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Bio-intensive Management of Pink Mealybug, *Maconellicoccus hirsutus* Green in Mulberry

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A study was conducted to evaluate organics *viz.,* botanicals, fish oil products and predators for the management of Pink mealybug, *Maconellicoccus hirsutus* in mulberry. Among the treatments tested, fish oil rosin soap (FORS) @ 25 g/lit was found to be very effective causing highest per cent mortality of *M. hirsutus* of 86.52 and 86.84 per cent on 15 DAT in first and second trials respectively. This was followed by 78.57 and 86.22 per cent in fish oil rosin liquid @ 0.2 per cent on 15 DAT during first and second trials respectively. In another trial, highest per cent reduction of pink mealybug was recorded in two trials on 60 days after release of adult *Cryptolaemus montrouzieri* beetles at 5 nos. (67.7 and 50.2) and 10 nos. (79.4 and 66.2) per square meter.

Key words: Pink mealybug, Botanicals, Bio-control agents.

Mulberry (*Morus* spp.) a sole food of the silkworm, *Bombyx mori* L. is prone to attack by more than 300 insect and non-insect species in varying intensities during different stages of crop and seasons (Kotikal, 1982).The pink mealybug, *Maconellicoccus hirsutus* Green (Hemiptera: Pseudococcidae) a pest of mulberry has become quite a serious threat to mulberry cultivation in the recent past. It causes apical shoot malformation popularly known as '*Tukra'*. Prevalence of *M. hirsutus* in very severe form was recorded in entire sericulture belt of Tamil Nadu (Baskaran *et al*., 1992). It assumed serious pest status due to its sedentary nature, waxy coating over the body and concealed way of living in apical buds. The population increased from March and was more during April and May and reached its peak during July and August causing the maximum damage to mulberry (Ali, 1995). Even though, synthetic chemicals are very effective in controlling the pest, they are generally not employed owing to high toxicity to silkworms. Hence, an attempt was made to assess the efficacy of non-chemical agents *viz.,* botanicals, fish oil products and *Cryptolaemus montrouzieri* against *M. hirsutus.*

Materials and Methods

Field evaluation of fish oil products and botanicals against M. hirsutus

Two field experiments were carried out in Randomized Block Design (RBD) with eight treatments and three replications. Well established five year old mulberry gardens located at two villages *viz.,* Sallipatti and Eripalayam of Udumalpet block of Tiruppur district were selected for study. The experiment was conducted on mulberry variety (V1) planted at a spacing of 105 cm x 90 cm x 60 cm (paired row system) which received all recommended cultural practices. Eight products were evaluated (Table 1 &2)

Wetting agent Teepol @ 1 ml / lit was added for treatments involving botanicals for better adherence on the treated leaf surface. Efficacy of the treatments was assessed by *in situ* sampling of total nymphal and adult population during pre and post treatment periods. Pre treatment count on the pest population was recorded at 20 randomly selected plants before application of treatments. Post treatment counts were recorded on 3, 5, 7, 10 and 15 days after spraying.

Field efficacy of C. montrouzieri adults against M. hirsutus

Two mulberry gardens with severe infestation by *M. hirsutus* were selected for the experiment. The experimental area was netted with wire mesh to restrict the movement of the released predators within the plot. Adult beetles were released in the evening time at the rate of 5 and 10 beetles/ m_2 after taking into consideration the natural population in the plots. The experiments were replicated ten times. Population of mealybugs and *C. montrouzieri* were observed at 10 days interval from five plants . Population of mealybugs was also recorded in the nearby field where the predatory beetles were not released. A control plot was also provided with wire mesh and maintained 25 metres away from the treatment to avoid the movement of predators into that area and no insecticidal spray was given after imposing the treatments. The data were corrected for the change in population both in predator

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released and in control plot using methods developed by Henderson and Tilton (1955). Data derived from field experiments were analysed in randomized block design and laboratory experiments with complete randomized design (Gomez and Gomez, 1984).

