

Effect of Medicinal Plant Extracts on Mealy Bugs (*Maconellicoccus hirsutus* Green) Affecting Mulberry

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Efficacy of aqueous leaf extracts of medicinal plants viz., *Eucalyptus globulus*, *Ocimum sanctum* and *Piper betle* were evaluated against the hatching of eggs, mortality of nymphs and mortality and fecundity of adult mealy bugs (*Maconellicoccus hirsutus* Green) under *in vitro* conditions. Totally seven concentrations 1, 5, 10, 20, 50, 70 and 100 percent were tested against mealy bugs. The results revealed that with the increase in the concentration of extracts, there was a corresponding decrease in hatching, nymphal & adult mortality and fecundity in all the extracts tested. The hatching of eggs was minimum at 100 percent concentration in *E. globulus* (20.00%) followed by *O. sanctum* (30.42%) and *P. betle* (36.06%) over control (96.73%). The growth and development of nymphs and adults were adversely affected after the treatment. The nymphs did not attain the adult stage and there was total mortality of nymphs in different treatments. The duration of nymphal stage was reduced by 2-10 days in *E. globulus*, 1-7 days in *O. sanctum* and 1-2 days *P. betle* at higher concentrations. However, at lower concentrations it was prolonged by 2-4 days in all the three extracts. At lower concentrations the mortality of adults was on par with the control. Similarly the adult duration was also reduced by 3-4 days at 100 percent concentration and prolonged by 5-6 days at lower concentrations in all the extracts. With the increase in concentrations of the extracts there was decrease in the fecundity of eggs. Thus, the leaf extracts of *E. globulus* was found to be most effective followed by *O. sanctum* and *P. betle* against mealy bugs.

Key words: Pest control, Mealy bugs, *Eucalyptus globulus*, *Ocimum sanctum*, *Piper betle*

Introduction

The silkworm (*Bombyx mori*) derives almost all the nutrients essential for its growth from the mulberry foliage (Horie and Watanabe, 1980). Of all the mulberry pests, mealy bug - *Maconellicoccus hirsutus* Green (Hemiptera) are considered to be the most dreadful one causing 'tukra' disease. The pest is more prevalent in all the mulberry growing areas during summer and pre-monsoon seasons leading to a recurring loss of about 20-30% in leaf yield. The pink mealy bugs are "hard-to-kill pest" because of their protected habitat and white waxy or mealy coating (Mani, 1989). Usually the nymphs of mealy bugs settle on the tender portion of the apical shoot and suck the sap, which leads to crumpling and wrinkling of apical leaves. A number of insecticides have been tried against mulberry mealy bugs (Reddy and Kotikal, 1988). The commonly employed chemicals such as dichlorvos, aldicrab, carbafulan etc., hardly control this pest. Silkworm are very much sensitive to these pesticides, therefore extensive use of insecticides on mulberry the chief food plant of silkworm is harmful. Although pesticides are useful in killing pests, farmers have to wait for a longer duration to use the leaves to silkworms due to its residual toxicity. Hence, of late plant extracts (botanicals) have assumed special significance. Keeping this in view, the present study was conducted with aqueous leaf extracts of three medicinal plants namely *Eucalyptus globulus* Labill. (Myrtaceae), *Ocimum sanctum* Linn. (Lamiaceae) and *Piper betle* Linn. (Piperaceae) to test the effect of these extracts on different stages of mealy bugs affecting mulberry for the first time.

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Materials and Methods

The study was conducted during summer (March - June 2005) when there was maximum infestation of mealy bugs. Adults were collected from the tukra affected mulberry garden at Jnanabharathi campus, Bangalore University, Bangalore. They were cultured and multiplied on pumpkins under the laboratory conditions.

The aqueous extracts of *E. globulus*, *O. sanctum* and *P. betle* were prepared separately by homogenizing 100 g of the fresh leaves (medium type) in 100 ml of distilled water using a grinder. The homogenate was filtered. The resulting extract was kept as a stock (Babu *et al.*, 1994). Further it was diluted with distilled water to obtain different concentrations (conc.) i.e., 1, 5, 10, 20, 50, 70 and 100 percent (crude extract). The effect of these extracts on different stages of mealy bugs *viz.*, egg, nymphs and adults were tested simultaneously under *in vitro* conditions. The freshly laid eggs (3 egg sacs/replication), nymphs (III instar) and adults were dipped completely in different conc. of the extracts. Later nymphs and adult mealy bugs (20 each/replication) were released on to the mulberry leaves previously dipped with the plants extracts. Then transferred to petriplates and kept in BOD incubators maintained at a temperature of $25 \pm 2^\circ\text{C}$ and $60 \pm 10\%$ relative humidity. The leaves were changed daily. Totally there were 8 treatments in each plant extracts with three replications. The percentage of hatching of eggs, mortality counts of nymphs, adults and fecundity were recorded daily. The duration of the developmental period of eggs, nymphs and adults were observed in each treatment and noted. Data was analysed statistically for analysis of variance (ANOVA) and critical difference test at $P < 0.05$.

