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EFFICACY OF SOME IPM STRATEGIES AGAINST COTTON MEALYBUG *PHENACOCCUS SOLENOPSIS* TINSLEY

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ABSTRACT

The cotton mealybug *Phenacoccus solenopsis* Tinsley (Hemiptera: Pseudococcidae), has become a widespread serious pest and causing economic losses. In an attempt to control this different organic amendments, seed treatment practices, plant products and insecticides were evaluated. The highest kapas yield of 7.8 q/ ha was recorded in flonicamid treated plots followed by 7.7 q/ ha in thiodicarb treated plots as against 2.8 q/ ha in control. Cost-benefit ratio was also higher in these treatments recording 1.83 and 1.81 CBR, respectively. Though the insecticides were found effective, organic amendments + foliar spraying of plant products treatments was safer to coccinellids recording 13.5 and 14.2/ 10 plants. The same trend was also observed with regard to *Chrysoperla zastrowi sillemi* and spiders coccinellids varied from 2.3 to 5.3, *C. zastrowi sillemi* from 2.1 to 3.2 no's/ 10 plants in various insecticides sprayed fields as against 8.35 in control. Similarly, the population of spiders varied from 0.3 to 0.5 no's/ 10 plants as against 2.47 in control.

Key words: Cotton, *Phenacoccus solenopsis,* cotton, mealybugs, organic amendments, seed treatment, plant products, insecticides, coccinellids, spiders, *Pseudomonas fluorescens*, NSKE, *Chrysoperla zastrowi sillemi*, FORS liquid.

Cotton *Gossypium hirsutum* is the most important commercial crop and India is having maximum area (9 million ha as against 33 million ha in the world). Despite the larger area, the productivity remains very low i.e., 276 kg/ ha when compared to the world average of 550 kg/ ha. The primary biological cause of decreased productivity is due to pest infestation from seedling to maturity. Recently, mealy bug (*Phenacoccus solenopsis*) has attained the status of major pest causing maximum yield loss. Cotton mealybug was first reported in India by Kaur et al. (2008) indicating their infestation in cotton cultivating states viz., Punjab, Haryana, Rajasthan, Gujarat, Madhya Pradesh, Maharashtra, Tamil Nadu, Andhra Pradesh and Karnataka; *P. solenopsis* has been recorded from 154 plant species including field and horticultural crops. Mealybug infestation caused economic damage to cotton, brinjal, okra, sesame, tomato, and sunflower (Arif et al., 2009). The presence of massive mealybug clusterings on the underside of the leaves provides the appearance of a thick mat with waxy secretion, stunting, inflated cotton growth points. Mealybugs that produce honey dew aid in the growth of black sooty mould, which hinders photosynthesis. Heavy infestation causes the plant to yellow, wither, lose its leaves, and ultimately die. Mealybugs also infest flowers and fruits, which are completely covered in the mealybugs' waxy white coating. Fruit that has been infested may drop off or remain on the host in a dried-out state (Mani, 1989).

Economic damage by mealybug was observed on cotton, okra, brinjal, tomato, sesame, and sunflower (Arif et al., 2009). Mealy bug makes the growing point of cotton stunted, swollen and presence of heavy mealybug clusterings on the under surface of the leaves gives the appearance of thick mat with waxy secretion. Honey dew secreted by the mealybug helps in the development of black sooty mould, which interfere with the photosynthesis. Heavy infestation leads to yellowing, withering, defoliation and even death of the plant. Mealybugs also infest the flowers and fruits and they will be entirely covered with white, waxy coating of the mealybugs. Infestation can lead to fruit drop or it may remain on the host in a dried and shriveled condition (Mani, 1989). Of late, serious damage by mealybugs results in retarded growth and late opening of bolls, which affects the yield (Tanwar et al., 2007). Leaves twist and wilt after being injected with saliva. Accordingly, the present study was undertaken to evolve an IPM package.

MATERIALS AND METHODS

First field trial was conducted at Rayapalayam, Thirumangalam block, Madurai, Tamil Nadu during kharif 2019 for evaluating the efficacy of basal application of organic amendments superimposed with foliar application of plant products on rainfed variety SVPR 2. Two rounds of foliar spray were given as and when the population of mealybug crosses the economic damage level. Apart from pretreatment counts, post-treatment counts were made of crawlers and adult mealybugs/ 5 cm apical shoot in 10 randomly selected plants/ replication after 15, 30, 45 and 60 days of spraying (DAT). Finally, kapas yield (kg/ ha) and cost-benefit ratio were worked out. Second field trial was conducted at farmers holding of Rayapalayam, Thirumangalam block, Madurai, Tamil Nadu to evaluate efficacy of certain new insecticide molecules in SVPR 4 cotton and its impact on the activities of natural enemies. Two rounds of foliar application were given at 15 days interval. Population of mealybug crawlers and adults/ 5 cm shoot length from 10 randomly selected plants on 3, 7, 10 and 14 DAT was recorded and % reduction was estimated. Cost-benefit ratio was also worked out. The highly effective treatments identified from field trial I and II were integrated and the trial was taken up to evolve an IPM package. The population count was made on 25, 40, 60, and 75 DAT and the cost-benefit ratio, the impact of treatments on the natural enemies were also worked out. The data on mealybug incidence were transformed and then subjected to statistical analysis using AGRES statistical package. The differences in treatment means were compared based on Least Significant Difference (LSD p=0.05).

