Effect of botanical insecticides on the growth and silk production of Ambagoan and Lakhimpur strains of eri silkworm, *Samia cynthia* ricini (Boisduval)

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ABSTRACT

Castor, *Ricinus communis* L. (Malpighiales : Euphorbiaceae) is an important non-edible oilseed crop, the leaves of which also serve as primary food plant of eri silkworm, *Samia cynthia ricini* Boisduval. A study was undertaken to evaluate the effect of botanical insecticides *viz.,* Neem oil and Karanj oil on the growth and silk production of plain white and brick red strains of eri silkworm during *Kharif* and *Rabi*, 2011-12 at Ericulture Laboratory of RARS, Palem. The experiment was conducted with 50 larvae per treatment with five treatments of botanicals and an untreated control. During fourth instar least larval weight of 0.38g was recorded in the plain white strain of eri silkworm larvae that were fed with karanj oil (5mL/lit) treated leaves followed by the larvae fed with 2 mL/lit karanj oil (0.46 g) and 10 mL/lit neem oil (0.5g). In brick red strain the weight of the larva was significantly higher compared to the plain white strains and this strain has shown some resistance to karanj oil treatment. Effective rate of rearing (ERR) varied from 76.84 to 89.9% in plain white strains, whereas in brick red strains it ranged from 79.88% to 91.46%. Comparatively shorter larval duration was recorded in brick red strains than plain white strains. In plain white strains, significantly higher weight was recorded in the cocoons formed out of worms fed with 3mL/lit neem oil (1.89g) and 2 mL/lit karanj oil (1.82g) treated leaves. In brick red strains, higher shell weight of 0.64g was recorded with control treatment closely followed by 2 ml/lit karanj oil (0.50g) treatment showing its loss of efficacy. The treatmental differences were significant with respect to fecundity and non significant differences were noticed with hatching per cent.

Key words: Eri silkworm, Botanicals, effective rate of rearing, shell ratio, fecundity, hatchability, cocoons

INTRODUCTION

India is known for the production of all commercially exploited insects silk and ranks next to China. Apart from the marvelous mulberry silk, which is quite popular the world over, there are a few other varieties that are equally attractive. They are collectively termed as 'vanya silks' comprising tasar, eri and muga silks. In India, ericulture is an age old cottage industry, once confined to the state of Assam. Overtime, it has spread to other North Eastern States, applicable for local conditions, thus making Ericulture a remunerative subsidiary cottage industry. Castor (*Ricinus communis* L.) is one of the ancient oil seed crops grown in India, a primary food plant of eri silkworm. In Andhra Pradesh, Mahabubnagar district occupies first position with an area of 0.66 lakh ha with a production of 0.48 lakh tons and with productivity of 727 kg/ha (2011-2012).

Among the commercially exploited non-mulberry silkworms, the eri silkworm, *Samia cynthia ricini* Boisduval (Lepidoptera : Saturniidae) is the only species domesticated completely and adopted to indoor rearing all through the year (Reddy, 2000; Debaraj *et al.,* 2002). The eri silkworm can be reared throughout the year to a maximum of 6-7 times a year (Rajesh Kumar and Elangovan, 2012). Over 25 species of plants have been reported as hosts (Arora and Gupta, 1979). However, the degree of preference with regard to the acceptance of the host leaf, the worm growth, development and cocoon yield varies.

Eri cocoon shells contribute considerably to spun silk production. Therefore, the silk content in the shells plays a significant role in increasing the spun silk output. Several attempts have been made in this direction and use of some plant extracts have proved beneficial in increasing the silk cocoon and egg yield in mulberry silkworm, *Bombyx mori* L. (Rajashekhargouda, 1991; Murugan *et al.,* 1998). Even in eri silkworm, 10% aqueous extracts of *Amaranthus spinosus*, *Tridax procumbens* and *Parthenium hysterophorus* are known to improve the economic traits (Jayaprakash Rao, 1998). Various biochemicals present in the botanicals *viz.,* â-sitosterol, campesterol, stigmasterol, glucose, galactose,

ascorbic acid, saponin and oleic acid are known to act as larval biting factors (Hamamura *et al.,* 1961) and some as insect growth regulators (Murugan *et al.,* 1998).

The indiscriminate and excessive use of insecticides for the control of insect pests leads to development of insecticidal resistance leading to environmental pollution. In this context the present study was undertaken to know the effect of botanical insecticides (Chari and Muralidharan, 1985; Prabhakar *et al.,* 2003) on the growth and silk production of two eri silkworm strains.