Results and Discussion

Efficacy of fish oil products and botanicals against M. hirsutus on mulberry

In the first field experiment, fish oil rosin soap (FORS) @ 25 g/lit was significantly effective

Table 1. Efficacy of fish oil products and botanicals against *M. hirsutus* on mulberry - Experiment I

Treatment	No. of mealybugs / 20 plants	Per cent mortality of mealybugs				
	PTC	3 DAT	5 DAT	7 DAT	10 DAT	15 DAT
Neem oil @ 1.5 %	34.67	49.29$_{g}$	54.29$_{g}$	59.94$_{f}$	66.07$_{g}$	52.16$_{g}$
		(44.60)	(47.46)	(50.73)	(54.37)	(46.24)
Neem oil @ 3 %	35.00	58.23$_{e}$	65.64$_{e}$	70.16$_{d}$	71.79$_{f}$	57.83$_{f}$
		(49.73)	(54.12)	(56.89)	(57.92)	(49.50)
Pungam oil @ 3 %	36.33	52.73$_{f}$	62.59$_{f}$	67.94$_{e}$	74.79$_{e}$	63.68$_{e}$
		(46.57)	(52.29)	(55.51)	(59.86)	(52.94)
Neem oil+Pungam oil @ 1.5 % + 1.5 %	37.33	58.28$_{e}$	65.38$_{e}$	70.45$_{d}$	74.50$_{e}$	63.25$_{e}$
		(49.77)	(53.96)	(57.07)	(59.67)	(52.68)
Fish oil rosin liquid @ 0.1 %	36.33	64.31$_{c}$	71.09$_{c}$	75.56$_{b}$	78.87$_{c}$	72.36$_{c}$
		(53.31)	(57.47)	(60.37)	(62.63)	(58.28)
Fish oil rosin liquid @ 0.2%	35.33	66.96$_{b}$	73.65$_{b}$	38.70$_{g}$	84.24$_{b}$	78.57$_{b}$
		(54.91)	(59.11)	(38.47)	(66.61)	(62.43)
Fish oil rosin soap @ 12.5 g/lit	34.67	62.29$_{d}$	67.92$_{d}$	73.28$_{c}$	77.58$_{d}$	69.92$_{d}$
		(52.12)	(55.50)	(58.88)	(61.74)	(56.74)
Fish oil rosin soap @ 25 g/lit	34.33	71.48$_{a}$	76.66$_{a}$	86.56$_{a}$	89.26$_{a}$	86.52$_{a}$
		(57.72)	(61.11)	(68.49)	(70.87)	(68.46)
Control (Untreated check)	36.33	0.00	0.00	0.00	0.00	0.00
SEd	NS	0.1891	0.1951	0.2386	0.1715	0.2822
CD (p=0.05)	NS	0.4056	0.4185	0.5118	0.3679	0.6053
CV (%)	-	2.97	2.91	3.6	2.39	4.19

PTC- Pretreatment count
DAT – Days after treatment
In a column means followed by a common letter are not significantly different, DMRT (P=0.05)
Values in parentheses are arc sine transformed values

compared to all other treatments. It recorded the highest per cent mealy bug mortality of 71.48 on 3 DAT which was followed by 66.96 per cent in fish oil rosin liquid @ 0.2 per cent (Table 1). On 15 DAT, FORS @ 25 g/lit recorded 86.52 per cent mortality followed by fish oil rosin liquid @ 0.2 per cent (78.57 %). In case of other treatments, the per cent mortality ranged from 49.29 to 89.26 with lowest per cent mortality of mealybugs in Neem oil @ 1.5%

In the second field experiment also FORS @ 25 g/lit recorded the highest per cent mortality of mealybug (74.10) on 3 DAT which was statistically superior over all other treatments (Table 2). This was followed by 72.06 per cent in fish oil rosin liquid @ 0.2 per cent. FORS @ 25 g/lit recorded 86.84 per cent mortality on 15 DAT and was followed by fish oil rosin liquid @ 0.2 per cent (86.22 %). The per cent mortality ranged from 46.23 to 89.70 in other treatments and the lowest per cent mortality of mealybug was registered in Pungam oil @ 3.0%.