RESULTS AND DISCUSSION

The results of field experiment revealed that basal application of FYM @ 12.5 t/ ha + *Pseudomonas flourescens* as seed treatment @ 10 g/ kg of seed + two foliar sprays of FORS liquid @ 10 ml/ l + neem oil @ 10 ml/ l recorded the least mealybug populations (6.15/ 5 cm shoot length), which was statistically on par with standard check insect growth regulator, buprofezin 25 SC @ 2.0 ml/ l (6.42/ 5 cm shoot length). With regard to yield, highest yield of 4.6 q/ ha was recorded in the same treatment with CBR 1.63. The next best treatment was basal application of FYM @ 12.5 t/ ha + *Pseudomonas flourescens* as seed treatment @ 10 g/ kg of seed + two foliar sprays of NSKE 5% @ 50 ml/ l + neem oil @ 10 ml/ l with kapas yield of 3.9 q/ ha and CBR 1.51. Among the insecticide treatments, flonicamid 50 WG @ 2.0 g/ l recorded the lowest number of crawlers (4.53 mealybug crawlers and adults/ 5 cm apical shoot) followed by thiodicarb @ 2.0 g/ l (4.58 mealybug crawlers and adults/ 5 cm apical shoot) as against 33.75 no's in untreated control during kharif 2019. However, the mealybug population was higher (16.18 no's) in imidacloprid seed treated plots. The observations indicated the high effectiveness of flonicamid and thiodicarb against cotton mealybugs (Table 1).

The observations on the natural enemies viz., coccinellid, chrysopids and spiders in the insecticide treated plots revealed that all the insecticide sprayed were detrimental. The mean population of coccinellids/ 10 plants after two rounds of spray ranged from 2.3 to 5.7 in insecticide sprayed plots as against 13.6/ 10 plants in control. However, seed treatment with imidacloprid was safer to coccinellids. The same trend was also observed with regard to *Chrysoperla zastrowi sillemi* and spiders. The population of *C. zastrowi sillemi* varied from 1.2 to 2.7 no's/ 10 plants in insecticide sprayed fields as against 8.25 in control. Similarly, spiders varied from 0.3 to 0.8/ 10 plants as against 2.67 in control. Maximum kapas yield of 7.8 q/ ha was recorded in flonicamid treated plots followed by 7.7 q/ ha thiodicarb. Cost-Benefit ratio was also higher in these treatments recording 1.73 and 1.71 CBR respectively (Table 1).

Flonicamid 50 WG @ 2.0 g/ l and thiodicarb @ 2.0 g/ l were the best among all the treatments recording mean mealy bug population of 4.02 and 3.91 crawlers and adults/ 5 cm apical shoot respectively after two sprays as against 16.33 in untreated control. With regard to yield, highest kapas yield of 7.8 q/ ha was recorded in flonicamid treated plots followed by thiodicarb. Cost-Benefit ratio was also higher in these 1.83 and 1.81, respectively. The observations taken on the natural enemies viz., coccinellid, chrysopids and spiders in treatments revealed that all the insecticide sprayed were detrimental. The mean population of coccinellids/ 10 plants after two rounds of spray ranged from 2.3 to 5.3 in insecticide sprayed plots as against 13.7/ 10 plants in control. However, organic amendments + foliar spraying of plant products treatments were safer. The same trend was also observed with regard to *Chrysoperla zastrowi sillemi* and spiders (Table 1).