MATERIALS AND METHODS

To study the effect of botanical insecticides on the growth and silk production of eri silkworm, a lab trail was conducted in well equipped Ericulture Laboratory of Regional Agricultural Research Station, Palem, Andhra Pradesh. The rearings were undertaken during *Kharif* and *Rabi* 2011-2012. The experiment was conducted in completely randomized block design with six treatments *viz.,* Neem oil @ 3mL, 5mL and 10 mL/lit and Karanj oil @ 2mL and 5mL/lit and untreated control on two eri silkworm strains *viz.,* Plain white cocoon type (Ambagoan) and brick red cocoon type (Lakhimpur) using the most popular PCH-111 hybrid leaves.

The disease free layings (eggs) of two eco races of eri silkworms were procured from Regional Eri Research Station (Central Silk Board), Shadnagar. Prior to brushing rearing rooms and appliances were disinfected with 2% formalin and 5% bleaching powder solution. The eggs were incubated at room temperature and undergone black boxing for uniform hatching. Standard rearing methods were adopted as recommended by Dayashankar (1982).

The worms were fed with untreated castor leaves by maintaining 50 larvae per treatment upto second moult. From second instar onwards, the eri worms were fed with treated leaves commencing from 24 hrs after treatment with the botanicals. The leaves were dipped in the botanical solution, drained out the solution and fed to the eri silkworms. The observations on weight of eri silkworm were recorded at the end of third, fourth and fifth instars by taking 10 worms per treatment using electronic balance with 0.01g accuracy. Matured worms were mounted in the bamboo Chandrika with optimum spacing (i.e. 50-60 worms/sq feet) and maintained with proper aeration in the mounting room. During rearing, precautionary measures such as use of disinfectant, proper bed cleaning and sanitation techniques were advocated as recommended by Sarkar (1988). The cocoons were harvested on sixth day of spinning. The temperature and relative humidity during the season were recorded using the dry and wet bulb thermometer (Table 1).

Table 1. Monthly mean temperature and relative humidity in Ericulture Laboratory of RARS, Palem

Year/Month	Temperature (°C)		Relative humidity (%)
	Dry bulb	Wet bulb	
August	29.4	26.4	88.4
September	28.1	25.4	87.6
October	27.4	24.1	89.2
November	27.1	23.6	88.5
December	26.4	22.4	82.4
January	25.1	20.9	62.8
February	27.6	22.4	70.8
March	30.4	27.9	70.1

The duration of different stages of larvae fed with treated leaves was recorded. The observations were also recorded on the cocoon parameters *viz.,* cocoon weight, pupal weight, shell weight, shell ratio percentage by taking 10 cocoon samples from each replication. The shell percentage was calculated by using the following formula.

$$\text{Shell (\%)} = \frac{\text{Shell weight}}{\text{Cocoon weight}} \times 100$$

Grainage parameters, such as fecundity and hatching per cent were recorded by taking 10 female moths per replication.

The data generated during the course of investigation was analyzed statistically at 5 per cent level of significance and the data showing values in percentage were subjected to angular transformation as per Snedecor and Cochran (1979). The ranking of treatment means was done following Duncan's Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

The results of the plain white (Ambagoan) and brick red (Lakhimpur) strains of eri silkworm obtained on the larval, cocoon and grainage parameters are presented hereunder.

Effect on larval weight

The larvae fed with the treated leaves showed significant differences in their weights during fourth and fifth instars as compared to the control. But the treatmental differences were non significant during the third instar. During fourth instar least larval weight of 0.38g was recorded in the plain white strain of eri silkworm larvae that were fed with karanj oil (5mL/lit) treated leaves followed by the larvae fed with 2 mL/lit karanj oil (0.46g) and 10 mL/lit neem oil (0.5g) treated leaves with no statistical variation among them. The larvae that were nourished with the leaves devoid of botanical insecticides recorded significantly higher larval weight (1.5g) closely

followed by the larvae treated with 3 mL/lit neem oil (0.98g) (Table 2). In brick red strain the weight of the larva was significantly higher compared to the plain white strains and this strain has shown some resistance to karanj oil treatment, because lowest larval weight of 0.65g and 2.54g was recorded in the 10 ml/lit neem oil treatment during fourth and fifth instars respectively (Table 3). During fifth instar, ambagoan strain of eri silkworms fed with karanj oil treated (5 mL and 3 mL/lit) leaves recorded least larval weight of 1.50g and 1.75g respectively and were statistically on par with each other, and maximum larval weight was observed with 3mL/lit neem oil treated leaves (2.68g) with highest survival rate of 91.5% and control (3.42g) (Table 2). These results are in agreement with the findings of Shivkumar *et al.* (1995), who observed that 40 mg and 60 mg of *Achyranthes aspera* sprayed on mulberry leaves and fed to three, four, five and six day old fifth instar larva resulted in reduction of larval weights significantly.

