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Evaluation of different plant extracts for management of mealy bugs and leaf rollers in the mulberry field

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Abstract
The study was conducted to see the insecticidal effect of medicinal plants namely *Lantana camara* Linn. (lantana), *Allium sativum* Linn. (Garlic), *Zingiber officinale* Rose. (Ginger), *Azadirachta indica* Juss.(neem) and *Vitex negundo* Linn.(vitex) at farmer garden, Medenahalli village, Bangalore and Sericulture Department, Bangalore University against mealy bug *Maconellicoccus hirsutus* during summer season. In case of leaf roller *Diaphania pulverulentalis*, it was sprayed at farmer garden, Tagachuguppae village, Bangalore and Mulberry farm Sericulture Department, Bangalore University during winter season respectively. The results indicated that among all the extracts tested, the 2% lantana extract has controlled the mealy bugs infestation to 46.87-49.00%, the percent of nymphs and adult mealy bugs was reduced to 24.09-39.92% and 23.68-24.62% respectively on fifth day after treatment. In case of leaf rollers, the 11% vitex extract has reduced the percent of mulberry infestation to 46.86-56.32%, the second and third instar larvae of leaf roller reduced to 38.80-46.87% and 27.85-30.70% respectively on fifth day after treatment. The result indicated that the lantana extract at lower concentration 2% and 11% was found to be better to control mealy bugs and leaf rollers compared to other extracts which are safer concentration for silkworm without any harm.

Keywords: Plant extracts, *Maconellicoccus hirsutus*, *Diaphania pulverulentalis*, Field

1. Introduction
Sericulture is an agro based cottage industry mainly practiced by the small and marginal farmers of our country, which offers more employment opportunities and generating higher income. More than 59 countries in the world have been involved in natural silk production [1]. India has an unique distinction of producing commercially all the four types of natural silk yielded by sericigenous insects viz. Mulberry silkworm *Bombyx mori* Linn., Tropical tasar silkworm *Antheraea mylitta* Drury., Muga silkworm *Antheraea assama* West wood., and Eri silkworm *Samia cynthia ricini* Boisdual [2]. Mulberry silk production involves mulberry cultivation, which is the sole food of rearing the silkworm, reeling of cocoons and weaving of fabric [3]. Of all these, the mulberry cultivation plays a significant role in determining the production of raw silk. In mulberry cultivation, there are four important factors viz. climate, variety, agronomical inputs and plant protection measures which determine the leaf yield and quality [4]. However, some of the major constraints for the successful cultivation and production of quality mulberry leaf are insufficient rainfall, non availability of agronomical inputs and outbreak of pests and diseases [5]. So far, over 300 species of insect and non-insect pests have been reported to infest mulberry crop causing qualitative and quantitative damage [6]. The major pests of mulberry are Leaf roller, Bihar hairy caterpillar, Cut worm (Lepidoptera), Jassid, Spiralling white fly, Mealybug, Scale insect (Homoptera) [7].
Among the various pests, the mealybug *M. hirsutus* Green causing damage to the mulberry plant by infesting the apical portion and it occupies the key position in reducing the mulberry leaf yield and quality [8]. The reduction of leaf quality leads to poor performance of silkworm cocoon production [9]. The leaf roller *D. pulverulentalis* Hampson (Lepidoptera: Pyralidae) is causing serious damage with an average incidence of 27.85% in Karnataka, 20.98% in Andhra Pradesh and 16.48% in Tamil Nadu [10] and the incidence is severe during winter months (October-February). Since mulberry is the sole food plant of the silkworm *B. mori*, application of chemical pesticides to manage the pests of mulberry is not advisable. Large numbers of chemical pesticides are available for the ruled out these harmful pests. But spray of these toxic

chemicals directly or indirectly influence the rearing of silkworm and cocoon productivity. Therefore it is most appropriate to investigate on the viable, effective, economical and safer botanical formulations for mulberry pest management. Keeping this in view, the present study was undertaken to explore the different species of plants having insecticidal properties against the mealy bug *M. hirsutus* and leaf roller *D. pulverulentalis*.