Results and Discussion

Plant extracts have been extensively tested for control of insect pests in many agricultural crops including mulberry (Opender Koul, 1982). In the present investigation, the effect of aqueous leaf extracts of medicinal plants *viz.*, *E. globulus*, *O. sanctum* and *P. betle* were evaluated against the hatching of eggs, mortality of nymphs and mortality and fecundity of adult mealy bugs (*M. hirsutus*) under *in vitro* conditions.

The hatching of eggs was delayed by 2-4 days in extracts of *E. globulus*, *O. sanctum* and *P. betle* over control. At higher conc. there was complete inhibition of hatching. Maximum suppression of hatching was recorded in 100% conc. of *E. globulus* with only 20.00% hatching

followed by *O. sanctum* (30.42%) and *P. betle* (36.06%) compared to control (96.73%) (Table 1).

The mortality of nymphs was rapid in *E. globulus* followed by *O. sanctum* and *P. betle* at all conc. At higher conc., cent percent mortality of nymphs was observed after 3 days of treatment in *E. globulus*. While in *O. sanctum* and *P. betle* total mortality was after 7 and 11 days of treatment respectively (Table 2). The growth and development of the nymphs was adversely affected in all extracts at all the conc. None of the nymphs attained the adult stage. The duration of the nymphal stage was reduced in *E. globulus* and *O. sanctum* which ranged from 2-7 days. However while in *P. betle*, the nymphal period was prolonged by 2-4 days at lower conc. While at 100% conc. the duration was reduced by 2 days and they became inactive and showed aversion in feeding. This may be attributed to the odour of the specific compounds present in extracts. Similar observation was also made by Kaushal *et al.* (2003) against *Spilosoma obliqua* by using extracts of Asteraceae family. At later stages they became brownish - black in colour in *E. globulus* and *O. sanctum* treatments. While in *P. betle* extracts they became reddish brown and turned blackish and caused mortality. Irregularity and 2-4 days delay in moulting was also observed in all the conc. of extracts tested. This might be due to the dual effect i.e., by spraying the extracts on mealy bugs and feeding of the treated leaves to them. At lower conc. there was not much effect of extracts on the nymphs and it was on par with the control. This may be due to dilution of toxicants present in the extracts.

The mortality of adults was on par with the control in all the extracts studied at lower conc. At higher conc. 100 percent mortality of adults was observed on 8th day in case of *E. globulus*. Whereas, in case of *O. sanctum* and *P. betle* it was on 9th and 11th day respectively (Table 3). The duration of adults was prolonged by 5-6 days in different extracts at lower conc. of 10-50 percent over control. However at 100 percent conc. the duration was reduced by 3-4 days. During adult stage the extracts were found to be less effective compared to nymphal stage. This may be probably due to protective mealy substances present on the body. Therefore, the plant extracts are needs to be used during early stages of infestation. Babu *et al.* (1994) have made a preliminary attempt to control tukra disease in mulberry using aqueous leaf extracts of *Azadirachta indica*, *Rhizophora apiculata*, *Adathoda vasica*, *Parthenium hysterophorous*, *Lantana camara* and *Prosopis juliflora*. Among these plant extracts *A. indica* and *A. vasica*, were found to be more effective. It was observed that the pest could not be controlled completely but the spray of leaf extract prevented further spread of the disease. Handique and Baruah (2000) reported that tukra incidence was

Table 1. Effect of different concentrations of medicinal plants extracts (aqueous) on the hatching of mealy bugs eggs