Larval Duration

Botanical treatments have exerted significant influence on total larval duration. The batch of plain white worms nourished with leaves devoid of botanicals recorded least larval duration (21.04 days) followed by 3 mL/lit neem oil treated worms (21.64 days), while in brick red strain, the batch of worms treated with 3 mL/lit neem oil recorded lowest larval duration (20.21days) followed by untreated control (20.45 days). The eri silkworms nourished with 5 mL/lit karanj oil recorded the longest larval duration (22.38 and 21.2 days in plain white and brick red strains respectively).

Effective Rate of Rearing

Botanicals significantly influenced effective rate of rearing the highest being in control (89.9%) in plain white strains. In brick red strain, the highest ERR was recorded in control and 2 ml/lit karanj oil treated worms (91.46%) with no statistical variation among them.

Effect on cocoon parameters

Significant differences were observed between the treatments with regard to the cocoon parameters *viz.,* Cocoon weight, shell weight and shell ratio (%) in both the strains. But none of the botanicals tested has any significant influence on pupal weight in plain white strains. Cocoon parameters of the brick red strains were higher compared to the plain white strains.

Cocoon and pupal weight

In plain white strains, among the treatments significantly higher weight was recorded in the cocoons formed out of worms fed with 3 mL/lit neem oil (1.89g) and 2 mL/lit karanj oil (1.82g) treated leaves. These two treatments were significantly on par with control (2.21g) (Table 2). In brick red strains the neem oil (10 ml/lit) treatment was least preferred as the cocoon and pupal weights (1.74 and 1.32g respectively) were less in this treatment (Table 3).

Shell weight and Shell Ratio (%)

Plain white cocoons spun by the worms fed on untreated leaves recorded significantly higher shell weight and shell ratio (0.37g and 16.74% respectively) closely followed by the cocoons spun by the worms fed with 3 mL/lit neem oil treated leaves (0.29 and 15.34% respectively). In brick red strains,

Table 2. Effect of Botanicals on growth and silk production of plain white strain of eri silkworm, *Samia cynthia ricini* during 2011-12 (Pooled data of two seasons)

Treatment	Larval weight (g)			ERR (%)	Larval duration (days)	Cocoon wt (g)	Pupal wt (g)	Shell wt (g)	Shell ratio (%)	Fecundity	Hatching (%)
	III	IV	V								
Neem oil (3 ml/lit)	0.49	0.98^{b}	2.68^{ab}	82.24^{c}	21.64^{b}	1.89^{a}	1.60	0.29^{b}	15.34^{b}	228^{b}	92.0
Neem oil (5 ml/lit)	0.40	0.78^{b}	2.15^{b}	80.12^{d}	22.18^{d}	1.75^{b}	1.52	0.23^{d}	13.14^{d}	200^{bc}	92.0
Neem oil (10 ml/lit)	0.25	0.50^{c}	1.95^{bc}	79.88^{e}	22.26^{c}	1.50^{b}	1.35	0.15^{f}	10.0^{e}	180^{f}	85.0
Karanj oil (2 ml/lit)	0.38	0.46^{c}	1.75^{c}	84.72^{b}	21.98^{c}	1.82^{ab}	1.58	0.24^{c}	13.19^{d}	205^{b}	94.28
Karanj oil (5ml/lit)	0.26	0.38^{d}	1.50^{c}	76.84^{f}	22.38^{f}	1.48^{b}	1.26	0.22^{e}	14.86^{c}	192^{c}	90.0
Untreated Control	0.64	1.50^{a}	3.42^{a}	89.9^{b}	21.04^{a}	2.21^{a}	1.64	0.37^{a}	16.74^{a}	275^{a}	94.28
F-test	NS	Sig	Sig	Sig	Sig	Sig	NS	Sig	Sig	Sig	NS
CD at 5%	-	0.38	0.75	1.035	0.146	0.42	-	0.014	0.16	28.01	-
SEM±	0.24	0.18	0.32	0.397	0.056	0.18	0.32	0.012	0.04	14.92	0.749

shell weight and shell ratio (0.38g and 18.9%) were least with neem oil 3 ml/lit. Higher shell weight of 0.64g was recorded with control treatment closely followed by 2 ml/lit karanj oil (0.50g) treatment showing its loss of efficacy.