2. Materials and Methods

The five medicinal plant extracts such as *Lantana camara* Linn. (lantana), *Allium sativum* Linn. (garlic), *Zingiber officinale* Rose. (ginger), *Azadirachta indica* Juss.(neem) and *Vitex negundo* Linn.(vitex) were evaluated against mealy bugs (March-April'2007) and leaf rollers (Nov-Dec'2007) both *in vitro* and *in vivo* conditions.

2.1 Extraction of plant extracts (using water):

The selected plant materials was collected from the field and thoroughly washed with tap water 3-4 times and finally with distilled water. The fresh extract was prepared by taking the known quantity of plant material and crushed in mixer by adding required quantity of water (100gm of plant material was crushed by adding 200 ml of water). The extract was filtered through muslin cloth and the concentration of the filtrate was prepared to 100 per cent and stored in clean reagent bottle maintained as stock solution. From this stock solution, 1, 3, 5, 7, 9, 11, 13, 15, 20 and 25 per cent extracts were prepared and used by following the procedure suggested [11, 12].

2.2 Screening of plant extracts against mealy bugs and leaf rollers

Preliminary study was carried out to see the toxicity of plant extracts against pest infested plants, nymphs and adults of mealybug *M. hirsutus* using various concentrations viz. 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10% prepared from the extracts of the following plants viz. lantana, garlic, ginger, neem and vitex. After treatment, the mortality was calculated at different intervals such as 24, 48 72, 96, 120, 144 and 168 h. Based on the screening, one concentration from each plant extract viz. 2% lantana; 4% garlic; 8% ginger; 8% neem and 10% vitex were selected and tested in the field to see the controlling efficiency against mealy bugs affected field as well as on mealy bugs.

In case of leaf roller *D. pulverulentalis*, similar screening was conducted, as a result one concentration/plant extract were selected i.e.11% lantana; 15% garlic; 15% ginger; 20% neem and 25% vitex to study its effect in the leaf roller infested field as well as on 2nd and 3rd instar larvae leaf roller.

2.3 Field testing of plant extracts against mealy bugs

The field experiment was conducted in a plot measuring of 104.36×104.36 sq. ft. (25 cents) (RBD) in two mulberry gardens at Medenahalli village, Bangalore Rural District and Bangalore University campus, Bangalore. The field comprised of three blocks and six treatments (each treatment replicated three times). The measurement of each treatment plot was 4 cents comprising of 190 plants. Normal fertilizer application dose and agronomical practices were followed. Each treatment was prepared by mixing required extract along with an emulsifier soap solution of teepal.

T1 - Check with water spray
T2 - 2% Leaf extract of Lantana
T3 - 4% Bulb extract of Garlic
T4 - 8% Rhizome extract of Ginger
T5 - 8% Leaf extract of Neem
T6 - 10% Leaf extract of Vitex

The treatments were used on 25 days old mulberry plants (comprising pest infested plants) in cooler hours. Observations were recorded from the preceding day of spraying, 3rd day and 5th day.

2.4 Field testing of plant extracts against leaf rollers

Similarly, two mulberry gardens were selected at Tagachuguppae village, Bangalore Urban District, Bangalore and Bangalore University campus, Bangalore to study the effect of following treatments against leaf roller *D. pulverulentalis*

T1 - Check with water spray
T2 - 25% Leaf extract of Vitex
T3 - 20% Leaf extract of Neem
T4 - 15% Rhizome extract of Ginger
T5 - 15% Bulb extract of Garlic
T6 - 11% Leaf extract of Lantana

These extracts were taken and their spray solutions were prepared as indicated above and sprayed on 25 days old mulberry plants in cooler hours.

