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Effect of Insecticides on the Tukra Disease of Mulberry Caused by Mealy Bug *Maconellicoccus hirsutus* Green and their Impact on the Larvae of Silkworm *Bombyx mori* L.

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ABSTRACT

Different insecticides are used to control the mealy bug as well as to know the effect of insecticides on the growth and development of silkworm *Bombyx mori* L. The maximum per cent population reduction (61.28%) of mealy bugs was observed with Oxydemeton methyl 0.05 per cent and dimethoate 0.05 per cent (58.18%) treatments. DDVP and nimbicidine treatments were also found to be effective at all three concentrations. Studies on insecticidal toxicity to silkworm larvae recorded relatively shorter waiting period (3-5 days) for nimbicidine and DDVP at all three concentrations. Whereas, longer waiting period (7-10 days) for dimethoate and Oxydemeton methyl at 0.05, 0.025 and 0.0125 per cent concentrations were noticed. Oxydemeton methyl (at all three concentrations) in spite of its high effectiveness against the mealy bugs is not recommended to use on mulberry leaves due to its high residual toxicity and unfavourable effects on the silk worm. DDVP and nimbicidine at all the three concentrations recorded shorter waiting period, satisfactory control of mulberry mealy bugs and favourable effects on the economic character of silkworm.

Key words: Tukra disease, *Maconellicoccus hirsutus*, *Bombyx mori*, Insecticides, Larvae

The quality of mulberry leaf has a great influence on the amount ingested by the silkworm (*Bombyx mori* L). Tukra is a major problem in mulberry gardens caused by pink mealy bug (Thangamani and Vivekandan 1983). The infestation of mealy bugs causes morphological and anatomical changes in different plants, including mulberry like curling of leaves, sickening and flattening of stems at the growing point (Babu *et al.* 2003). As a result of these, "Chawki" rearing of silkworms is affected as the young silkworm must be fed with tender mulberry leaves. Despite considerable social concern on the use of chemical control, most of the proponents of integrated pest management endorse the view that the wise and timely use of appropriate chemical control is an essential component of plant protection technology. The growers also seldom resort to chemical interventions for the control of pests and diseases. Since, the mulberry leaf is fed directly to the silkworms and as the worms is highly fragile and there is a need to screen the traditional insecticides and fungicides for selection of suitable, effective and safer compounds for control of insect pests and diseases in mulberry. In this direction the present study was undertaken to investigate the effect of insecticides on the tukra disease of mulberry caused by mealy bug and their impact on the larvae of silkworm.

MATERIALS AND METHODS

Two experiments were conducted separately to evaluate the efficacy of insecticides against tukra disease to know the effect of insecticides on the growth and development of silkworm under field and laboratory conditions, respectively. To evaluate the efficacy of different insecticides a field experiment was conducted at Insectary, Department of Entomology, Tirupati during first fortnight of May. Spraying was done with four promising insecticides at three different concentrations (Table 1).

Table 1 Details of the insecticides used in the experiment

Common name	Dose	Trade name	For-mulation	Source of supply
Oxy demeton methyl	0.05% 0.025% 0.0125%	Metasystox	25% EC	Devidayal Ltd.,
Dimethoate	0.05% 0.025% 0.125%	Rogor	30 EC	Rallis India Ltd.,
Dichlorvos	0.05% 0.025% 0.125%	DDVP	76 EC	Syngenta India Ltd.,
Azadiractin	12 ppm 6 ppm 3 ppm	Nimbicidine	1500 ppm	Nishant Ecotechnologies Ltd.,

The efficacy of certain insecticides viz Oxydemeton methyl, dimethoate and dichlorvos each at three different concentrations viz 0.05, 0.025 and 0.0125 per cent including one botanical insecticide nimbicidine at 6, 4.5 and 3 ppm concentrations were imposed after noticing the mealy bug population. Details of treatments and layout of the experiment in randomized block design, with three replications and gross plot size is 5 × 3 m^2. The required quantity of spray solution was prepared and applied on mulberry in each treatment with knap-sack sprayer to cover the foliage thoroughly.

Preparation of insecticidal solution

The quantity of the chemical required was calculated as per the formula given below:

$$d = \frac{(a \times b)}{c}$$

Where,

a: Per cent of toxicant desired (recommended)
b: Volume (in ml) of liquid required for application
c: Per cent of toxicant available in the commercial insecticide formulation
d: Volume (ml) of commercial formulation required.