Evaluation of plant products for mealybug indicated the superiority of FORS @ 25 g/lit over other treatments followed by fish oil rosin liquid @ 0.2% and Fish oil rosin liquid @ 0.1 %. FORS is a safe, non-poisnous natural product (Singh and Rao, 1979). It acts by forming a barrier between leaves and armours of the insect resulting in the arrest of their movement. It has asphyxiant with antifeedent effect (Ranga Reddy and Lakshimi narayana, 1986). Results of the present study indicated the utility of FORS in mulberry ecosystem. Singh and Rao (1979) observed that FORS was effective even in rainy season resulting in eighty three per cent mortality of hemipteran pests. Thus, FORS holds the key as one of the component of mulberry mealybug management.

Effect of field release of C. montrouzieri on mealybug population

In the earlier period (upto 10 days after release) marginal difference was noticed between control plot and treated plot, whereas, pronounced difference was noticed later. In the first field experiment, the per cent reduction over control was more in 10 beetles released/m_2 than 5 beetles released/m_2. At 20 DAR, the reduction of 57.8 per cent in 10 beetles released/m_2 and 35.9 per cent in 5 beetles released/m_2 was noticed. The per cent reduction was more (79.4) in 10 beetles released/ m_2 at 60 DAR whereas in 5 beetles released/m_2 67.7 was observed. In control plot, there was a steady increase in pest population with maximum of 330.5 and 195.8 in the field experiment I and II,

Table 2. Efficacy of fish oil products and botanicals against *M. hirsutus* on mulberry - Experiment II

Treatment	No. of mealybugs / 20 plants	Per cent mortality of mealybugs				
	PTC	3 DAT	5 DAT	7 DAT	10 DAT	15 DAT
Neem oil @ 1.5 %	33.00	49.27$_{g}$	55.31$_{g}$	59.14$_{e}$	63.77$_{f}$	53.15$_{e}$
		(44.58)	(48.05)	(50.27)	(52.99)	(46.81)
Neem oil @ 3 %	33.67	57.48$_{e}$	62.14$_{e}$	65.09$_{d}$	70.53$_{d}$	58.31$_{d}$
		(49.30)	(52.03)	(53.78)	(57.12)	(49.78)
Pungam oil @ 3 %	32.33	46.23$_{h}$	55.11$_{g}$	59.04$_{e}$	66.71$_{e}$	50.59$_{f}$
		(42.84)	(47.93)	(50.21)	(54.76)	(45.34)
Neem oil+Pungam oil @ 1.5 % + 1.5 %	33.33	54.67$_{f}$	58.39$_{f}$	64.09$_{d}$	66.83$_{e}$	49.29$_{g}$
		(47.68)	(49.83)	(53.18)	(54.83)	(44.59)
Fish oil rosin liquid @ 0.1 %	33.33	64.01$_{c}$	68.54$_{c}$	71.38$_{b}$	76.80$_{b}$	66.97$_{c}$
		(53.14)	(55.88)	(57.66)	(61.20)	(54.92)
Fish oil rosin liquid @ 0.2%	34.33	72.06$_{b}$	85.38$_{a}$	57.66$_{f}$	89.70$_{a}$	86.22$_{a}$
		(58.09)	(67.52)	(49.41)	(71.28)	(68.21)
Fish oil rosin soap @ 12.5 g/lit	33.33	62.10$_{d}$	64.77$_{d}$	68.41$_{c}$	74.00$_{c}$	69.34$_{b}$
		(52.00)	(53.59)	(55.80)	(59.34)	(56.38)
Fish oil rosin soap @ 25 g/lit	34.00	74.10$_{a}$	83.31$_{b}$	86.86$_{a}$	89.69$_{a}$	86.84$_{a}$
		(59.41)	(65.89)	(68.74)	(71.27)	(68.73)
Control (Untreated check)	35.33	0.00	0.00	0.00	0.00	0.00
SEd	NS	0.3029	0.2894	0.8924	0.2448	0.4617
CD (p=0.05)	NS	0.6497	0.6208	1.9142	0.5251	0.9903
CV (%)	-	4.79	4.34	13.47	3.46	7.04