Observations were recorded from the preceding day of spraying to fifth day. Per cent reduction of larval population was worked out on third and fifth day after spraying. Both mealy bugs/leaf rollers incidences was assessed by recording the number of healthy and infested plants and the cumulative percentage of infestation was worked out as under.

$$\textbf{Percentage of incidence} = \frac{\text{No. of pest infested plants}}{\text{Total number of plants/unit area}} \times 100$$

2.5 Statistical Analysis of Data

Multivariate analysis was the statistical tools utilized to study how the plant extracts related to one another, and how it works on the pest and its infestation to distinguish between the cases on which the observations are made to determine the mean reduction of nymphs and adult mealy bugs as well as reduction of second and third instar larvae of leaf roller and their infestation of the plants after the treatment.

3. Results

Efficacy of botanical extracts was evaluated against mealy bugs and leaf rollers. The results of this experiment have been presented and discussed under the following sub-headings.

3.1 Evaluation of plant extracts against mealy bugs at field

The mortality of the mealy bugs recorded on third and fifth day after spray of the plant extracts indicated that, the pest infested plants and pests incidence recorded on third day after spray was lesser compare on fifth day after treatment. It was also observed that the mortality of the nymphs was higher than that of adults. Among the treatments tested, 10% vitex extract has recorded maximum per cent reduction of nymphs, adult mealy bugs and its infestation both at Medenahalli village and Bangalore University on fifth day after treatment was 67.81-69.00%, 57.48-65.50 and 63.19-69.73 respectively. The minimum reduction of infested plants, nymphs and adult mealy bugs recorded with 2% lantana extract was 46.87-49.00%, 24.09 - 39.92 and 23.68 - 24.62 respectively on fifth day after treatment. The effect of other plant extracts on the pests are showed in the Tables-1&2

Table 1: Efficacy of plant extracts against mealy bug (*Maconellicoccus hirsutus*) infestation and its population (Field trial - Medenahalli village) (Mean values)

Parameters	Treatments																		CD @ 5%
	T1-Control			T2-Vitex			T3-Neem			T4-Zinger			T5-Garlic			T6-Lantana			
	Count (%)																		
	Zero	1st	2nd	Zero	1st	2nd	Zero	1st	2nd	Zero	1st	2nd	Zero	1st	2nd	Zero	1st	2nd	
No.of infested plants reduced	6.9	12.39	17.12	7.87	5.27	2.53	8.97	6.22	3.92	6.78	4.36	3.15	8.17	5.67	4.50	7.09	4.74	3.77	6.53
Percentage of infested plants reduced					33.05	67.81		30.66	56.32		35.67	53.58		30.67	44.98		33.05	46.87	
No.of mealy bug nymphs reduced	16.0	24.31	32.37	21.19	11.35	7.31	21.97	14.34	9.29	24.42	17.76	12.67	23.07	17.60	13.97	25.20	19.11	15.14	3.27
Percentage of mealy bug nymphs reduced					46.44	65.50		34.73	57.72		27.27	48.12		23.71	39.45		24.17	39.92	
No.of mealy bug adults reduced	5.5	8.93	13.16	6.64	4.02	2.01	10.01	7.84	5.65	9.07	7.46	6.29	9.69	8.46	7.14	11.70	10.22	8.93	2.72
Percentage of mealy bug adults reduced					39.46	69.73		21.68	43.56		17.75	30.65		12.69	26.32		12.65	23.68	

Table 2: Efficacy of plant extracts against mealy bug (*Maconellicoccus hirsutus*) infestation and its population (Field trial at Bangalore University)

Parameters	Treatments																		CD @ 5%
	T1-Control			T2-Vitex			T3-Neem			T4-Zinger			T5-Garlic			T6-Lantana			
	Count (%)																		
	Zero	1st	2nd	Zero	1st	2nd	Zero	1st	2nd	Zero	1st	2nd	Zero	1st	2nd	Zero	1st	2nd	
No. of infested plants reduced	13.2	16.4	17.94	15.78	10.39	4.89	17.15	12.31	8.11	16.09	12.02	7.47	14.86	10.78	7.90	14.20	10.14	7.24	10.25
Percentage of infested plants reduced	-	-	-	-	34.14	69.00	-	28.19	52.70	-	25.31	53.58	-	27.51	46.87	-	28.63	49.00	
No. of mealy bug nymphs reduced	18.5	25.6	34.61	26.32	16.61	11.19	22.54	15.06	10.22	26.13	19.67	16.61	25.66	19.86	18.19	26.57	20.72	20.17	2.66
Percentage of mealy bug nymphs reduced					36.89	57.48		33.19	54.66		24.72	36.43		22.60	29.11		22.02	24.09	
No. of mealy bug adults reduced	4.6	10.4	15.24	9.78	6.55	3.60	11.70	9.62	6.44	11.41	9.97	7.81	15.54	13.51	10.78	12.39	10.92	9.34	3.19
Percentage of mealy bug adults reduced					33.03	63.19		17.78	44.96		12.62	31.55		13.06	30.63		11.86	24.62	