Conc.	Total no. of eggs treated	Eggs hatched/day										Total no. of eggs hatched	Percentage Hatchability				
		1	2	3	4	5	6	7	8	9	10			11	12		
Control	400	NH	NH	NH	NH	100	103	75	0	0	0	0	0	0	0	398±53.66	96.73
		<i>Eucalyptus globulus</i>															
1	324	NH	NH	NH	NH	NH	50	30	23	91	68	35	20			317±30.19	97.84
5	180	NH	NH	NH	NH	NH	10	20	38	35	40	13	9			165±15.79	91.67
10	270	NH	NH	NH	NH	NH	29	20	36	48	63	10	9			215±21.95	79.63
20	225	NH	NH	NH	NH	NH	NH	30	45	40	40	0	0			155±20.78	68.89
50	185	NH	NH	NH	NH	NH	NH	NH	10	20	62	30	0			122±21.16	65.95
70	252	NH	NH	NH	NH	NH	NH	NH	15	25	40	0	0			80±14.74	31.75
100	243	NH	NH	NH	NH	NH	NH	NH	10	10	13	10	0			43± 5.74	20.00
F value		1.52															
CD at 5%		27.17															
		<i>Ocimum sanctum</i>															
1	279	NH	NH	NH	NH	19	19	20	45	48	57	17	0			225±19.84	93.33
5	325	NH	NH	NH	NH	15	22	39	73	43	38	0	0			230±29.06	92.59
10	350	NH	NH	NH	NH	6	25	55	54	48	29	0	0			217±47.63	93.97
20	225	NH	NH	NH	NH	18	25	25	32	44	21	0	0			165±32.83	44.44
50	378	NH	NH	NH	NH	NH	NH	14	105	75	48	0	0			242±26.03	32.10
70	387	NH	NH	NH	NH	NH	NH	28	104	12	12	0	0			156±36.07	32.50
100	355	NH	NH	NH	NH	NH	NH	NH	12	49	47	0	0			118±15.00	30.42
F value		2.37															
CD at 5%		33.87															
		<i>Piper betle</i>															
1	225	NH	NH	NH	NH	19	19	20	45	48	57	17	0			210±20.51	80.65
5	270	NH	NH	NH	NH	15	22	39	73	43	38	0	0			250±24.94	70.77
10	315	NH	NH	NH	NH	6	25	55	54	48	29	0	0			296±23.76	72.00
20	315	NH	NH	NH	NH	18	25	25	32	44	21	0	0			140±15.61	73.33
50	405	NH	NH	NH	NH	NH	NH	14	105	75	48	0	0			130±39.75	64.02
70	400	NH	NH	NH	NH	NH	NH	28	104	12	12	0	0			130±33.88	40.31
100	315	NH	NH	NH	NH	NH	NH	NH	12	69	47	0	0			120±25.72	36.06
F value		3.04															
CD at 5%		30.00															
NH - Not hatched																	

Table 2. Effect of different concentrations of medicinal plants extracts (aqueous) on the mortality of mealy bugs at nymphal stage.

