The Bioscan 10(1): 01-04, 2015
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
www.thebioscan.in

EFFECT OF FEEDING PROPORTIONATELY MIXED MULBERRY LEAVES ON DOUBLE HYBRID SILKWORM

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KEYWORDS
Larval weight
Cocoon weight
Cocoon shell ratio
Denier
Disease incidence
Bombyx mori

Received on :
10.09.2014

Accepted on :
07.01.2015

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ABSTRACT
The economic characters *viz*. larval weight (52.80 g), single cocoon weight (2.58 g), single shell weight (0.52 g), cocoon - shell ratio (20.15 per cent), yield/10,000 larvae brushed (23.30 kg), cocoon filament length (994.33 m), cocoon filament weight (0.31 gm), denier (2.85), lower incidence of diseases (1.66 per cent), and effective rate of rearing (98.66 per cent) of race CSR_2 double hybrid silkworm were found to be superior when silkworm larvae were reared on the leaves of V_1 mulberry variety. On the other hand larval weight (42.85 g), single cocoon weight (2.05 g), single shell weight (0.44 g), cocoon - shell ratio (17.05 per cent), yield/10,000 larvae brushed (19.66 kg), cocoon filament length (941 m), cocoon filament weight (0.21 gm), denier (1.99), higher incidence of diseases (5.00 per cent) and effective rate of rearing (95 per cent) were found to be inferior in case of silkworm larvae reared on the leaves of M_5 mulberry variety.

INTRODUCTION

India is the only country in the world producing all the four types of natural textile silks from silkworm *viz.*, Mulberry silkworm (*Bombyx mori* L.), Tasar silkworm (*Antheraea mylitta* D.), Muga silkworm (*Antheraea assamensis*) and Eri silkworm (*Philosamia ricini*). Of the four species, the mulberry silkworm is reared on large scale (Anonymous, 1983). By producing self employment in rural areas, not only the rural migration is arrested but also the cottage and small industries get established in rural India.

The growth and development of the larvae and subsequently cocoon production are greatly influenced by nutritional quality of mulberry leaves (Krishnaswami, 1978). Generally silkworm growers do not maintain the pure culture of mulberry variety on their farm. In many cases it is a mixture of two or more mulberry varieties. The nutritional statuses of different mulberry varieties are also differed. Hence, with this view the studies were carried out to find out the effect of proportionately mixed mulberry leaves on double hybrid silkworm.

MATERIALS AND METHODS

The investigation on the effect of feeding proportionately mixed leaves of mulberry verities on the biology and economic traits of double hybrid silkworm was carried out during January-February 2014 at Department of Agricultural Entomology, College of Agriculture, Latur. The experiment was conducted in a randomised block design with ten treatments and three replications. Each treatment consisted of 100 silkworms. The treatment details are shown in Table 1.

Disease free layings of silkworm double hybrid race were used to feed on the leaves of three different mulberry varieties *viz.*, M_5, V_1 and S_{1635} in the present investigation. The fresh mulberry leaves of above three varieties were obtained from already established mulberry plantation at the farm of Department of Agricultural Entomology, College of Agriculture, Latur.

Rearing method

The disease free layings of the double hybrid silkworm were kept for hatching in laboratory. After hatching of the eggs the chawki worms were brushed as per the treatments and they were separated into rearing trays. The tender mulberry leaves as per the treatments were chopped and sprinkled over the worms. The bed was made in a uniform size as per space required to the worms.

The food, spacing and cleaning were done as per the stage of worms and their requirement. The equal quantity of food on the basis of weight as per treatment was given to the larvae for feeding. The chopped mulberry leaves were fed to the larvae at 6, 10, 16 and 21 hours in a day. The size of the chopped leaves was regulated according to condition and size of the worm. During moulting period the worms were kept without food and were not disturbed. The quantity of food was increased as per the growth of the silkworm. The spacing and cleaning were done as per the stage of worms and their requirement. The disinfectants used were Formalin (2%)

solution, Bleaching powder (0.3%) Lime powder and Vijeta powder.