Note: Ist count - 3rd day after spray; 2nd count - 5th day after spray

Table 3: Efficacy of plant extracts against leaf roller (*Diaphania pulverulentalis*) infestation and its population (Field trial at Thagachuguppae village)

Parameters	Treatments																		CD @ 5%
	T1-Control			T2-Vitex			T3-Neem			T4-Zinger			T5-Garlic			T6-Lantana			
	Count (%)																		
	Zero	1st	2nd	Zero	1st	2nd	Zero	1st	2nd	Zero	1st	2nd	Zero	1st	2nd	Zero	1st	2nd	
No.of Infested plants reduced	7.53	11.58	18.39	9.74	5.70	3.14	8.71	5.09	2.80	6.94	4.20	2.65	8.29	5.02	2.87	8.27	5.53	4.39	5.42
No. of infested plants reduced (%)	-	-	-	-	41.52	67.81	-	41.52	67.82	-	39.43	61.84	-	39.40	65.33	-	33.06	46.86	
No.of second instar leaf roller reduced	9.61	13.68	16.74	10.72	6.27	2.49	10.97	4.63	3.53	9.63	5.51	4.37	7.80	5.75	4.56	7.51	6.33	3.99	7.17
Second instar leaf roller reduced (%)					41.51	76.77		57.79	67.82		42.78	54.62		26.28	41.54		15.71	46.87	
No.of third instar leaf roller reduced	3.29	3.29	3.76	5.70	1.98	1.98	7.34	2.80	2.22	5.51	2.10	2.10	5.22	3.62	2.51	5.96	4.13	4.13	5.07
Third instar leafroller reduced (%)					55.26	65.26		61.85	69.75		51.89	61.89		30.65	51.92		22.70	30.70	

Table 4: Efficacy of plant extracts against leaf roller (*Diaphania pulverulentalis*) infestation and its population (Field trial at Bangalore University campus)

Parameters	Treatments																		CD @ 5%
	T1-Control			T2-Vitex			T3-Neem			T4-Zinger			T5-Garlic			T6-Lantana			
	Count (%)																		
	Zero	1st	2nd	Zero	1st	2nd	Zero	1st	2nd	Zero	1st	2nd	Zero	1st	2nd	Zero	1st	2nd	
No.of Infested plants reduced	9.18	11.84	15.70	8.79	5.14	2.83	11.2	6.98	3.36	9.44	5.04	3.64	8.69	5.27	3.01	8.12	4.92	3.55	7.27
No.of infested plants reduced (%)	-	-	-	-	41.51	67.82	-	37.86	70.12		46.59	61.48		39.43	65.33		39.43	56.32	
No.of second instar leaf roller reduced	7.92	11.14	14.26	11.8	5.14	3.56	9.11	4.84	2.66	8.33	5.04	3.64	8.18	5.48	4.18	9.20	7.09	5.63	7.78
Second instar leaf roller reduced (%)					56.59	69.93		46.87	70.80		39.50	56.30		33.01	48.90		22.93	38.80	
No.of third instar leaf roller reduced	3.02	3.81	5.49	5.14	2.83	2.24	4.23	2.12	2.12	4.58	2.52	2.00	5.48	4.18	2.09	4.92	4.47	3.55	4.09
Third instar leafroller reduced (%)					44.94	56.42		39.88	49.88		44.98	56.33		23.72	61.86		9.15	27.85	

