Subsequently the biology and management strategies were studied and reported in this paper.

Material and methods

Random survey on the incidence of mealybugs were made by observing ten randomly selected plants in each plot and likewise the survey was made in twelve districts of Tamil Nadu for *P. solenopsis* and in four districts (Coimbatore, Erode, Tiruppur and Salem) for *P. marginatus*.

Seasonal incidence was also studied by making monthly observations on the incidence of mealybug on cotton and papaya for six months. The population count was made on infested samples of approximately 5 cm area and the mean was calculated and correlated with weather factors *Viz*., maximum temperature, minimum temperature, relative humidity, rainfall, rainy days and sun shine hours.

A leaf disc of 5 cm was taken and the individual discs were dipped in the respective solutions of botanicals and insecticides for a minute and shade dried. This was replicated five times. Twenty five adults were released per replication and observations were made on the mortality of the insect at 1, 2, 3 and 15 days after treatment, and compared with untreated check where only water is used.

The infested twigs along with insects were removed from the plant and the entire twig with adult mealybug was dipped in the respective insecticide solution. The treated samples were kept in the petridish as mentioned in the earlier method to study the mortality counts. The results were expressed in percentage of mortality.

Field experiments were conducted in randomized block design to evaluate the bioefficacy of newer insecticides against *Phenacoccus solenopsis* on cotton and *P. marginatus* on papaya at Tamil Nadu Agricultural University, Coimbatore. Each host plant was sprayed with recommended dose of insecticide and was replicated thrice. Pre and post treatment counts were taken 1, 3, 5, 7 and 10 days after the spray.

For papaya, observations were recorded on three leaves per tree in alternate fashion in opposite direction. The data has been recorded by following grade chart as well as number of mealybugs per 25 cm^2.

The grade chart followed during the study was presented here under;

Grade	Per cent infestation
0	No infestation
1	1 – 10
2	11 - 20
3	21 - 30
4	31 - 40
5	41 - 50
6	51 - 60
7	61 - 70
8	71 - 80
9	81 - 90
10	91 - 100

And the per cent infestation was worked out using the following formula,

$$\text{Per cent infestation} = \frac{\text{Total grade points}}{\text{Max. grade x No. of leaves observed}} \times 100$$

Laboratory (leafdip & leaf disc) and field trials were also carried out to evaluate the effective insecticide against these pests. Pre and post counts were also made on the incidence of these mealybugs in ten randomly selected plants/places respectively.

Results and discussion

The results indicated that earlier *P. solenopsis* was predominant in many places of Tamil Nadu and was slowly replaced by *P. marginatus* especially in Coimbatore, Erode and Tiruppur districts. The level of incidence varied from 0.00 to 60 per cent on many crops. For *P.solenopsis*, the hosts are cotton, sunflower, vegetables (brinjal, tomato, bhendi, cucurbits), pulses and parthenium. While for *P. marginatus*, papaya, tapioca, *Plumeria alba*, jatropha, mulberry, almost all vegetables, flower crops, weeds, including forest trees like teak, rain tree and *Prosopis* are considered as important hosts. So far rose, jasmine and crosandra are found to be free from the infestation of this pest. Entire papain industry at Coimbatore was lost due to the severity of the pest on papaya which slowly spread to mulberry, and tapioca in neighboring districts.

The seasonal incidence of *Phenacoccus solenopsis* Tinsley population was maximum (35 insects/ 5cm) during June and decreased slowly during September and there was no incidence up to February. Multiple correlation studies with weather parameters and natural enemy activities indicated that there was a significant positive correlation with minimum temperature and significantly negative correlation with relative humidity. For every one unit increase of minimum temperature, there was an increase of 0.77 unit of the pest population and likewise a unit increase in morning relative humidity resulted in decrease in pest population by 0.75 units.

Paracoccus marginatus was positively correlated with maximum temperature on *Plumeria alba.* However, it was positively correlated with minimum temperature on *Carica papaya, Jatropha curcas* and *Psidium guajava.*

Among the insecticides evaluated chlorpyriphos recorded overall reduction of 100 per cent followed by dichlorvas (90%) imdaclorprid (89.99%), thiamethoxam (86.66%) and profenophos ((80%) while neem oil recorded the least reduction percentage of 63.33. *P. solenopsis* (Table 1).

