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Influence of Thyroxine on the Economic Parameters of the Bivoltine Silkworm, *Bombyx mori* L.

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Effect of topical application with 5, 10 and 15 μg/m*l* thyroxine on the pre-cocoon, cocoon, postcocoon and silk improvement were studied in bivoltine silkworm NB_{18} breed of *B. mori* L. Thyroxine was applied independently on alternate days to silkworm of IV and V instar larvae. The treatment of all different concentrations resulted in a significant increase in commercial characters like larval weight, silkgland weight, cocooning percentage, female cocoon weight and its shell weight and male cocoon shell weight and its ratio, cocoon dimension, length of the filament and its weight and oviposition. However, there was no significant change in larvel weight in 5 μg/m*l* treated group and larval duration was significantly decreased. But moth emergence percentage and hatching percentage did not show any significant change when compared with that of carrier control

Key words : Thyroxine, *Bombyx mori*, silk improvement, commercial characters

INTRODUCTION

The treatment with vertebrate hormones has been shown to influence the economic parameters of the silkworm, *B. mori*(Magadum, 1987; Magadum and Magadum, 1992, 1993). Thyroxine hormone is known for its ubiquitous nature in effecting basal metabolic rate and growth promoting factor i.e. gastric function and protein synthesis in several vertebrate animals (Rosenberg, 1945; Underwood, 1953; Pitt- Rivers and Tata, 1958, Tata, 1963; 1970; Etkin, 1964; Beck, 1968; Gorbman, 1969; Choudhuri *et al.*, 1987). The effect of thyroxine showed a remarkable physiological changes in insects (Romeis and Wust, 1929, 1932; Ashbell, 1935; Mathias and Lucile, 1954; Moudgal *et al.*, 1958; Srinivasan *et al.*, 1955; narasimhamurthy *et al.*, 1987).

The studies documented that thyroxine administration to Nistari (Majumdar and Medda, 1975; Medda *et al.*, 1980; Choudhuri and Medda, 1985, 1986) Pure Mysore, NB_7 and NB_{18} (Thyagaraj *et al.*, 1985). Pure Mysore (Magadum and Hooli, 1988) resulted in enhanced larval body weight, cocoon shell weight, cocooning and moth emergence percentages, synthesis of lipids, proteins and or steroids, fecundity and egg weight accompanied by reduction in larval duration in PM × NB_{18} and $NB_{18} \times NB_7$ (Murthy, 1985; Anonymous, 1986). It has been further reported that the administration of lower concentration of thyroxine increased and higher concentration decreased the protein content of haemolymph plasma in some race of *B. mori* (Choudhuri *et al.*, 1987).

The above studies confirmed that thyroxine influences physiological processes and economic parameters in different races of the silkworm, *B. mori*. Since the physiological processes and economic traits are dependant on the dose, way of administration, duration of treatment and race of the silkworm, the present investigation was undertaken in the bivoltine silkworm, *B. mori* L. (Lepidoptera), to know the effect of higher concentration of thy-

roxine to IV and V instar larvae on the economic parameters of bivoltine silkworm cocoon crop.

MATERIALS AND METHODS

The eggs of bivoltine NB_{18} silkworm were obtained from grainage centre Rayapur, Dharwad district, Karnataka State, and reared in the laboratory by improved methods of rearing techniques (Krishnaswami, 1978). The larvae were maintained on freash mulberry leaves (K2). The IV instar larvae were divided into five experimental groups including controls and every group consists of uniformly weighed larvae in five replication of 20 worms. Thyroxine Sodium tablets I.P (Warner company), a synthetic crystalline hormone of thyroid is used in this study. It was dissolved in small quantity of distilled water and diluted to 5, 10 and 15 µg/m*l* by adding distilled water. The topical application was made with small sterilized cotton ball on the dorsal side of the larvae. Each larvae was topically applied with one of the three doses of thyroxine on alternate days. In each application 5 m*l* of solution was used to treat 100 larvae. Distilled water treated control and untreated control were also maintained.

The pre-cocoon, cocoon and post-cocoon parameters were recorded separately. The larval and silk gland weights were recorded before commencement of the spinning activity. The larval duration was recorded from the day of hatching to till the completion of the spinning activity. The cocoon parameters such as cocoon length, width, female and male cocoon weights and their shell weights were recorded on the 5th day after the completion of spinning activity and filament length was recorded with epprovette by reeling single cocoon. The reeled silk was dried in hot-air oven and weight was taken in an electrical balance. The cocoon shell ratio and denier of the filament was calculated. The egg productivity was recorded in the adult after mating. The cocooning, moth emergence and hatching percentages were also calculated by the formulas shown in the tables.