The full grown worms were released on mountages for spinning cocoons. The harvesting of cocoon was made on fifth day of release of worms on the mountages as per the treatments. Two lots of randomly selected 10 cocoons from each treatments and replications were observed to record the cocoon parameters. The first lot was used for recording cocoon weight. The second lot was used for determining the single filament length.

Method of recording observations

Larval weight (g)

The maximum larval weight was recorded by taking the weight of 10 matured larvae just before the onset of spinning.

Single cocoon weight (g)

The cocoon weight was recorded on 6th day of spinning. The average of 10 cocoons was taken as single cocoon weight.

Single shell weight (g)

The cocoon was cut open at one end and the shell weight was recorded. The average of 10 shells was taken as single shell weight.

Cocoon-shell ratio (%)

The cocoon shell ratio was calculated as,

$$\text{Cocoon - shell ratio (\%)} = \frac{\text{Cocoon shell weight}}{\text{Cocoon weight}} \times 100$$

Yield/10,000 larvae brushed (kg)

Table 1: Treatment details

Treatments	Treatments details
T_1	M_5 (100%).
T_2	V_1 (100%).
T_3	S_{1635}(100%).
T_4	M_5 + V_1 (60 % + 40%).
T_5	M_5 + V_1 (40% + 60%).
T_6	S_{1635} + V_1 (60 % + 40%).
T_7	S_{1635} + V_1 (40 % + 60%).
T_8	M_5 + S_{1635} (60 % + 40 %)
T_9	M_5 + S_{1635} (40 % + 60 %)
T_{10}	M_5 + V_1 + S_{1635} (equal proportions.)

100 cocoons were weighted and the cocoon yield per 10,000 larvae brushed was computed and expressed in kg.

Cocoon filament length (m)

Cocoon filament length was measured by reeling 10 cocoons after boiling in the water with the help of epprovate.

Incidence of diseases (%)

Observations for grasserie and flacherrie diseases were recorded separately by recording number of healthy and diseased larvae during the course of rearing in different treatments and percentage incidence of diseases was worked out as follow

$$\text{Disease \%} = \frac{\text{No. of diseased larvae}}{\text{Total No. of larvae}} \times 100$$

Cocoon filament weight (g)

Cocoon filament weight was measured by reeling 10 cocoons in three replications with the help of electronic balance and expressed in g.

Effective rate of rearing (%)

The effective rate of rearing was calculated by using following formula

$$= \frac{\text{No. of cocoons harvested}}{\text{No. of larvae retained}} \times 100$$

Denier

It is the term used to denote the thickness of silk filament and expressed in terms of ratio of weight of filament to the filament length multiplied by 9000.

$$\text{Denier} = \frac{\text{Filament weight (g)}}{\text{Filament length (m)}} \times 9000$$

RESULTS AND DISCUSSION

Larval weight (g)

The significantly highest larval weight of 52.80 g was recorded in treatment T_2 *i.e.* feeding on the leaves of V_1 (100%) (Table 2). The significantly lowest larval weight (42.85 g) was recorded in treatment T_1 i.e. those larvae fed on the leaves of M_5 (100%). Patil (2004) observed larval weight to the tune of 34.80 g when silkworm larvae (MYS x $CSR_{2)}$ fed on leaves of V_1. Gawade (2006) stated larval weight of 40.78 g when grown on leaves of mulberry variety V_1. Ilyas *et al.* (2013) recorded significantly superior in larval weight (45.08 g) of bi x bivoltine hybrid

Table 2: Effect of feeding proportionately mixed mulberry leaves on the economic traits of double hybrid silkworm