Effect on grainage parameters

Observations on the effect of botanicals on the fecundity and hatchability per cent indicted that significant differences were noticed with respect to fecundity and non significant differences were noticed with respect to hatching per cent.

Fecundity

Females emerged from the plain white strains of eri silkworm cocoons without botanical treatment (control) laid more number of eggs (275) closely followed by neem oil (3 ml/lit) (228) and 5 ml/lit (200) and karanj oil (2 ml/lit) (205) with no statistical variation among them (Table 2). In brick red strains fecundity was higher with moths emerged from pupae formed from worms fed on karaj oil (2 ml/lit) treated leaves (320) and control (341) with no statistical variation among them (Table 3).

Hatchability per cent

Feeding of plain white and brick red strains of eri silkworms treated with different botanical treatments has no influence on hatchability.

Prabhakar *et al.* (2003) reported that module III containing spray of quinolphos at 45 DAS and NSKE at 70 DAS was effective in controlling the semilooper population, while two sprays of NSKE was equally effective. Ahmed *et al.* (2010) studied the efficacy of 5 kinds of plant extracts or botanicals viz., neem seed oil, castor oil, a mixture of neem seed oil and sesame oil, leaf extracts of custard apple and Bara Bishkatali (*Polygonum orienta*) against bihar hairy caterpillar, *Spilosoma obliqua* and *Heliothis armigera* in sunflower. The treatments neem seed oil, a mixture of neem seed oil and sesame oil and castor oil exhibited better results in controlling the pest population over control.

This is a clear indication that, though neem oil and karanj oil are significantly superior in reducing the pest population, they have an adverse effect on the growth and rearing performance of eri silkworm. This was in contrast with the findings given by Hadimani and Patil (2003) and Rajashekargouda (1991). Further, determining the safety period for botanicals, particularly with reference to ericulture needs immediate attention in order to ensure good performance from the eri silkworm, inspite of adapting ecofriendly pest management measures.

ACKNOWLEDGEMENT

The authors are grateful to the National Bank for Agriculture and Rural Development (NABARD) for their financial assistance for conducting these studies.

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Table 3. Effect of Botanicals on growth and silk production of brick red strain of eri silkworm, *Samia cynthia ricini* during 2011-12 (Pooled data of two seasons)

Treatment	Larval weight (g)			ERR (%)	Larval duration (days)	Cocoon wt (g)	Pupal wt (g)	Shell wt (g)	Shell ratio (%)	Fecundity	Hatching (%)
	III	IV	V								
Neem oil (3 ml/lit)	0.38	1.02^{b}	3.32^{b}	88.5^{b}	20.21^{a}	2.01^{d}	1.63^{b}	0.38^{d}	18.9^{f}	305^{b}	94.28
Neem oil (5 ml/lit)	0.35	0.88^{b}	3.01^{c}	84.72^{c}	20.69^{c}	1.98^{e}	1.52^{d}	0.36^{e}	20.6^{c}	300^{b}	92.0
Neem oil (10 ml/lit)	0.28	0.65^{c}	2.54^{e}	80.12^{d}	20.9^{d}	1.74^{f}	1.32^{f}	0.32^{f}	18.4^{e}	290^{b}	92.0
Karanj oil (2 ml/lit)	0.32	0.94^{bc}	2.82^{d}	91.46^{a}	21.18^{e}	2.21^{b}	1.76^{b}	0.50^{b}	22.9^{b}	320^{ab}	95.83
Karanj oil (5ml/lit)	0.25	0.80^{b}	2.85^{d}	79.88^{e}	21.2^{e}	2.18^{c}	1.38^{c}	0.45^{c}	20.4^{d}	302^{b}	92.0
Untreated Control	0.62	1.72^{a}	3.95^{a}	91.46^{a}	20.45^{b}	2.61^{a}	1.58^{a}	0.6^{a}	24.5^{a}	341^{a}	96.9
F-test	NS	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	NS
CD at 5%	-	0.35	0.12	1.081	0.152	0.014	0.029	0.018	0.15	35.01	-
SEM ±	0.28	0.21	0.04	0.056	0.061	0.016	0.014	0.016	0.05	15.94	0.762

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Received: 10.3.2013 Revised: 22.5.2013 Accepted: 31.05.2013