Each mean values, a record of ten worms is shown in Tables 1, 2, 3 and 4. The experiments were conducted twice to conclude the results. The data collected were subjected to analysis of varience test to find out the significant between the treated and control groups (Raghawa Rao, 1983). The percent values of cocoon shell ratio, cocooning %, moth emergence % and hatching percentage were transformed to sine angular values for statistical analysis.

RESULTS AND DISCUSSION

The data on the effect of thyroxine on the economic parameters of the silkworm, *B. mori* are presented in the Table 1, 2, 3 and 4.

1. Larval weight

Larval weight was improved significantly by the application of all the doses of thyroxine except in the group treated with 5 µg/m*l* when compared with that of carrier control (Table 1). The significant increase in larval weight might be due to response of the hormone at high concentration to the breed used here. Similar results have been reported in different breeds, concentration and duration of treatment of thyroxine in *B. mori*(Majumdar and Medda, 1975; Murthy, 1954; Thyagaraja *et al.*, 1985; Anonymous, 1986; Narasimhamurthy *et al.*, 1987; Magadum and Hooli, 1988; Rajshekargouda, 1991). The response to the hormone on larval weight might be due to influence on the important physiological process of growth and development or due to enhanced synthesis of proteins, DNA and RNA by the fat body in *B. mori* (Thyagaraja *et al.*, 1985; Narasimhamurthy *et al.*, 1987).

2. Larval duration

The larval duration decreased significantly in all the trated groups except with 5 µg/m*l* treated group (Table 1). It could be suggest that the duration of treatment or concentration applied to the larvae might have effected on moulting hormone which control moulting and metamorphosis in insects or due to the enhanced growth of larvae. Similar results have been reported that dietary or topical application of thyroxine to different races of silkworm

Table 1. *Effect of thyroxine on pre-cocoon parameters of the silkworm, B. mori*

Group	Treatment Doses (µg/m*l*)	Larval weight (g)	Silkgland weight (g)	Larval duration (Hr)	Cocooning %
I	5	4.340	0.778	637	98.10*
		(107)	(106)	(87)	82.08**
					(106)
II	10	4.520*	0.865*	634*	96.17*
		(111)	(118)	(86)	78.61**
					(104)
III	15	4.655*	0.904*	633*	95.52*
		(115)	(123)	(86)	77.75**
					(104)
IV	Distilled water	4.038	0.731	730	91.80
	control	(100)	(100)	(100)	73.36**
					(100)
V	Normal control	4.000	0.758	732	89.66
		(99)	(103)	(100)	71.19**
					(97)
F.test	-	(S)	(S)	(S)	(S)
S.Em±	-	0.194	0.058	37.79	1.07
C.D. at 5%	-	0.341	0.114	94.09	2.52

* - Significant increase/decrease at 5%
** - Angular transformed values.
S - Significant
NS - Non Significant
S.Em ± - Standard error mean
D.D. - Critical difference
Percent increase/decrease over that of the carrier control in parenthesis

$$\% \text{ cocooning} = \frac{\text{Number of cocoon formed}}{\text{Total number of larvae kept}} \times 100$$

larvae significantly decreased the larval duration, might be due to the enhanced growth (Majumdar and Medda, 1975; Thyagaraja *et al.*, 1985; Narasimhamurthy *et al.*, 1987; Magadum and Hooli, 1988; Rajshekargouda, 1991).

3. Silkgland weight

The wet weight of the silkgland was significantly increased in all the treated groups except with 5 µg/m*l* treated group (Table 1). A maximum increase of 23% silkgland weight was observed in 15 µg/m*l* treated group when compared with that of carrier control (Table 1). Similar results have been reported in the different breeds of the silkworm *B. mori* (Medda *et al.*, 1980; Magadum and Hooli, 1988). The significant increase in silkgland weight might be due to the increased synthesis of proteins, RNA and DNA by the silkgland as reported by Medda *et al.*, (1980).

4. Cocooning perentage

The cocooning percentage was significantly increased in all the treated groups (Table-1). However, it has been reported that topical application of thyroxine to polyvoltine silkworm, the Mysore breed, *B. mori* decreased the cocooning percentage (Magadum and Hooli, 1988). Hence, further investigation is essential in this regard.