Care was taken for proper mixing of the insecticide with water and to prevent the drift of spray fluid to adjacent plots and for through coverage of insecticides on plant surface.

Per cent population reduction of mealy bugs was recorded on 1, 3, 5, 7 and 10 days after spraying by using the formula:

$$\text{\% population reduction over control} = 1 - \frac{\text{Post treatment population}}{\text{Pre-treatment population}} \times \frac{\text{Pre-treatment population in control}}{\text{Post-treatment population in control}} \times 100$$

Effect of insecticides on the growth and development of silkworm

The experiment was carried out with IV and V instar of $MY_1 \times CSR_2$ race of mulberry silkworm larvae. One day after application of insecticide treatments, the leaves from the treated plots were picked up and fed to the IV instar larvae. In each treatment a minimum of 50 diseases free larvae were maintained with three replications. For further feedings also the leaves from the same plot were used for feeding the larvae. Similarly after application of insecticides on 3, 5, 7 and 10 days the leaves were picked up and fed to the another batches of IV instar silkworm larvae. Another experiment was carried out in the same manner with V instar larvae by feeding the insecticides treated leaves from V instar onwards only to know the effect of insecticides. Larval morality was calculated by using the formula:

$$\text{\% mortality} = \frac{\text{Number of worms showing mortality due to insecticide toxicity}}{\text{Total number of worms / treatment}} \times 100$$

Experimental data were statistically analyzed by the methods of CRD, RBD and two factorial with randomized block design concept in two way ANOVA.

Table 2 Efficacy of insecticides against mulberry mealy bug *Maconellicoccus hirrutus* at different days after spraying

Insecticides	Per cent reduction over control					Mean
	1 DAS	3 DAS	5 DAS	7 DAS	10 DAS	
Oxydemeton methyl 0.05	61.28	54.21	49.42	33.44	27.51	45.17
Oxydemeton methyl 0.025	59.58	52.67	47.40	29.38	24.49	42.70
Oxydemeton methyl 0.0125	48.50	45.53	31.61	26.56	23.49	35.14
Dimethoate 0.05	58.18	52.51	48.50	30.63	26.40	43.24
Dimethoate 0.025	56.60	48.59	40.57	27.51	23.72	39.40
Dimethoate 0.0125	44.44	37.89	28.42	21.49	19.52	30.35
Dichlorvos 0.05	50.58	42.72	33.50	27.49	21.38	35.13
Dichlorvos 0.025	46.69	36.79	28.35	25.24	19.18	31.25
Dichlorvos 0.0125	40.44	32.58	22.63	21.60	18.37	27.13
Nimbicidine 0.05	48.43	41.57	37.65	34.55	19.29	36.30
Nimbicidine 0.025	42.64	38.49	35.44	31.35	16.37	32.86
Nimbicidine 0.0125	32.15	28.42	20.55	16.76	14.31	22.44
Mean	49.13	42.67	35.34	27.17	21.17	35.09
	Days		Insecticides		D × F interaction	
F test	**		**		**	
S. Em.	0.10		0.15		0.34	
$C.D_{0.05}$	0.20		0.31		0.68	

**Significant at 1% level, NS: Not significant

RESULTS AND DISCUSSION

Efficacy of insecticide against mulberry mealy bug

Observations recorded on the mealy bug population at one day after insecticidal application showed that all the treatments were significantly superior to untreated check. The maximum reduction of 61.28 percent was obtained with Oxydemeton methyl 0.05 per cent concentration followed by 59.58 per cent mortality with Oxydemeton methyl 0.025 per

cent, 58.18 per cent with dimethoate 0.05 per cent (Table 2). Three days after spraying minimum mortality of 28.42 per cent was observed with nimbicidine (3 ppm) whereas maximum mortality of 54.21 per cent was noticed with Oxydemeton methyl (0.05%). The per cent population reduction with other treatments ranged between 38.49 and 52.67. The same pattern of population reduction at five days after spraying was observed as the population reduction ranged between 20.55 and 49.42 per cent. However, at seven days after spraying and ten days after spraying, efficacy or reduction ranged from 16.76 to 33.44 per cent and 14.31 to 27.51 per cent, respectively.