Conc./Days	Mortality (%)																	Total nymphal period (days)
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
Control	0.00	0.00	0.00	13.33	15.00	25.00	31.67	48.33	53.33	55.00	55.00	55.00	55.00	-	-	-	-	13
	<i>Eucalyptus globulus</i>																	
1	11.70	26.67	50.00	71.67	75.00	90.00	95.00	96.67	98.33	98.33	100.00	-	-	-	-	-	-	17
5	21.65	46.67	68.33	76.67	90.00	91.67	98.33	98.33	100.00	-	-	-	-	-	-	-	-	17
10	36.67	53.33	70.00	81.67	85.00	93.33	96.67	96.67	100.00	-	-	-	-	-	-	-	-	16
20	36.67	53.33	65.00	66.67	85.00	96.67	100.00	-	-	-	-	-	-	-	-	-	-	15
50	63.34	68.33	81.67	93.33	96.67	96.67	100.00	-	-	-	-	-	-	-	-	-	-	13
70	48.35	58.33	85.00	95.00	96.67	98.33	100.00	-	-	-	-	-	-	-	-	-	-	13
100	70.00	73.33	100.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11
F value	43.77	22.41	30.56	29.05	54.33	33.18	76.63	86.13	383.16	169.00	243.00	-	-	-	-	-	-	8.15
CD at 5%	4.17	5.72	6.20	5.81	4.41	5.20	2.16	1.27	0.87	1.75	1.52	-	-	-	-	-	-	2.46
	<i>Ocimum sanctum</i>																	
1	18.33	31.67	46.67	48.33	68.33	83.33	85.00	87.86	96.67	96.67	98.33	98.33	100.00	-	-	-	-	11
5	25.00	28.33	36.67	58.33	70.00	83.33	90.00	90.71	91.67	91.67	96.67	100.00	-	-	-	-	-	9
10	30.00	38.33	60.00	61.67	80.00	86.67	91.67	93.10	98.33	98.33	100.00	-	-	-	-	-	-	9
20	33.33	33.33	61.67	61.67	70.00	90.00	93.33	94.05	96.67	96.67	100.00	-	-	-	-	-	-	7
50	38.33	48.33	58.33	75.00	88.33	95.00	96.67	96.67	96.67	96.67	100.00	-	-	-	-	-	-	7
70	38.33	53.33	71.67	78.33	91.67	93.33	96.67	96.67	100.00	-	-	-	-	-	-	-	-	7
100	43.33	50.00	68.33	83.33	91.67	93.33	100.00	-	-	-	-	-	-	-	-	-	-	3
F value	4.39	6.05	20.83	24.52	20.46	20.25	72.61	68.07	40.82	41.92	78.11	121.50	243.00	-	-	-	-	10.97
CD at 5%	4.99	5.01	3.82	3.97	4.50	4.43	3.52	3.02	1.63	0.87	1.44	1.52	-	-	-	-	-	2.13
	<i>Piper betle</i>																	
1	1.67	10.00	26.67	33.33	45.00	58.33	65.00	71.67	71.67	73.33	75.00	86.67	91.67	95.00	96.67	98.33	100.00	13
5	5.00	16.67	33.33	50.00	51.67	71.67	73.33	75.00	80.00	95.00	95.00	95.00	95.00	98.33	96.67	98.33	100.00	12
10	8.33	20.00	40.00	48.33	60.00	68.33	68.33	81.67	86.67	95.00	95.00	96.67	96.67	93.33	98.33	100.00	-	11
20	0.00	40.00	65.00	65.00	71.67	73.33	76.67	78.33	86.67	86.67	90.00	95.00	95.00	98.33	100.00	-	-	11
50	5.00	23.33	38.33	60.00	76.67	76.67	81.67	86.67	96.67	96.67	96.67	98.33	100.00	-	-	-	-	11
70	0.00	48.33	60.00	76.67	83.33	80.00	81.67	88.33	88.33	91.67	95.00	98.33	100.00	-	-	-	-	9
100	15.00	26.67	65.00	80.00	91.67	93.33	93.33	93.33	95.00	98.33	100.00	-	-	-	-	-	-	7
F value	2.75	3.78	4.48	4.16	5.42	4.43	5.26	3.37	5.33	10.72	14.60	24.59	28.96	40.94	72.38	72.67	243.00	12.88
CD at 5%	2.36	5.98	7.87	17.33	7.93	7.15	5.96	5.67	4.58	3.33	2.88	2.19	2.06	1.88	1.51	1.66	0.95	1.82

Table 3. Effect of different concentrations of medicinal plants extracts (aqueous) on the mortality and fecundity of adult mealy bugs.

