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Influence of Tukra Affected Mulberry Leaves on Larval and Cocoon Characters of Mulberry Silk Worm (*Bombyx mori* L.)

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ABSTRACT

The silkworm larvae fed with tukra affected leaves from hatching to spinning stage resulted marginal enhancement in the larval weight and reduction in total larval span of silkworms. However, the other quantitative characters showed no significant difference between all the treatments and control with regards to larval mortality percent, cocoon weight, pupal weight, cocoon yield/10,000 larvae brushed and ERR. An increased shell weight (1.93 g) and shell ratio (18.58%) was observed with feeding of high per cent disease index of leaves to the silkworm larvae. It may be due to the tukra affected leaves contained increased protein, total sugars and decreased phenol content compared to healthy leaves due to the infection of pathogens.

Key words: Tukra disease, Mulberry mealy bug, Biochemical changes, Mulberry silk worm

In India, more than 100 insects have been recorded on mulberry of which, few attain damaging proportions. About 20-25 per cent of crop loss occurs by combined incidence of pests and diseases. These organisms are the main obstacles causing considerable loss in yield and nutritive values of mulberry foliage. Tukra is a common problem in mulberry gardens caused by *Maconellicoccus hirsutus* Green (Thangamani and Vivekandan 1983). The infestation of mealybugs causes morphological and anatomical changes in different plants, including mulberry like curling of leaves, sickening and flattening of stems at the growing point (Sriharan *et al.* 1979, Babu *et al.* 2003) causing crop loss up to 4500 kg/ha/year (Muralikumaran and Baskaran 1992a, b). Feeding the silkworm with the infected leaves adversely affects the health of silkworm and the cocoon yield in terms of quality and quantity (Suryanarayana and Ganesh 1969, Noamani *et al.* 1976, Sullia and Padma 1987, Umeshkumar 1991). Hence the present investigation was carried out to know the impact of tukra affected leaves on mulberry silk worm larvae *Bombyx mori* L.

MATERIALS AND METHODS

Influence of tukra affected leaves on the growth and development of silkworm

An experiment was carried out to study the influence of tukra affected leaves on larval growth and development in $MY_1 \times CSR_2$ race of mulberry silkworm. Based on the per cent disease index of tukra, infested leaves were divided into 3 categories viz 10, 50 and 100 PDI and with these leaves an experiment was conducted to assess the influence of tukra infection and growth of *Bombyx mori*. A minimum of 50 disease free larvae were maintained in each treatment. The tukra affected V_1 variety leaves which are having 100 percent disease index were fed to silkworm larvae from hatching and continued up to spinning stage of the larvae. Similarly, leaves having 50, 10 and 0 (control) per cent disease index were picked up and fed to the separate batches of newly hatched silkworm larvae and continued up to the cocoon formation stage. All studies including '0' level disease (above) were maintained with four replications. Further observations with regard to larval characters like larval mortality, Larval weight and larval duration and cocoon character like cocoon weight, pupal weight, shell weight, shell ratio, cocoon yield and ERR were recorded from the 1st instar onwards.

Biometric observations recorded on larval and cocoon characters

Fifty larvae were maintained and daily observations were taken for the following parameters.

Larval mortality (%)

Larval morality in each instar was calculated by using the formula:

$$\% \text{ mortality} = \frac{\text{No. of worms showing mortality due to insecticide toxicity}}{\text{Total number of worms / treatment}} \times 100$$

Larval duration (days0

The durations of all five instars larvae were recorded in each treatment.

Larval weight (g)

Weights of silk worm larvae instar wise were recorded by weighing 10 larvae selected randomly in each treatment.

Cocoon characters

Ten cocoons harvested on 5th day of mounting of matured worms were randomly selected at in each treatment replication wise and the cocoon parameters viz mean cocoon weight, shell weight, pupal weight, shell percentages cocoon yield per 10,000 larvae brushed and effective rate of rearing were recorded in each treatment.

Single cocoon weight (g)

Ten cocoons in each treatment were collected randomly and average cocoon weight was calculated.

Pupal weight and shell weight (g)

Cocoons were cut open at the narrow end with a blade without damaging the pupa. Ten pupae were separated from the shell and the weights of pupa and shell were recorded.

Shell percentage

The shell percentage for each cocoon was calculated by using the following formula and the average was calculated:

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

Cocoon yield per 10,000 larvae brushed

Cocoon yield for each treatment was recorded and converted to 10,000 worms yield.

Effective rate of rearing (ERR)

The number of cocoons harvested at the end of rearing was counted and ERR was calculated by using the following formula:

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

Bio chemical changes

Total soluble proteins, sugars and phenols were estimated with Lowry *et al.* (1951), Dubais *et al.* (1956), Bray and Thrope (1954) methods respectively in tukra affected and healthy mulberry leaves in three different varieties viz V_1, M_5 and Local at 10, 20, 30, 50 and 100 PDI.