5. Cocoon weight, shell weight and shell ratio

A significant increase in the female cocoon weight, shell weight and shell ratio were obtained in all the treated groups. But there was no significant change in the cocoon shell ratio with 5 µg/m*l* thyroxine treated group (Table 2). In males a significant increase in

Table 2. *Effect of thyroxine on the cocoon parameters of the silkworm, B. mori*

Group	Treatment Doses (μg/m*l*)	Female cocoon weight (g)	Female cocoon shell weight (g)	Female cocoon shell ratio (%)	Male cocoon weight (g)	Male cocoon shell weight (g)	Male cocoon shell ratio (%)
I	5	2.06* (120)	0.410* (129)	18.35 25.33** (106)	1.79 (108)	0.382* (112)	21.38* 27.49** (114)
II	10	2.25* (131)	0.421* (132)	19.60* 26.28** (113)	1.69 (102)	0.399* (114)	22.32* 28.18** (119)
III	15	2.00* (116)	0.400* (126)	20.01* 26.56** (116)	1.82 (110)	0.374* (109)	20.82 27.13** (111)
IV	Distilled water control	1.71 (100)	0.317 (100)	17.23 24.50** (100)	1.65 (100)	0.341 (100)	18.70 25.62** (100)
V	Normal control	1.78 (104)	0.309 (97)	16.29 23.73** (94)	1.65 (100)	0.358 (104)	18.56 25.48** (99)
F.test	-	(S)	(S)	(S)	(NS)	(S)	(S)
S.Em±	-	0.094	0.014	0.838	0.090	0.016	1.037
C.D.at 5%		0.184	0.027	10.644	0.177	0.031	2.033

* - Significant increase/decrease at 5%
** - Angular transformed values.
S - Significant
NS - Non Significant
S.Em ± - Standard error mean
D.D. - Critical difference
Percent increase/decrease over that of the carrier control in parenthesis

$$\text{Female/Male cocoon shell ratio} = \frac{\text{Cocoon shell weight}}{\text{Cocoon weight}} \times 100$$

the cocoon shell weight and cocoon shell ratio were obtained in all the treated groups, except in the cocoon shell ratio treated with 15 μg/m*l* thyroxine (Table 2). Similar results are obtained in different races of Silkworm, *B. mori*(Majumdar and Medda, 1975; Thyagaraj *et al.*, 1985; Magadum and Hooli, 1988; Rajshekargouda, 1991).

6. Cocoon dimension

The length and width of the cocoon were significantly increased in all the treated groups of thyroxine, except in the width of the group treated with 5 μg/m*l* when compared with that of the carrier control (Table 3). Similar results have been reported with supplementation or topical application of thyroxine to $PM \times NB_4D_2$ race of the silkworm, *B. mori* (Rajshekargouda, 1991).

7. Silk filament length, weight and denier

A significant increase in the filament length and weight were obtained in all the treated groups, except with 5 μg/m*l* thyroxine treated group when compared with the corresponding parameters of the carrier control (Table 3). However, filament denier did not show any significant change in all the treated groups. A maximum denier was obtained with 10 μg/m*l* thyroxine treated group.

8. Moth emergence percentage

There was no significant change in the moth em-

Table 3. *Effect of thyroxine on the cocoon parameters of the silkworm, B. mori*

Group	Treatment doses (μg/m*l*)	Length of the cocoon (mm)	Width of the cocoon (mm)	Silk filament length (mt)	Weight of the filament (g)	Denier of silk filament (g)
I	5	38.30*	55.35	759.0	0.255	3.023
		(111)	(104)	(107)	(115)	(107)
II	10	37.30*	60.00*	816.75*	0.302*	3.300
		(108)	(113)	(115)	(137)	(118)
III	15	38.00*	58.25*	913.0*	0.298*	2.937
		(110)	(109)	(129)	(135)	(104)
IV	Distilled water	34.38	53.00	706.0	0.220	2.804
	control	(100)	(100)	(100)	(100)	(100)
V	Normal control	34.00	51.50	700	0.221	2.841
		(98)	(97)	(100)	(100)	(101)
F.test	-	(S)	(S)	(S)	(S)	(NS)
S.Em±	-	0.943	1.261	31.69	0.019	0.316
C.D.at 5%		1.857	2.484	77.01	0.049	0.789

* - Significant increase/decrease at 5%
** - Angular transformed values.
S - Significant
NS - Non Significant
S.Em ± - Standard error mean
D.D. - Critical difference
Percent increase/decrease over that of the carrier control in parenthesis

$$\text{Denier} = \frac{\text{Single cocoon filament weight}}{\text{Single cocoon filament length(mt)}} \times 9000$$

ergence in all the treated groups when compared with that of carrier control (Table 4). This indicates that at these concentration thyroxine has no toxic effect on the cocoon crop. However, it has been reported that moth emergence percentage decreased or no change in the groups treated with thyroxine depending on the concentration and duration of the treatment in the silkworm, the Pure Mysore breed, *B. mori*(Magadum and Hooli, 1988).