Profenophos 50 EC recorded the highest percentage of reduction (95.99) followed by endosulfan and thiomethoxam. The lowest insect mortality was noticed on imidacloprid 17.8 SL by recording the 85 per cent mortality (Table 2).

The results on the efficacy of different insecticides/ entomopathogen against *P. solenopsis* Tinsley in the field are presented in the Table 1. The insecticides, profenophos and methyl parathion were found to be quite effective and caused cent per cent mortality one day after treatment while imidacloprid, fish oil rosin soap and dimethoate caused cent per cent mortality after two days of the treatment imposition. All the test insecticides were found to be quite effective upto 10 days of the application. *Beauveria* was found to be moderately effective and caused 77 per cent mortality after 10 days of treatment (Table 3). Further FORS @ 25 g lit^{-1} and its combination with Agrospray oil, chlorpyriphos, dichlorvos and profenphos resulted in cent per cent mortality of papaya mealybug at 24 Hours after Treatment (HAT). Among the synthetic insecticides dichlorvos @ 1 ml lit^{-1} recorded the highest mortality of about 85 per cent at 72 HAT. *Beauveria bassiana* and Consotia each at 10 g lit^{-1} recorded 5.00 per cent mortality at 72 HAT. Agrospray oil @ 20 ml lit^{-1} recorded 25.00 per cent mortality at 72 HAT

The results of the field experiment carried out to evaluate the bioefficacy of newer insecticides, botanicals and microbial formulations against *P. marginatus* are presented in the Table 3. The per cent infestation of mealybugs ranged from 87.78 to 94.44. All the treatments had significant control of mealybugs over the untreated check. However, FORS @ 25 g lit ^{1} recorded the lowest infestation (2.22%) at 1 day after treatment (DAT). The combinations *viz.,* FORS + profenophos (25 g + 2 ml lit^{1}), Acephate + FORS (2 g + 25 g lit^{1}) and dichlorvos + FORS (1 ml + 25 g lit ^{1}) were also found promising recording lowest infestation of mealybugs.

Among the synthetic insecticidal treatments, acephate 75 WP @ 2g lit^{-1} recorded 11.11 per cent infestation followed by dichlorvos @ 1 ml lit^{-1} (21.11 %), profenophos 50 EC @ 2 ml lit^{-1} (32.22%) at 5 DAT. *B. bassiana* @ 5 g lit^{1}, Consortia @ 10 g lit^{-1} and Consortia + *B. bassiana* (5 + 5 g lit^{1}) recorded 57.78, 66.67 and 57.78 per cent infestation, respectively.(Table 3)

FORS alone and combination with insecticides recorded 0.00 per cent infestation at 5 and 10 DAT. However, at 14 DAT, the infestation of mealybugs started to build up again. Chlorpyriphos @ 2 ml lit^{-1} was also found to be quite effective in checking the mealybug infestation (Table 4). The population of mealybugs per 25 cm^{2} leaf area ranged between 47.00 and 54.00 before the spraying of insecticides. FORS and combination with synthetic insecticides reduced the population of mealybug effectively (Table 5).

Efficacy of insecticides like profenophos, chlorpyriphos, acepahte and fish oil rosin soap was reported by Kavitha and Suresh (2007) and Dhawan *et al*., (2008). However the effective period was upto 7- 10 days. Though methyl parathion was found to be quite effective owing to long term persistence and toxicity to natural enemies it cannot be recommended. Insecticidal control is not the only solution for the invasive pests. On the other hand Integrated approach for the management have been suggested involving prevention, monitoring, removal of affected plant material and weeds, use of botanicals and fish oil rosin soap to eliminate crawlers, conservation of coccinellid predators like *Cryptolaemus montrouzieri* and *Harmonia octomaculata* and lycaenid butterfly, *Spalgis epius* are recommended for effective management. Need based application of insecticides like profenophos 50 EC 2 ml/l. chlorpyriphos 20 EC 2ml/l, dimethaote 2 ml/l, imidacloprid 0.6 ml/l and thiamthoxam 0.6g/l were recommended as a last option for their management.