Table 3 Influence of different insecticides on larval mortality (%) of mulberry silk worm *Bombyx mori* L. fed from IV and V instar onwards at different days after spraying

Treatments	Larval mortality (%)									
	VI instar					V instar				
	3 DAS	5 DAS	7 DAS	10 DAS	Mean	3 DAS	5 DAS	7 DAS	10 DAS	Mean
Oxydemeton methyl (0.05%)	73.50	67.00	36.50	14.50	47.88	61.00	52.00	26.50	6.50	36.50
	(59.02)	(54.95)	(37.16)	(22.38)	(43.38)	(51.36)	(46.15)	(30.97)	(14.76)	(35.81)
Oxydemeton methyl (0.025%)	57.00	50.00	24.50	7.50	34.75	48.50	43.00	21.50	5.00	29.50
	(49.03)	(45.00)	(29.66)	(15.89)	(34.89)	(44.14)	(40.97)	(27.61)	(12.86)	(31.40)
Oxydemeton methyl (0.0125%)	41.50	30.50	21.00	3.00	24.00	37.00	26.50	16.50	2.50	20.63
	(40.09)	(33.52)	(27.27)	(9.83)	(27.68)	(37.46)	(30.97)	(23.95)	(9.05)	(25.36)
Dimethoate (0.05%)	54.00	53.00	20.00	6.70	33.43	55.00	38.50	11.00	3.50	27.00
	(47.29)	(46.72)	(26.56)	(15.00)	(33.89)	(47.87)	(38.34)	(19.35)	(10.76)	(29.08)
Dimethoate (0.025%)	44.00	41.50	12.00	6.50	26.00	37.00	34.00	10.00	3.50	21.13
	(41.54)	(40.09)	(20.25)	(14.76)	(29.16)	(37.46)	(35.66)	(18.41)	(10.76)	(25.57)
Dimethoate (0.0125%)	36.00	38.50	10.00	4.50	22.25	28.00	23.50	9.00	1.50	15.50
	(36.87)	(38.35)	(18.41)	(12.23)	(26.47)	(31.93)	(28.94)	(17.43)	(6.93)	(21.31)
Dichlorvos (0.05%)	50.50	16.00	10.50	6.50	20.88	37.00	15.50	10.50	2.50	16.38
	(45.29)	(23.57)	(18.90)	(14.76)	(25.63)	(37.46)	(23.18)	(18.90)	(9.05)	(22.15)
Dichlorvos (0.025%)	37.00	15.50	11.00	6.50	17.50	29.00	15.00	6.00	2.50	13.13
	(37.46)	(23.16)	(19.35)	(14.76)	(23.68)	(32.58)	(22.78)	(14.13)	(9.05)	(19.63)
Dichlorvos (0.0125%)	27.50	13.50	10.50	3.50	13.75	22.00	10.00	3.50	1.00	9.13
	(31.61)	(21.55)	(18.86)	(10.76)	(20.69)	(27.97)	(18.43)	(10.76)	(5.74)	(15.72)
Nimbicidine (6 pm)	38.00	14.50	10.00	4.50	16.75	29.00	9.50	4.50	2.50	11.38
	(38.06)	(22.38)	(18.41)	(12.23)	(22.77)	(32.58)	(17.95)	(12.23)	(9.05)	(17.95)
Nimbicidine (4.5 pm)	27.00	13.00	9.50	2.50	13.00	21.50	9.50	3.50	1.50	9.00
	(31.29)	(21.08)	(17.95)	(9.05)	(19.84)	(27.61)	(17.95)	(10.76)	(6.93)	(15.81)
Nimbicidine (3 pm)	13.50	13.60	8.50	2.50	9.50	10.50	9.00	3.50	1.50	6.13
	(21.47)	(21.08)	(16.94)	(9.05)	(17.25)	(18.90)	(17.43)	(10.78)	(6.93)	(13.51)
Control	10.50	10.50	8.00	2.50	7.88	10.00	8.50	3.50	1.50	5.88
	(18.90)	(18.90)	(16.40)	(9.05)	(15.81)	(18.35)	(16.94)	(10.76)	(6.93)	(13.25)
Mean	39.23	29.00	14.77	5.48	22.12	32.73	22.65	9.96	2.73	17.02
	(38.30)	(31.60)	(22.01)	(13.06)	(26.24)	(34.28)	(27.36)	(17.39)	(9.14)	(22.04)
	Days	Treatments	Interaction			Days	Treatments	Interaction		
S.Em.±	0.30	0.55	1.09			0.28	0.51	1.01		
$C.D_{0.05}$	0.86	1.55	3.09			0.80	1.44	2.87		