PTC- Pretreatment count
DAT – Days after treatment
In a column means followed by a common letter are not significantly different, DMRT (P=0.05)
Values in parentheses are arc sine transformed values

respectively. In the second field experiment, the per cent reduction over control was more in 10 beetles released/m_2 than 5 beetles released/m_2. At 20 DAR, the reduction of 36.2 per cent in 10 beetles released/ m_2 and 27.6 per cent in 5 beetles released/m_2 was recorded. The per cent reduction was higher (66.2) in 10 beetles released/m_2 at 60 DAR whereas in 5 beetles released/m_2 50.2 was observed. The initial decrease in mealybug population was limited due to feeding by adult beetles alone. The effect of predator release was felt from twenty days after release. A longer oviposition period and egg period

Table 3. Effect of *C. montrozieuri* release on mealybug population on mulberry – Field experiment I

Number of *C. montrouzieri* released/ m_2	Mean no. of mealybugs/5 plants									
	20 DAR		30 DAR		40 DAR		50 DAR		60 DAR	
	No.	PR	No.	PR	No.	PR	No.	PR	No.	PR
5 beetles	54.3	35.9	78.1	38.6	91.5	48.4	123.2	50.7	106.7	67.7
	(7.4)$_{b}$		(8.8)$_{b}$		(9.5)$_{b}$		(11.1)$_{b}$		(10.3)$_{b}$	
10 beetles	35.7	57.8	56.5	55.6	73.3	58.6	82.6	66.9	68.0	79.4
	(6.0)$_{a}$		(7.5)$_{a}$		(8.6)$_{a}$		(9.1)$_{a}$		(8.2)$_{a}$	
Control	84.8	-	127.3	-	177.5	-	250.1	-	330.5	-
	(9.2)$_{c}$		(11.3)$_{c}$		(13.3)$_{c}$		(15.8)$_{c}$		(18.1)$_{c}$	

In a column, means followed by a common letter are significantly different by DMRT (P=0.05)
PR- per cent reduction in population over control

of the predator together accounted for this delayed effect. Both larval and adult feeding contributed to the success of a predation in the field (Ermolenko, 1965). Mzhavanadze (1984) observed seventy per cent control against Camellia scale, *Chloropulvinaria floccifera* only after three years after the release of 5000 coccinellids. Hence sustained releases over a longer period may bring about desired control of mulberry mealybug.

Biological control involving periodic release of predators by supplementary release may bring out the desired control measure (Coppel and Mertin, 1977) that strengthens the present study. A maximum of 79 per cent control was achieved at 10 beetles/ m_2. The study confirms the superiority of *C. montrouzieri* in suppressing the pest population. In a perennial crop like mulberry, where insecticide usage is limited, native predators have greater role in suppressing the pest population. Present finding is strengthened by the above factor and indicated the ecological superiority of native predator in biological suppression of pink mealybug.

Table 4. Effect of *C. montrozieuri* release on mealybug population on mulberry – Field experiment II

Number of *C. montrouzieri* released /m2	Mean no. of mealybugs/5 plants									
	20 DAR		30 DAR		40 DAR		50 DAR		60 DAR	
	No.	PR	No.	PR	No.	PR	No.	PR	No.	PR
5 beetles	66.2	27.60	68.5	26.6	87.5	32.5	103.6	35.7	97.5	50.2
	(8.1)b		(8.3)b		(9.3)b		(10.2)b		(9.9)b	
10 beetles	58.3	36.20	52.5	43.7	68.0	47.5	76.1	52.7	66.1	66.2
	(7.6)a		(7.2)a		(8.2)a		(8.7)a		(8.1)a	
Control	91.5	-	93.3	-	129.7	-	161.2	-	195.8	-
	(9.5)c		(9.6)c		(11.4)c		(12.7)c		(14.0)c	

In a column means followed by a common letter are significantly different by DMRT (P=0.05)

PR- per cent reduction in population over control

It is evident from the present study that fish oil products and *C. montrouzieri* can safely be used for the effective management of pink mealybug in the mulberry ecosystem.

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