Table 1. Effectiveness of chemicals against cotton mealy bug - leaf dip method

	Chemicals	Percentage mortality		Over all reduction (%)
		24HAT	48HAT	
T1	Chlorpyriphos 2.5ml/lit	100	0	100
T2	Dichlorvas 1ml/lit	80	10	90
T3	Endosulfan 3.5ml/lit	60	13.33	73.33
T4	Imidaclorprid 0.4gm/lit	86.66	3.33	89.99
T5	Profenophos 2.0ml/lit	70	10	80
T6	Neem oil 3ml/lit	53.33	10	63.33
T7	Thiamethoxam 0.5g/lit	80	6.66	86.66
T8	Control	0	0	0

Table 2 Effectiveness of chemicals against *P.solenopsis* in cotton - insect dip method

	Chemicals	Percentage mortality			Overall reduction %
		24HAT	48HAT	72HAT	
T1	Chlorpyriphos 2.5ml/lit	46.87	40.62	0	87.46
T2	Dichlorvas 1ml/lit	52	32	8	92
T3	Endosulfan 3.5ml/lit	21	66.66	8.3	94.96
T4	Imidaclorprid 0.4gm/lit	20	60	5	85
T5	Profenophos 2.0ml/lit	21	71.42	3.57	95.99
T6	Neem oil 3ml/lit	12.5	62.5	12.5	87.5
T7	Thiamethoxam 0.5g/lit	40.85	45.42	7.14	93.41
T8	Control	0	0	0	0

Table 3. Toxicity of insecticides against *Phenacoccus solenopsis* Tinsley on cotton

S.No	Treatments	Dose (g or ml/lit)	PTC (Nos.)	Percentage mortality *				
				1 DAT	2 DAT	3 DAT	7 DAT	10 DAT
1	Thiamethoxam 20WG	0.4	44.67	81.33 (64.44)^{b}	97.87 (81.81)^{a}	100.00 (89.10)^{a}	Nil	Nil
2	Imidacloprid 70WS	0.4	47.00	96.12 (78.64)^{a}	100.00 (89.10)^{a}	Nil	Nil	Nil
3	Triazophos 40EC	2.5	44.33	65.15 (53.82)^{c}	91.95 (72.59)^{b}	97.51 (80.92)^{a}	Nil	Nil
4	FORS	20	47.00	97.89 (81.65)^{a}	100.00 (89.10)^{a}	Nil	Nil	Nil
5	Dimethoate 30EC	2	43.33	97.98 (81.83)^{a}	100.00 (89.10)^{a}	Nil	Nil	Nil
6	Profenophos 50EC	2	42.33	100.00 (89.10)^{a}	Nil	Nil	Nil	Nil
7	Methyl parathion 50EC	2	47.00	100.00 (89.10)^{a}	Nil	Nil	Nil	Nil
8	Acephate 75SP	2	43..33	81.35 (64.42)^{b}	99.36 (85.41)^{a}	100.00 (89.10)^{a}	Nil	Nil
9	*Beauveria bassiana* ($2x10^{8}$ /ml)	5	48.67	8.85 (17.30)^{d}	15.19 (22.93)^{c}	24.14 (29.43)^{b}	66.74 (54.78)^{a}	76.54 (61.03)^{a}
10	Untreated control		44.33	0.00 (0.19)^{d}	0.00 (0.19)^{d}	0.00 (0.19)^{c}	0.00 (0.19)^{b}	0.00 (0.19)^{b}
CD Value (0.05)		-	-	3.2531	2.5207	1.7562	2.2991	1.8712

Pre treatment count (PTC) Days after treatment (DAT)

Figures in parantheses are arc sin transformed values. Mean followed by same letter (s) in a column are not significantly different by DMRT P=0.05

Table 4. Efficacy of some insecticides and microbial formulations against papaya mealybug, *Paracoccus marginatus*