Note : Ist count - 3rd day after spray; 2nd count - 5th day after spray

3.2 Evaluation of plant extracts against leaf rollers at field

The results on the field trials conducted at Tagachuguppae village and Bangalore University using plant extracts against leaf rollers revealed that the mortality of the second instar was higher than that of third instar. Among the plant extracts tested, the per cent reduction of pests infested plants, 2nd and 3rd instar larvae of leaf roller recorded with 25% vitex extract on fifth day after treatment was ranged from 67.81-67.82%, 69.93-76.77 and 56.42-65.26 respectively. Incase of 11% lantana extract, the pest infestation and the 2nd and 3rd instar leaf roller larvae reduction was 46.86-56.32, 38.80-46.87 and 27.85-30.70 respectively. The toxicity of other plant extracts viz. garlic, ginger and neem are reported in Tables-3-4.

4. Discussion

Botanicals are reported to be safer than synthetic insecticides, easily biodegradable, environmentally safe, non-persistent and easily available and processed [13]. The results on the plant extracts tested against mealy bugs revealed that the higher percent of reduction of plant infestation, nymphs and adult mealy bugs recorded with 10% vitex extract was higher compare to other extracts. As the dose level of the plant extracts increases, the percentage of mortality of the nymphs and adult mealy bugs also increases. The leaf extract of *Vitex negundo* was found to be toxic against *S.littoralis* [14], *Plutella xylostella* [15]. The presence of toxic compounds like terpenes, cinol, sabeniene, sesqueterpenes in *Vitex negundo* extract might be the reason for its higher repellency property [16]. Also this is in agreement with the findings of the neem seed kernel extract which showed maximum reduction of mealybug incidence from 9.06 to 2.85% with suppression of 69.03% in the field area at Hindupur, Andhra Pradesh [17]. Even both ginger and garlic have been found effective in controlling leaf roller, thrips, mealy bugs, fruit, stem and bark borers, hairy caterpillar and aphids also [18]. But due to its persistant odour in mulberry after treatment, the silkworm *Bombyx mori* consumption was less. The impact in tissue of the silkworm when fed with normal and crude *Azadirachta indica*, *Ocimum sanctum* and *Parthenium hysterophorus* extracts against mealy bugs shows normalcy, but in the tukra infected mulberry leaves fed by silkworms the tissues shows slight degenerative with nutritional impact upon them [19].

Similarly among the extracts tested against leaf roller, 11% lantana extract controls the leaf roller infestation, second and third instar leaf roller incidence at optimum level. The results are in concordance with the findings that the methanol extract of *Lantana camara* (L.) leaves which was found more effective than ethanol as methanol has been inhibited by 2.8% infected leaf compare to 1.1% increase by Ethanol extract [20]. *Lantana camara* (L.) leaf extract found effective, antifungal property of *L.camara* and *O. sanctum* against *Drechslera sorokiniana* were reported. Even leaf applications of crude aqueous extract of *L. camara* leaves are highly effective in controlling the lepidopteran pest *S. litura* reported [21]. Adulticidal activity of essential oil of *Lantana camara* (L.) leaves against mosquitoes also reported [22].

Biopesticides considered being safe to natural enemies and free from any residue problem on the crop and in the environment [23]. The use of plant extracts with insecticidal properties has the potential of reducing the effects of insect pests of forest tree and agricultural crops. These can be of importance to the resource-poor farmers in many areas of the developing world. If these biopesticides produced commercially and farmers are trained for their use there is no doubt that these eco-safe products can replace the hazardous chemicals of the field in coming days.

Thus from the fore going discussion, it was concluded that among the extracts tested, the 2% and 11% lantana extract extract can be used to control mealy bugs and leaf rollers and its infestation respectively without harming the silkworm since the mulberry is only food plant for mulberry silkworm *Bombyx mori* L. This plant product is also eco-friendly, easily available and economically viable.

5. Conclusion

Based on the results of the study mulberry growers may use botanical extracts instead of chemicals which is used for the suppression of mealy bugs and leaf rollers in mulberry fields.

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