Treatment	Treatment details	Economic trait									
		Larval weight (g)	Cocoon weight (g)	Shell weight (g)	Cocoon shell ratio (%)	Cocoon yield (kg)	Filament length (m)	Filament weight (g)	Denier	Disease incidence (%)	ERR (%)
T_1	M_5 (100%).	42.85	2.05	0.44	17.05(9.81)	19.66	941.00	0.21	1.99	5.00(2.866)	95(71.85)
T_2	V_1 (100%).	52.80	2.58	0.52	20.15(11.62)	23.30	994.33	0.31	2.85	1.66(0.955)	98.66(80.75)
T_3	S_{1635}(100%).	47.21	2.40	0.44	18.10(10.42)	21.40	966.33	0.25	2.34	3.00(1.719)	97.49(77.18)
T_4	M_5 + V_1 (60 % + 40%).	47.23	2.38	0.49	18.16(10.46)	21.53	967.66	0.25	2.32	2.66(1.528)	97.15(76.43)
T_5	M_5 + V_1 (40% + 60%).	46.97	2.28	0.49	18.30(10.54)	21.80	965.66	0.25	2.30	3.00(1.719)	97.12(76.21)
T_6	S_{1635} + V_1 (60 % + 40%).	47.26	2.26	0.49	18.26(10.52)	21.86	966.00	0.25	2.20	3.00(1.719)	97.40(76.92)
T_7	S_{1635} + V_1 (40 % + 60%).	47.03	2.44	0.49	18.14(10.45)	21.45	966.66	0.25	2.32	3.66(2.101)	97.49(77.17)
T_8	M_5 + S_{1635} (60 % + 40 %)	47.27	2.28	0.49	18.18(10.47)	21.41	965.66	0.25	2.32	3.66(2.101)	97.25(76.53)
T_9	M_5 + S_{1635} (40 % + 60 %)	47.12	2.26	0.49	18.21(10.49)	21.70	966.33	0.26	2.42	3.33(1.910)	96.86(75.74)
T_{10}	M_5 + V_1 + S_{1635} (equal proportions.)	48.32	2.28	0.49	18.22(10.49)	21.63	968.66	0.27	2.54	3.33(1.910)	97.13(76.34)
	SE +	1.04	0.02	0.001	0.007	0.29	3.53	0.007	0.09	0.71	0.27
	C.D. at 5%	3.12	0.05	0.003	0.022	0.86	10.58	0.022	0.25	0.24	0.91
	C.V. (%)	3.85	1.21	0.75	0.12	2.31	0.63	5.08	6.23	22.04	2.06

(CSR16 x CSR_{17}) when reared on mulberry variety V_1. Durande *et al*. (2012) reported superior larval weight of 39.10 g when silkworm larvae reared on 100 % leaves of V_1, S-1635 and mixed leaves of 50 % V_1 and 50 % S_{1635}.

Cocoon weight (g)

The significantly highest single cocoon weight (2.58 g) was observed in the case of treatment T_2 i.e. larvae sole fed on leaves of V_1 and the significantly lowest single cocoon weight (2.05 g) was recorded in treatment T_1 i.e. larvae sole fed on leaves of M_5 Patil (2004), Gawade (2006), Illyas *et al*. (2013) and Durande (2010) recorded significantly superior single cocoon weight to the tune of 2.22. 2.12, 1, 98 and 1.80 g of silkworm reared on mulberry variety V_1, respectively.

Single Shell weight

The significantly highest shell weight (0.52 g) was recorded by treatment T_2 *i.e*. larvae sole fed on leaves of V_1. The lowest shell weight (0.44 g) was recorded by treatment T_1 *i.e*. larvae sole fed on the leaves of M_5 and treatment T_3 *i.e*. larvae fed on the leaves of mulberry variety S-1635. The significantly highest single shell weight to the extent of 0.37 to 0.512, 0.341, 0.372 and 0.399 g in respect of silkworm races *viz*., PM x CSR_2 , bivoltine hybrid, PM x CSR_2 and CSR_{16} x CSR_{17} were reported by Gawade (2006), Rayar (2011), Durande (2013) and Illyas *et al*. (2013), respectively, when reared on leaves of V_1 mulberry variety . However Durande (2013) also reported inferior single shell weight (0.334 g) of silkworm larvae PM x CSR_2 when grown on leaves of M_5 mulberry variety.