Data collected from two different experiments i e larval and cocoon characters obtained from larvae fed with different per cent diseased and healthy leaves, biochemical changes in three different tukra affected varieties were analyzed in one way ANOVA.

RESULTS AND DISCUSSION

Influence of tukra disease on larval characters

Larval mortality (%)

In the first instar larvae, maximum mortality per cent (19.48) was observed when the larvae fed with leaves exhibiting 100 PDI. When 50 and 10 percent diseased leaves were fed to the first instar larvae the mortality per cent observed was 19.01 and 19.13, respectively. In control the mortality per cent resulted was 19.37 and it was also found that differences were non-significant among the different treatments. Similarly in II, IV and V instars also the significant difference was not observed among the treatments. In III instar larvae the significant difference was existed between the treatments.

Table 1 Influence of tukra disease on larval characters of mulberry silkworm *Bombyx mori.* L.

Treatments	Larval Mortality (%)					Larval duration (days)					Larval weight (g)				
	I instar	II instar	III instar	IV Instar	V instar	I instar	II instar	III instar	IV Instar	V instar	I instar	II instar	III instar	IV Instar	V instar
10 PDI	19.13 (10.74)	19.07 (10.67)	19.24 (10.86)	19.03 (10.64)	19.35 (10.97)	4.26	3.42	5.63	6.77	8.14	0.31	0.58	1.9	3.16	9.23
50PDI	19.01 (10.61)	19.51 (11.15)	19.42 (11.05)	19.24 (10.86)	19.21 (10.83)	4.29	3.16	5.17	6.17	8.35	0.33	0.59	2.05	3.58	9.18
100 PDI	19.48 (11.12)	19.90 (10.49)	19.88 (10.47)	19.34 (10.97)	19.16 (10.78)	4.27	3.36	5.47	5.75	8.32	0.41	0.58	2.17	3.77	9.33
Control	19.37 (11.00)	19.21 (10.82)	18.75 (10.33)	19.37 (11.00)	19.36 (10.99)	4.23	3.18	5.45	6.54	8.29	0.3	0.54	1.91	3.02	8.97
General Mean	19.25 (10.87)	19.17 (10.78)	19.07 (10.68)	19.25 (10.87)	19.27 (10.89)	4.26	3.28	5.43	6.31	8.28	0.34	0.57	2.01	3.38	9.18
F test.	NS	NS	**	NS	NS	NS	*	*	**	NS	**	NS	**	**	*
S.Em.	0.13	0.15	0.08	0.14	0.08	0.07	0.06	0.08	0.08	0.12	0.02	0.01	0.02	0.03	0.06
$C.D_{0.05}$	NS	NS	0.27	NS	NS	NS	0.19	0.28	0.25	NS	0.05	NS	0.07	0.11	0.18

Values in parentheses are Arc sin transformed

*Significant at 5% level

**Significant at 1% level NS : Not significant

Larval duration (days)

In Larval duration the significant difference was not observed between the treatments in I and V instar larvae. Whereas in II and III instars the significant difference observed at 0.05% level and in IV instar it was significant at 1% level.

Larval weight (g)

The maximum larval weight of 0.41g was observed in the first instar larvae fed with leaves exhibiting 100 per cent disease index and the minimum of 0.30g was observed in the larvae when fed with healthy leaves. In II instar larvae all the differences were non-significant among the different treatments, whereas in III, IV and V instars significant difference existed among the different treatments (Table 1).

Influence of tukra disease on cocoon characters of mulberry silkworm

Cocoon weight

The average weight of ten cocoons were maximum (10.39 g) when larvae fed with leaves exhibiting 100 per cent disease index and minimum (10.22 g) when larvae fed with healthy leaves. In all the other treatments, the differences were not significant (Table 2).

Pupal weight

The differences were non-significant among the different treatments in respect of the pupal weight of larvae fed with disease affected leaves.

Shell weight

The minimum shell weight of 1.84 g was with control and maximum was (1.93 g) with the treatment when the larvae were fed with leaves exhibiting 100 per cent disease index. There were no significant differences between 10 PDI and control whereas in 50 PDI shell weight was 1.92 g.

Table 2 Influence of tukra disease on cocoon characters of mulberry silkworm *Bombyx mori.* L.