Application of FORS 2.5%, neem oil 3% and NSKE 5% were found effective by recording the least population of cotton mealybugs (Bharathi and Muthukrishnan, 2017). Natarajan et al. (1991) found that FORS 2%, neem oil 0.5% and mineral oil 2% were effective in controlling sucking pests of cotton. Balasubramanian and Murali Baskaran (2000) identified

Table 1. Efficacy of some IPM components against cotton mealy bugs (kharif 2019)

Treatments	Population of mealy bug crawlers and adult/ 5 cm apical shoot		Mean population of coccinellids/ 10 plants		Mean population of *Chrysoperla zastrowi sillemi*/ 10 plants		Mean population of spiders/ 10 plants		Yield (q/ ha)	CBR
	PTC	Mean	PTC	Mean	PTC	Mean	PTC	Mean		
Basal application of organic amendments in combination with plant products as foliar spray										
T_1 - FYM @ 12.5 t/ ha + *Pseudomonas fluorescens* as seed treatment @ 10g/ kg of seed	19.5	8.40 (2.898)^{c}	-	-	-	-	-	-	3.0	1.32
T_2 - T_1 + (Spray of NSKE 5% 50ml/ l + neem oil 5ml/ l + detergent powder 1g/ l)	18.7	7.17 (2.678)^{b}	-	-	-	-	-	-	3.9	1.51
T_3 - T_1 + (Spray of FORS liquid 10ml/ l + karanj oil 10 ml/ l + detergent powder 1g/ l)	17.8	9.23 (3.038)^{c}	-	-	-	-	-	-	2.7	1.25
T_4 - T_1 + (Spray of FORS liquid 10ml/ l + neem oil 10 ml/ l + detergent powder 1g/ l)	19.9	6.15 (2.480)^{a}	-	-	-	-	-	-	4.6	1.63
T_5 - FORS @ 10 ml/ l	19.5	10.92 (3.305)^{d}	-	-	-	-	-	-	2.3	1.12
T_6 - Buprofezin 25 SC @ 2.0 ml/ l (250g ai/ ha)	18.2	6.42 (2.534)^{a}	-	-	-	-	-	-	4.3	1.57
T_7 - Untreated control	20.2	18.77 (4.332)^{e}	-	-	-	-	-	-	2.0	-
SE(d)	NS	0.45	-	-	-	-	-	-	-	-
CD (p= 0.05)	NS	0.90	-	-	-	-	-	-	-	-
New insecticides										
T_1 - Seed treatment with imidacloprid 70WS @ 10 g/ kg	22.5	16.18 (4.022)^{g}	9.5	13.5 (3.674)^{a}	4.6	8.9 (2.983)^{a}	1.2	2.5 (1.581)^{a}	4.8	1.20
T_2 - Foliar spray of acetamiprid 20SP @ 0.5 g/ l	23.6	9.65 (3.106)^{f}	10.3	4.2 (2.049)^{c}	5.1	1.3 (1.140)^{e}	1.5	0.3 (0.548)^{c}	5.6	1.24
T_3 - Thiomethoxam 25WG @ 0.5g/ l	20.5	8.11 (2.848)^{d}	9.7	3.9 (1.975)^{c}	7.0	2.3 (1.517)^{bc}	0.9	0.4 (0.632)^{bc}	6.1	1.35
T_4 - Abamectin 1.8EC @ 0.5 ml/ l	22.3	7.21 (2.685)^{c}	8.6	2.5 (1.581)^{e}	5.6	1.4 (1.183)^{e}	1.3	0.3 (0.548)^{c}	6.5	1.44
T_5 - Thiacloprid 240SC @ 0.5 ml/ l	23.2	6.33 (2.516)^{b}	8.2	3.9 (1.975)^{c}	6.0	2.7 (1.643)^{b}	1.4	0.8 (0.894)^{b}	7.0	1.55
T_6 - Thiodicarb 75WP @ 2 g/ l	22.0	4.58 (2.140)^{a}	10.1	2.3 (1.517)^{e}	4.9	1.2 (1.095)^{e}	1.3	0.3 (0.548)^{c}	7.7	1.71
T_7 - Diafenthiuron 50WP @ 2.5 g/ l	21.1	7.30 (2.702)^{c}	8.7	5.3 (2.302)^{b}	5.9	2.1 (1.449)^{c}	1.3	0.5 (0.707)^{bc}	6.7	1.48
T_8 - Flonicamid 50WG @ 2.0 g/ l	21.8	4.53 (2.128)^{a}	7.8	3.2 (1.789)^{d}	7.1	1.2 (1.095)^{e}	1.0	0.5 (0.707)^{bc}	7.8	1.73
T_9 - Spinosad 45SC @ 0.3 ml/ l	23.5	8.58 (2.929)^{e}	8.9	5.7 (2.387)^{d}	5.9	2.6 (1.612)^{b}	1.3	0.3 (0.548)^{c}	5.9	1.33
T_{10} - Control	24.0	33.75 (5.809)^{h}	9.2	13.6 (3.688)^{a}	6.1	8.25 (2.872)^{a}	1.4	2.67 (1.634)^{a}	4.3	-
SE(d)	NS	0.18	NS	0.23	NS	0.16	NS	0.19	-	-
CD (p= 0.05)	NS	0.38	NS	0.45	NS	0.30	NS	0.40	-	-

(contd.)