Cocoon shell ratio

The significantly maximum cocoon shell ratio (20.15 per cent) was recorded by treatment T_2 *i.e*. the larvae sole fed on leaves of V_1 and significantly minimum shell ratio of 17.05 per cent was observed in treatment T_1 *i.e*. larvae fed on leaves of M_5 (100%). Similar results were also reported by Anonymous (2001) Durande (2010) and Rayar (2011) who recorded the cocoon shell ratio of silk worm races *viz*., PM x NB_4D_2, PM x CSR_2 and bivoltine hybrid to the tune of 21.6, 20.70 and 20.27 per cent, respectively.

Cocoon yield/10,000 larvae brushed (kg)

The significantly highest cocoon yield (23.30 kg) was obtained in treatment T_2 *i.e*. sole feeding the leaves of mulberry variety V_1. The significantly lowest cocoon yield (19.66 kg) was obtained in treatment T_1 *i.e*. larvae fed on the leaves of M_5 (100%). The results in respect of cocoon yield are in good agreement with the results reported by Anonymous (2001), Durande (2010), Kamate *et al*. (2010) and Illyas *et al*. (2013) who recorded significantly highest cocoon yield of silkworm races *viz*., PM x NB_4D_2, PM x CSR_2, CSR_2 x CSR_4 and CSR_{15} x CSR_{17} to the tune of 18.13, 17.35, 18.96 and 18.55 kg , respectively.

Cocoon filament length

The significantly highest filament length (994.33 m) was recorded in the treatment T_2 *i.e*. larval feeding on the leaves of variety V_1 (100%). However it was significantly reduced to the extent of 941 m in the treatment T_1 i.e. those larvae fed on leaves of M_5 (100%). The significantly highest filament length of silkworm races viz., bivoltine hybrid PM X CSR_2, PM X CSR_2 , CSR_2 x CSR_4 and bivoltine hybrid to the extent of 849 to 906, 866.67, 872, 970 and 1067.28 m were also reported by Jaydeb *et al*. (2000), Gawade (2006), Durande (2010), Kamate *et al*. (2010) and Rayar (2011), respectively. Durande *et al*. (2012) observed lowest filament length of 688 m when grown on 100% leaves of M_5.

Filament weight (g)

The significantly highest filament weight of 0.31 g was recorded by the treatment T_2 *i.e*. larvae fed on the leaves of variety V_1 (100%). While it was significantly lowest (0.219 g) when it's larval stage fed on leaves of M_5 (100%). Durande (2010) also showed similar results. According to him the filament weight of silkworm races was found to be 0.26 g when reared on mulberry variety V_1. Durande *et al*. (2012) also reported inferior filament weight (0.22 g) in case of those larvae which were reared on 100% leaves of M_5.

Denier

The significantly highest value of denier (2.85) was recorded by treatment T_2 *i.e*. the larvae sole fed on leaves of mulberry variety V_1 while it was significantly lowest (1.99) in those larvae sole fed on leaves of M_5. The silkworm races viz., PM X CSR_2 and bivoltine hybrid recorded denier value of 2.71(Durande, 2010) and 2.55 (Rayar, 2011) when reared on mulberry variety V_1.

Incidence of diseases

The significantly lowest incidence of diseases (1.66 per cent) was observed in the treatment T_2 *i.e*. larvae sole fed on V_1. This could be due to good palatibility and digestibility of variety V_1 which is intern resulted into development of resistance in body of silkworm to its diseases. The significantly highest incidence of diseases (5.00 per cent) was observed in treatment T_1 *i.e*. larvae sole fed on leaves of M-5. Less incidence of diseases in silk worm reared on V_1 was also reported by (Anonymous, 2001, Patil, 2004, Gawade, 2006, Durande, 2010; Kamate *et al*., 2010, Durande *et al*., 2013).

Effective rate of rearing

The ERR ranged from 95.00 to 98.68 per cent. The significantly the highest ERR was recorded in treatment T_2 *i.e*. the larvae sole fed on V_1. The lowest ERR (95.00 per cent) was recorded in treatment T_2 *i.e*. larvae sole fed on M_5. Yogananda murthy *et al*. (2013) recorded lowest effective rate of raring (84.56%) on M_5 mulberry variety.

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