S.No.	Treatments	Per cent infestation						
		PTC	1 DAT	3 DAT	5 DAT	7 DAT	10 DAT	14 DAT
1.	FORS @ 25 g lit^{-1}	91.11	2.22 (7.04)^{a}	2.22 (7.04)^{a}	0.00 (0.00)^{a}	0.00 (0.00)^{a}	0.00 (0.00)^{a}	5.56 (13.48)^{a}
2.	Profenophos 50 EC @ 2 ml lit^{-1}	90.00	63.33 (52.75)^{d}	42.22 (40.52)^{d}	32.22 (34.58)^{d}	13.33 (21.41)^{c}	6.67 (14.64)^{cd}	21.11 (27.34)^{cd}
3.	Dichlorvos 76 SC @ 1 ml lit^{-1}	91.11	54.45 (47.56)^{d}	28.89 (32.50)^{c}	21.11 (27.25)^{c}	13.33 (21.41)^{c}	6.67 (14.64)^{cd}	25.56 (30.36)^{d}
4.	Acephate 75 WP @ 2 g lit^{-1}	87.78	41.11 (39.88)^{c}	17.78 (24.92)^{b}	11.11 (19.43)^{b}	4.44 (9.68)^{b}	1.11 (3.56)^{b}	15.56 (23.20)^{bc}
5.	Profenofos + FORS @ 2 ml+25 g lit^{-1}	90.00	5.55 (13.15)^{ab}	2.22 (7.04)^{a}	0.00 (0.00)^{a}	0.00 (0.00)^{a}	0.00 (0.00)^{a}	7.78 (16.12)^{a}
6.	Dichlorvos + FORS @ 1 ml+25 g lit^{-11}	87.78	5.56 (11.16)^{ab}	2.22 (7.04)^{a}	0.00 (0.00)^{a}	0.00 (0.00)^{a}	0.00 (0.00)^{a}	5.56 (13.48)^{a}
7.	Acephate + FORS @ 2 g+25 g lit^{-1}	87.78	6.67 (14.97)^{b}	2.22 (7.04)^{a}	0.00 (0.00)^{a}	0.00 (0.00)^{a}	0.00 (0.00)^{a}	6.67 (14.64)^{a}
8.	Acephate + *Beauveria bassiana* @ 2 g +5 g lit^{-1}	94.44	38.89 (38.58)^{c}	18.89 (25.69)^{b}	6.67 (14.64)^{b}	4.44 (9.68)^{b}	3.33 (8.52)^{bc}	13.33 (21.41)^{b}
9.	*Beauveria bassiana* @ 5 g lit^{-1}	90.00	80.00 (63.48)^{e}	70.00 (56.81)^{e}	57.78 (49.49)^{e}	48.89 (44.36)^{d}	66.66 (54.79)^{e}	85.56 (67.69)^{fg}
10.	Consortia @ 10 g lit^{-1}	94.44	86.67 (68.59)^{e}	77.78 (61.89)^{e}	66.67 (54.75)^{e}	53.33 (46.91)^{d}	76.67 (61.15)^{e}	88.89 (70.57)^{g}
11.	Consortia + *B. bassiana* @ 5 g+5 g lit^{-1}	90.00	81.11 (64.26)^{e}	73.33 (58.94)^{e}	57.78 (49.48)^{e}	51.11 (45.64)^{d}	67.78 (55.42)^{e}	80.00 (63.48)^{f}
12.	Chlorpyriphos 20 EC @ 2 ml lit^{-1}	90.00	53.33 (46.91)^{d}	31.11 (33.89)^{c}	25.56 (30.36)^{cd}	11.11 (19.43)^{C}	12.22 (20.42)^{d}	41.11 (39.88)^{e}
13.	Untreated check	92.22	94.45 (76.85)^{f}	95.56 (78.00)^{f}	96.67 (81.51)^{f}	97.78 (82.99)^{e}	97.78 (82.99)^{f}	98.89 (86.50)^{h}

In a column means followed by a common alphabets are not significantly different by DMRT (P= 0.05)
Values in parentheses are arc sin transformed values; Pre Treatment count (PTC); Day after treatment (DAT).

Table 5. Efficacy of some insecticides and microbial formulations against papaya mealybug, *Paracoccus marginatus*