(Table cont.)

Combination of best treatments										
T_1 - FYM @ 12.5 t/ ha + *Pseudomonas fluorescens* as seed treatment @ 10 g/ kg of seed + (Spray of NSKE 5% @ 50 ml/ l + Neem oil @ 5 ml/ l + detergent powder 1 g/ l)	25.7	9.87 (3.142)^{b}	7.5	13.5 (3.674)^{a}	4.6	8.9 (2.983)^{a}	1.2	2.5 (1.581)^{a}	4.9	1.44
T_2 - FYM @ 12.5 t/ ha + *Pseudomonas fluorescens* as seed treatment @ 10 g/ kg of seed + (Spray of FORS liquid @ 10 ml/ l + Neem oil @ 10 ml/ l + detergent powder 1 g/ l)	26.9	8.90 (2.983)^{b}	8.3	14.2 (3.768)^{b}	5.1	8.3 (2.881)^{b}	1.5	2.3 (1.517)^{a}	5.2	1.49
T_3 - Buprofezin 25 SC @ 2.0 ml/ l (250 g ai/ ha)	23.2	8.42 (2.902)^{b}	9.7	2.9 (1.703)^{c}	6.0	2.3 (1.517)^{c}	1.2	0.4 (0.632)^{b}	5.8	1.67
T_4 - Thiodicarb 75WP @ 2.0 g/ l	21.9	3.91 (1.977)^{a}	8.5	2.5 (1.581)^{c}	5.6	2.4 (1.549)^{c}	1.5	0.3 (0.548)^{b}	7.7	1.81
T_5 - Flonicamad 50 WG @ 2.0 g/ l	29.1	4.02 (2.005)^{a}	8.3	2.8 (1.673)^{c}	6.0	2.7 (1.643)^{c}	1.4	0.5 (0.707)^{b}	7.8	1.83
T_6 - Thiacloprid 240 SC @ 0.5 ml/ l	23.8	4.18 (2.0455)^{a}	9.1	2.3 (1.517)^{c}	4.9	3.2 (1.789)^{d}	1.3	0.3 (0.548)^{b}	7.3	1.75
T_7 - Abamectin 1.8 EC @ 0.5 ml/ l	21.8	4.85 (2.202)^{a}	8.7	5.3 (2.302)^{d}	5.9	2.1 (1.449)^{c}	1.3	0.5 (0.707)^{b}	6.4	1.65
T_8 - Untreated control	27.4	16.33 (4.041)^{c}	9.2	13.7 (3.701)^{ab}	6.1	8.35 (2.890)^{b}	1.4	2.47 (1.572)^{a}	2.8	-
SE (d)	NS	0.47	NS	0.33	NS	0.19	NS	0.19	-	-
CD at 0.05 %	NS	0.98	NS	0.65	NS	0.40	NS	0.40	-	-

NSKE - Neem seed kernel extract; FORS - Fish oil rosin soap; PTC - Pre-treatment count; DAT - Days after treatment; Mean of three replications; Values in column square root transformed values and original values are given; In a column means followed by a common letter not significantly different (p=0.05)

that organic amendments like neem cake along with 75% nitrogen was effective in reducing the sucking pests of cotton. Many researchers have identified the insecticidal property of azadirachtin (Prishanthini and Vinobaba, 2014; Arain, 2009; Gowda et al., 2013; Lanjar et al., 2015; Naik and Naik, 2012).

The present findings are in conformity with Arnold et al. (2013), who reported flonicamid 50 WG and dinotefuran 20 SG were found effective on root mealybugs of rhapis/ lady palms. On contrary, Nidheesh et al. (2020) identified thiamethoxam 25% WG @ 0.40 g/ l and dinotefuran 20% SG @ 0.25 g/ l as effective insecticides against cotton mealybugs Acephate and chlorpyriphos (Kumar et al., 2012), chlorpyriphos + cypermethrin (Mamoon-ur-Rashid et al., 2011), profenophos (Tanwar et al., 2011; Ahmad et al., 2011; Sanghi et al., 2015), buprofezin (Patel et al., 2010) and spirotetramat (12%) + imidacloprid (36%) (Dhawan et al., 1980) had been found effective against cotton mealybugs.

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AUTHOR CONTRIBUTION STATEMENT

GS performed the idea of this article, helped in writing and correction of manuscript. GS, MS provided materials and guidance to conduct the experiments. KN contributed statistical analysis, writing and framing of manuscript. Hence all authors equally contributed towards the experiments. The authors read and approved the final manuscript.

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interests.

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