Treatments	Cocoon weight (g)	Pupal weight (g)	Shell weight (g)	Shell ratio (%)	Cocoon yield (kg)	ERR (%)
10 PDI	10.30	8.43	1.87	18.14	5.15	77.73
50 PDI	10.35	8.43	1.92	18.51	5.17	78.17
100 PDI	10.39	8.46	1.93	18.58	5.19	78.42
Control	10.22	8.42	1.84	17.90	5.13	78.07
General mean	9.49	8.43	1.89	18.31	5.16	78.09
F Test	NS	NS	**	**	NS	NS
S.Em.	0.04	0.03	0.01	0.10	0.02	0.17
$C.D_{0.05}$	NS	NS	0.04	0.31	NS	NS

*Significant at 5% level

**Significant at 1% level NS : Not significant

Shell ratio

The maximum shell ratio of 18.58 per cent was recorded when larvae fed with leaves exhibiting 100 per cent disease index whereas the minimum shell ratio of 17.90 per cent observed when larvae fed with healthy leaves.

Cocoon yield (kg) / 10,000 larvae brushed and ERR

The cocoon yield and ERR noticed from all the treatments were statistically analyzed and showed no significance difference between each other.

Biochemical changes

Protein content in tukra affected leaves

In tukra affected V_1 mulberry variety with 100 PDI protein content was minimum (28.96 µg) while in healthy leaves maximum protein content was 35.69 µg. Whereas in M_5 variety, the values ranged between 24.34 and 30.89 µg and similarly in local variety the values ranged between 17.56 µg and 22.46 μg^{-1}.

Total sugar content in tukra affected leaves

Total sugar content estimated in different varieties of mulberry varied significantly as it ranged between 19.03 to 29.08 µg in V_1 variety, 17.41 to 28.35 µg in M_5 and from 12.03 to 20.36 µg in local variety.

Table 3 Influence of tukra disease on biochemical status in different varieties of mulberry leaves

Disease status	Proteins (µg)			Total sugars (µg)			Phenols (µg)		
	V_1	M_5	Local	V_1	M_5	Local	V_1	M_5	Local
10 PDI	30.18	26.42	18.64	22.67	20.18	14.65	87.39	68.84	66.59
20 PDI	32.67	28.04	20.42	24.89	22.32	16.79	94.56	71.39	78.56
30 PDI	33.19	28.81	21.09	26.34	25.41	18.26	110.63	85.56	83.91
50 PDI	34.03	29.96	21.94	27.12	26.53	19.44	120.20	93.92	91.36
100 PDI	35.69	30.89	22.46	29.08	28.35	20.36	141.38	113.82	110.95
Healthy leaves	28.96	24.34	17.56	19.03	17.41	12.03	30.26	26.45	20.15
SE.m ±		0.81			0.69			1.34	
CD		3.14			2.69			5.18	

Phenol content in tukra affected leaves

Phenol content estimated in tukra affected leaves exhibiting 100 per cent disease index was maximum (141.38 µg) in the leaves and minimum (30.26 µg) in healthy leaves of V_1 variety. Similarly in M_5 variety, it ranged between 26.45 and 113.82 µg whereas in local variety the phenolic values ranged between 20.15 and 110.95 µg (Table 3). The larval and cocoon characters were influenced when the

larvae were fed with tukra affected leaves. The recorded larval mortality (%) showed no significant difference between all the treatments, more or less in all instars. The larval duration and weight relatively decreased when the larvae fed with leaves having high per cent disease index. The larval weight increased when the larvae fed with leaves having high per cent disease index. There were no significant differences in cocoon characters viz cocoon weight, pupal weight, cocoon yield and ERR, whereas shell weight and shell ratio increased along with increasing per cent disease index of leaves when the larvae were fed at different instars and differences were significant among the treatments. The highest shell weight (1.93 g) and maximum shell ratio (18.57%) was recorded in larvae fed with 100 PDI leaves whereas minimum shell weight (1.83 g) and shell ratio (17.90%) was recorded in larvae fed with healthy leaves. This might be due to favourable food material devoid of deterrents for the mealy bugs and tukra with increased total sugars and proteins, while phenol content in the disease affected leaves caused deterrence to silkworm leading to less positive cocoon characters. These results are on par with Singh *et al.* (2002) who stated that marginal enhancement in the larval weight and reduction in total larval span of silkworms fed with tukra affected mulberry leaves. However, the other quantitative characters did not show any significant change. It may be due to accumulation of more nutrients in tukra infested mulberry leaves as a result of stunted growth of the mulberry plant. Similar results were reported by Veeranna (1997), Aftab *et al.* (1999) as shortening of larval duration, a significant increase in larval biomass cocoon, pupal and shell weights followed by lesser food consumed. When the larvae fed with tukra affected leaves. They stated that it may be due to higher moisture content and accumulated nutrients in tukra affected leaves.

The results of the study indicated that quantitative characters showed no significant difference between all the treatments and control with regards to larval mortality percent, cocoon weight, pupal weight, cocoon yield/10,000 larvae brushed and ERR. An increased shell weight and shell ratio was observed with feeding of high per cent disease index of leaves to the silkworm larvae.

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