S.No.	Treatments	Number of mealybugs per 25cm^2 area						
		PTC	1 DAT	3 DAT	5 DAT	7 DAT	10 DAT	14 DAT
1.	FORS @ 25 g lit^{-1}	51.00	4.67 (2.26)^{a}	2.33 (1.57)^{a}	0.00 (0.71)^{a}	0.00 (0.71)^{a}	0.00 (0.71)^{a}	3.67 (2.04)^{a}
2.	Profenophos 50 EC @ 2 ml lit^{-1}	50.33	31.67 (5.67)^{d}	20.00 (4.53)^{c}	16.67 (4.14)^{d}	6.67 (2.68)^{c}	4.00 (2.11)^{cd}	19.33 (4.45)^{f}
3.	Dichlorvos 76 SC @ 1 ml lit^{-1}	51.00	26.67 (5.21)^{c}	17.67 (4.26)^{c}	14.00 (3.81)^{c}	6.67 (2.68)^{c}	4.00 (2.11)^{cd}	19.33 (4.45)^{f}
4.	Acephate 75 WP @ 2 g lit^{-1}	49.67	22.00 (4.74)^{b}	12.33 (3.58)^{b}	7.00 (2.73)^{b}	3.33 (1.93)^{b}	1.00 (1.10)^{b}	15.67 (4.02)^{e}
5.	Profenofos + FORS @ 2 ml+25 g lit^{-1}	49.33	6.00 (2.54)^{a}	2.33 (1.57)^{a}	0.00 (0.71)^{a}	0.00 (0.71)^{a}	0.00 (0.71)^{a}	6.00 (2.54)^{bc}
6.	Dichlorvos + FORS @ 1 ml+25 g lit^{-1}	48.00	5.33 (2.40)^{a}	2.00 (1.48)^{a}	0.00 (0.71)^{a}	0.00 (0.71)^{a}	0.00 (0.71)^{a}	5.67 (2.48)^{b}
7.	Acephate + FORS @ 2 g+25 g lit^{-1}	47.00	5.67 (2.48)^{a}	1.67 (1.39)^{a}	0.00 (0.71)^{a}	0.00 (0.71)^{a}	0.00 (0.71)^{a}	7.33 (2.80)^{c}
8.	Acephate + *Beauveria bassiana* @ 2g+5g lit^{-1}	54.00	20.67 (4.60)^{b}	11.67 (3.49)^{b}	5.67 (2.47)^{b}	3.67 (2.02)^{b}	2.33 (1.57)^{bc}	12.33 (3.58)^{d}
9.	*Beauveria bassiana* @ 10 g lit^{-1}	47.33	42.00 (6.52)^{e}	36.00 (6.04)^{d}	28.67 (5.40)^{e}	24.67 (5.01)^{d}	32.00 (5.70)^{e}	41.67 (6.49)^{g}
10.	Consortia @ 10 g lit^{-1}	52.00	44.00 (6.67)^{e}	39.67 (6.34)^{d}	36.33 (6.07)^{f}	32.67 (5.76)^{e}	42.33 (6.54)^{f}	48.00 (6.96)^{h}
11.	Consortia + *Beauveria bassiana* @ 5g+5 g lit^{-1}	50.33	40.67 (6.41)^{e}	35.33 (5.98)^{d}	30.67 (5.58)^{e}	22.33 (4.78)^{d}	26.00 (5.15)^{e}	39.00 (6.28)^{g}
12.	Chlorpyriphos 20 EC @ 2 ml lit^{-1}	47.67	26.00 (5.15)^{c}	22.33 (4.78)^{c}	6.33 (2.61)^{b}	6.33 (2.61)^{c}	6.33 (2.61)^{d}	21.67 (4.71)^{f}
13.	Untreated check	50.33	52.67 (7.29)^{f}	54.00 (7.38)^{e}	57.33 (7.60)^{g}	59.67 (7.76)^{f}	63.33 (7.99)^{g}	71.00 (8.46)^{i}

References

Dhawan, A.K., Sarika Saini and Kamalddep Singh, 2008, Evaluation of novel and conventional insecticides for management pf mealybug, *Phenacoccus solenopsis* Tinsley in Punjab. Pest. Res. J., 20 (2): 214-216.

Hodgson, Chris, Abbas, G., Arif, M.J., Seed, S. and Karar, H., 2008, *Phenacoccus solenopsis* Tinsley (Sternorhyncha: Coccoidea: Pseudococcidae) an invasive mealybug damaging cotton in Pakistan and India, with a discussion on seasonal morphological variation. Zootaxa, 191: 1-35.

Suresh, S. and Kavitha, P.C., 2007, New records of coccoids in India. *In : Proc. XI Int. Symp. Scale Insect Stud.*, Oeiras, Portugal, 24-27.