Values in the parenthesis are angular transformed values

Pink mealy bug, *Maconellicoccus hirsutus* (Green) is a common "hard to kill pest" of horticultural crops including mulberry. No effective control measure was reported for eliminating the mealy bug population. Hence, the application of Dichlorvos and Nimbicidine each at three different concentrations viz 0.05, 0.025 and 0.0125 resulted in more than 30 per cent reduction of the pest population. Systemic insecticides viz Oxydemeton methyl (0.05%), dimethoate (0.05%) had resulted more than 45 per cent reduction of the pest population. The findings are in agreement with the reports of Beevi *et al.* (1992), Ali (1995).

Influence of different insecticides on the larval mortality of mulberry silkworm

Complete larval morality was observed in both IV and V instar larvae when fed with insecticide treated mulberry leaves immediately 1 day after spraying (days after sowing). The highest larval morality (73.50%) was observed at 3 days after sowing with Oxydemeton methyl 0.05 percent whereas the lowest larval morality of 13.50 percent was recorded with nimbicidine at 3 ppm concentration with nimbicidine at other two higher concentrations i e 4.5 and 6 ppm mortality percentages recorded were 27.00 and 38.00 percent, respectively. Whereas, in the higher concentration (0.05%)

of dichlorvos the percentage mortality recorded was 50.50 percent. The larval mortality recorded with Oxydemeton methyl at lower concentration of 0.025 and 0.0125 percent were 37.00 and 27.50 percent, respectively (Table 3). Observations recorded on the larval mortality percent at 5 days after sowing showed that all the insecticidal treatments except nimbicidine at 3 ppm were significantly superior and the larval mortality decreased compared to 3 days after sowing. The highest mortality (67.00%) was recorded with Oxydemeton methyl 0.05 per cent and minimum percentage mortality (13.50) was with nimbicidine 3.0 and 4.5 ppm. In all the insecticidal treatments, cent per cent mortality of silkworm was observed when the larvae were fed with insecticide treated leaves immediately or one day after spraying in both the cases of IV and V instars. Insecticidal applications on mulberry noticed to have a detrimental effect on silkworm larvae. These results are in accordance to (Bhosale *et al.* 1988).

V instar

The maximum mortality (61.00%) was observed with Oxydemeton methyl at 0.05 per cent and minimum mortality (10.50%) was with nimbicidine 3 ppm and in the remaining treatments the mortality ranged between 21.50 and 48.50 per cent at 3 DAS. The same trend was observed at 5 and 7 DAS. All the treatments were found safe for fifth instar larvae at 10 DAS.

The evaluation of different insecticides against the mealy bug *Maconellicoccus hirsutus* (Green) on mulberry showed that the maximum reduction of pest population was with oxy demeton methyl (0.05%) and dimethoate (0.05%). However, the application of relatively safer insecticides such as DDVP and nimbicidine were also observed effective in management of the pest population levels (<30%). Studies on toxicity of insecticides to mulberry silkworm larvae revealed that 100 per cent mortality was noticed when the insecticide treated mulberry leaves fed to the IV and V instar larvae on 1 DAS. Drastic reduction in morality per cent was noticed from 3 DAS onwards with DDVP and nimbicidine at all the three concentrations. For IV and V instar larvae, nimbicidine 3 ppm found as safe at 3 DAS. Nimbicidine at two other concentrations viz 4.5 ppm, 6 ppm and dichlorovs at all three concentrations were safe at 5 DAS. Dimethoate @ 0.0125 and 0.025 per cent had waiting period of 7 days. Oxydemeton methyl (at all three concentrations) in spite of its high effectiveness against the mealy bugs is not recommended to use on mulberry leaves due to its high residual toxicity and unfavourable effects on the silk worm. Since DDVP and nimbicidine at all the three concentrations recorded shorter waiting period, satisfactory control of mulberry mealy bugs and favourable effects on the economic character of silkworm recommended for mulberry mealy bug control.

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