Conc./ Days	Mortality (%)																Fecundity		Total adult period (days)
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	No.	% decrease over control	
Control	0.00	5.00	6.67	6.67	35.00	55.00	61.67	65.00	91.67	95.00	100.00	-	-	-	-	-	398.00	100	11
<i>Eucalyptus globulus</i>																			
1	0.00	3.33	13.33	20.00	30.00	46.67	50.00	70.00	86.67	98.33	100.00	-	-	-	-	-	338.00	84.92	11
5	5.00	10.00	21.67	30.00	46.67	61.67	75.00	76.67	98.33	98.33	100.00	-	-	-	-	-	266.00	66.83	11
10	5.00	16.67	25.00	38.33	45.00	50.00	75.00	78.33	93.33	96.67	98.33	100.00	-	-	-	-	202.00	50.75	12
20	5.00	23.33	23.33	33.33	45.00	51.67	68.33	71.67	81.67	90.00	90.00	96.67	96.67	98.33	100.00	-	196.00	49.24	15
50	11.67	15.00	16.67	25.00	36.67	46.67	60.00	63.33	78.33	86.67	95.00	98.33	100.00	-	-	-	180.00	45.22	13
70	15.00	23.33	33.33	41.67	48.33	55.00	65.00	73.33	93.33	98.33	100.00	-	-	-	-	-	100.00	25.12	11
100	11.67	18.33	23.33	28.33	55.00	80.00	93.33	100.00	-	-	-	-	-	-	-	-	78.00	19.59	8
F value	1.80	4.29	3.26	4.75	1.14	1.82	3.50	3.24	4.13	2.73	9.25	0.60	1.00	0	0	-	1.98	-	11.95
CD at 5%	2.75	3.55	3.36	3.79	5.72	6.08	5.18	4.75	2.60	2.10	0.94	1.61	1.76	0	0	-	25.14	-	1.94
<i>Ocimum sanctum</i>																			
1	6.66	13.33	23.33	25.00	41.67	48.33	60.00	63.33	91.67	96.67	100.00	-	-	-	-	-	354.00	88.94	11
5	6.66	16.67	21.67	31.67	45.00	55.00	63.33	78.33	90.00	96.67	98.33	100.00	-	-	-	-	244.00	61.30	12
10	11.67	21.67	35.00	48.33	53.33	63.33	78.33	85.00	86.67	88.33	88.33	96.67	100.00	-	-	-	246.00	61.80	13
20	8.34	8.33	21.67	36.67	55.00	63.33	71.67	90.00	91.67	91.67	96.67	98.33	98.33	100.00	-	-	92.00	23.11	15
50	6.66	13.33	23.33	28.33	70.00	71.67	80.00	90.00	91.67	93.33	93.33	95.00	96.67	96.67	100.00	-	42.00	10.55	15
70	8.34	11.67	31.67	50.00	81.67	88.33	96.67	96.67	98.33	98.33	98.33	100.00	-	-	-	-	34.00	8.54	12
100	6.66	11.67	78.33	86.67	95.00	98.33	98.33	98.33	100.00	-	-	-	-	-	-	-	28.00	7.03	9
F value	1.61	1.14	16.33	15.70	6.43	5.37	4.03	3.22	1.13	0.83	1.56	1.06	0.60	0.20	0	-	2.20	-	10.23
CD at 5%	1.90	3.52	3.92	4.45	6.14	5.61	5.61	5.58	3.05	2.83	2.54	1.57	1.61	1.97	-	-	28.36	-	1.91
<i>Piper betle</i>																			
1	0.00	8.33	15.00	16.67	20.00	33.33	35.00	46.67	61.67	73.33	90.00	100.00	-	-	-	-	374.20	94.02	12
5	1.67	6.67	15.00	18.33	28.33	38.33	45.00	58.33	70.00	81.67	95.00	96.67	100.00	-	-	-	338.20	84.97	13
10	3.33	11.67	18.33	30.00	40.00	48.33	51.67	60.00	73.33	75.00	76.67	78.33	85.00	90.00	95.00	100.00	228.00	57.28	16
20	5.00	6.67	16.67	20.00	28.33	43.33	55.00	63.33	70.00	76.67	81.67	91.67	96.67	100.00	-	-	218.00	54.77	14
50	13.33	18.33	25.00	28.33	38.33	50.00	55.00	65.00	73.33	81.67	91.67	98.33	100.00	-	-	-	164.60	41.45	13
70	21.67	26.67	28.33	35.00	43.33	55.00	56.67	66.67	71.67	83.33	91.67	100.00	-	-	-	-	158.40	39.69	12
100	33.33	40.00	48.33	51.67	56.67	70.00	75.00	76.67	78.33	91.67	100.00	-	-	-	-	-	154.20	38.69	11
F value	6.23	5.84	4.41	5.20	2.41	5.10	5.69	2.92	2.74	3.35	4.22	15.06	18.25	12.00	-	-	2.80	-	4.74
CD at 5%	3.63	3.81	4.47	4.47	5.37	3.76	3.66	3.71	3.89	3.12	2.96	0.95	1.21	1.51	-	-	31.11	-	2.40

suppressed by using neem product (Biomix-1) and the population of mealy bugs was considerably reduced, due to slow contact poisoning.

In all the extracts with the increase in conc. of extracts there was corresponding decrease in the no of eggs laid (fecundity) by the adults mealy bugs. Maximum reduction in fecundity was recorded in *E. globulus* (7.03%) followed by *O. sanctum* (19.59%) and *P. betle* (38.69%) over control (100%). Maximum fecundity was observed in control as well as at low conc. of 1, 10, and 20 percent. At higher conc. sterility in adults was noticed in case of *E. globulus* and *O. sanctum* treatments and there was no egg laying. Besides, they became brittle. While in case of *P. betle*, the reduction in fecundity was observed. Ilio *et al.* (1999) made similar reports where they observed a gradual decrease in fecundity with an increase of neem concentration. The plant extracts may possess a strong sterilant activity and an insecticidal action at high concentrations against mealy bugs.

A critical analysis of the data clearly indicates that *E. globulus* was most effective against all the stages (egg, nymph and adult) of mealy bugs followed by *O. sanctum* and *P. betle* over control at higher concentrations under *in vitro* conditions.

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