9. Egg productivity

The results suggest that the egg productivity increased significantly in all the treated groups except with 15 μg/m*l* thyroxine treated group (Table 4). This results support the views of earlier workers (Thyagaraj *et al.*, 1985; Murthy, 1985; Magadum, 1987; Rajshekargouda, 1991). It has also been reported that the increase is egg productivity might be due to increased protein, RNA and DAN synthesis in the ovary of the silkworm, *B. mori* (Choudhuri and Medda; 1985). The results, therefore, suggest that the used concentrations had no adverse effect on egg productivity of the silkworm, *B. mori.*

10. Egg hatching percentage

The results of the present study showed that the topical application with 5, 10 and 15 μg/m*l* thyroxine has no effect in egg hatching percentage when compared with that of carrier controls (Table 4). This indicates that the used concentrations had no adverse effect on the hatching percentage.

Thyroxine functions as an indespensable constituent of the body system, which exercises control over the rate of energy metabolism and influence the important physiological process of the growth and development in vertebrates (Underwood, 1953; Tata, 1963, 1970). It has been demonstrated that the vertebrate hormone, thyroxine can also play a vital role in the physiological precesses of lepidopteran silkworm races, wherin it stimulates significantly the

Table 4. *Effect of thyroxine on the post cocooning parameters of the silkworm, B. mori*

Group	Treatment doses (μg/m*l*)	Moth emergence %	Egg productivity (No)	Hatching %
I	5	96.29	668*	96.86
		78.76**	(113)	79.69**
		(118)		(103)
II	10	95.01	670*	92.80
		77.08**	(113)	74.44**
		(116)		(100)
III	15	90.93	638	93.09
		72.44**	(109)	74.66**
		(111)		(100)
IV	Distilled water control	81.25	590	92.73
		64.30**	(100)	74.32**
		(100)		(100)
V	Normal control	80.06	539	91.41
		63.44*	(91)	72.95**
		(98)		(98)
F.test	-	(NS)	(S)	(NS)
S.Em±	-	24.40	28.80	10.23
C.D.at 5%		60.87	68.12	24.20

* - Significant increase/decrease at 5%
** - Angular transformed values.
S - Significant
NS - Non Significant
S.Em ± - Standard error mean
D.D. - Critical difference
Percent increase/decrease over that of the carrier control in parenthesis

$$\text{Moth emerged percentage} = \frac{\text{Number of moth emerged}}{\text{Number of cocons kept}} \times 100$$

$$\text{Hatching percentage} = \frac{\text{Total Number of eggs hatched}}{\text{Total number of eggs laid}} \times 100$$

body growth, shortens the larval period and increases the shell weight (Majumdar and Medda., 1975). In *Calliphora erythrocephala* feeding of moderate amount of thyroxine, accelerated the larval growth and metamorphosis (Mathias and Lucile, 1954). It has been reported that the thyroxine can increases the silk yield in the silkworm, *B. mori*. (Thyagaraja *et al*., 1985; Rajshekargouda, 1991). Evidently treatment of thyroxine can elevate the economic parameters of the bivoltine silkworm and thyroxine is shown to accelerate vitellogenesis and increase the function of tropocytes in the germarium in insects (Landa, 1970).

It may be concluded that topical aplication of thyroxine to silkworm larvae has better effect on improving the commercial characters and silk improvement.

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적 요

Thyroxine을 5, 10, 15 μg/m*l*의 수준으로 이화성 누

에 NB_{18} 품종의 유충에 도말처리한 결과 유충, 견사선, 고치, 고치층 등의 무게가 증가되고 유충경과 일수는 단축되는 등, 누에의 실용형질이 개선됨을 확인하였다. 이러한 결과는 전반적으로 10-15 μg/m*l*의 thyroxine 처리구에서 얻어졌고 5 μg/m*l* 처리구는 대조구와 유의차를 보이지 않았다. 화아율과 부화율은 thyroxine처리의 영향을 받지 않았고 유충경과일수는 단축되었다.

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