Research Article

PERFORMANCE OF MULBERRY SILKWORM (*Bombyx mori* L.) UNDER LEAF AND SHOOT FEEDING METHODS

R. B. Thapa[1] and N. P. Ghimire[2]

[1]Institute of Agriculture and Animal Sciences, Rampur, Chitwan and [2]Sericulture Development Section, Khopasi, Kavre, Nepal

ABSTRACT

Two batches of newly hatched $J_{12} \times C_{12}$ strain worms were reared in two separate trays feeding one with succulent Kanva-2 mulberry twigs and another with soft and tender chopped leaves of the same mulberry variety up to third molt. Then after, 200 worms per tray with six replications were fed on leaf and shoot separately throughout the larval period including combinations of leaf and shoot feeding to young and grown up instars. The result indicated that shoot feeding and its inclusion to leaf feeding were significantly better giving encouraging results (41.76 kg cocoon/box) and high remunerative return (Rs. 7295/box) compared to leaf feeding (38.56 kg cocoon/box) and earning (Rs. 6705.28/box), respectively.

Key words: Mulberry silkworm, leaf vs shoot feeding, larval duration, shell ratio, cocoon yield

INTRODUCTION

Sericulture is an income generating agro-enterprise in the mid hill region to alleviate poverty, through increasing rural women employment and their income, and thus, has been given due priority by Agriculture Perspective Plan (APP, 1995). This is a potential sector of the agriculture to raise economic status of the farming community and also earning foreign revenue. Its success depends on the various factors including successful implementation of technological and managerial tools along with high yielding best-suited mulberry and silkworm varieties (Thapa and Shrestha, 1999; Ghimire, 2000).

In fact, the quantity and quality of silk are functions of quantity and quality of mulberry leaves and silkworm rearing technology has changed over time from leaf feeding to shoot feeding because of significant saving of labor and producing as many cocoons as possible of good quality, from a unit of silkworm seed or mulberry area (Benchamin and Nagaraj, 1987; Siddappaji *et al.*, 1992; Arunachalam, 1994; CSB, 1997). With shoot rearing, it was possible to reduce the labor force by approximately 60% at the fourth and 50% at the fifth age, and the amount of required leaves reduced by 25% and 10% at the fourth and fifth age, respectively (Krishnaswami *et al.*, 1988).

Rearing performance affects sharply in their ecological, biochemical, physiological and quantitative characters, which influence growth and development, and quantity and quality of silk they produce in different geographical locations, and thus, varies under different ecological conditions to make silkworm rearing cost effective and more productive (Hirobe, 1968; Shekharappa *et al.*, 1993). Therefore, this study was conducted to evaluate the performance of leaf and shoot feeding of mulberry silkworm on silkworm growth, development and quality cocoon production.

MATERIALS AND METHODS

Two trays (100-cm length, 50-cm width and 10 cm deep) were employed with three grams of silkworm eggs ($J_{12} \times C_{12}$ strain) in each tray for incubation. After hatching, larvae in one tray were reared on chopped, soft, tender Kanva-2 mulberry leaves and the next tray with succulent mulberry twigs of the same variety up to the third instars. Then after, larvae were transferred to individual trays for each replication under each treatment and reared following standard rearing practice (Tsuzuku, 2000).

The experiment was laid out in CRD with four treatments and six replications. Each replication (per rearing tray) included two hundred larvae and the treatments consisted of: (i) leaf feeding throughout the larval period; (ii) leaf feeding to the young and shoot feeding to the grown up worms; (iii) shoot feeding to the young and leaf feeding to the grown up worms; and (iv) shoot feeding throughout larval period. The shoot to leaf ratio of mulberry was calculated by sampling ten feeding shoots (weighing leaf with shoots and leaves only) and calculated as 65:40. This ratio formed the base to feed worms with equal quantity of shoot and or leaves by weighing in a special pan balance.

Weight of ten larvae was recorded from each tray during the fifth instar every day till the larvae were mounted for cocooning. Five larvae from each rearing tray were also preserved in 10% formaldehyde solution in vials for the extraction of silk glands. The preserved silkworm larvae were dissected, silk glands separated and dried in oven for 12 hrs at 75^0C and silk gland weighed separately in a sensitive electric balance (Scaltech® Germany).

The mature worms from each treatment were transferred to individual zigzag mountage for cocooning. Cocoons were harvested on the seventh day and cocoon characteristics such as number of cocoons per liter, single cocoon weight, single shell weight, and shell ratio were recorded separately. All biological parameters were analyzed using MSTAT software package using DMRT for mean comparisons.

RESULTS AND DISCUSSION

The pre-cocoon characters were superior in silkworms with shoot feeding throughout the larval period (Table 1). It resulted significantly the highest silk gland weight (0.48 g) followed by shoot to young and leaf to the grown up (0.44 g), leaf to the young and shoot to the grown up (0.39 g) and the lowest value in leaf feeding throughout the larval period (0.37 g), respectively. It also had the shortest fifth instar larval duration with the least deviation than rest of the treatments. Similarly, the pupation rate was the highest ($P< 0.01$) in shoot feeding (97.55%) followed by leaf and shoot (97.14%), leaf throughout or shoot and leaf feeding (96.40%), respectively. The shoot feeding also contributed 31.10% more silk gland weight and 1.20% higher pupation rate than leaf feeding indicating suitability of shoot feeding method.

Table 1. Pre-cocoon characters of J_{12} x C_{12} silkworm strain reared on Kanva-2 following different feeding methods during autumn in Dhunibeshi, 2001

Feeding methods	Silk gland wt (g)	Larval duration (h)	Pupation rate (%)
Leaf throughout the larval period	0.37 ± 0.00 c	171.00 ± 1.41 b	96.41 ± 0.17 c
Leaf to young + shoot to late ages	0.39 ± 0.00 c	191.00 ± 1.10 a	97.14 ± 0.10 b
Shoot to young + leaf to late ages	0.44 ± 0.00 b	171.00 ± 1.26 b	96.40 ± 0.23 c
Shoot throughout the larval period	0.48 ± 0.00 a	171.00 ± 0.63 b	97.55 ± 0.21 a
CV (%)	0.28	0.65	0.19
F- test	**	**	**

Same letters in a column are not significantly different by DMRT, ** highly significant ($P < 0.01$), ± Values indicate standard deviation

The shoot feeding throughout the larval period resulted the best cocoon characters such as number of cocoons/liter, single cocoon weight, single shell weight, shell percent and pupal weight (Table 2). The shoot feeding throughout the larval period or feeding shoots to the young and leaves to the grown up ages exhibited significantly the biggest size of cocoon (61-61.30 cocoons/ liter), the highest single cocoon weight (2.26-2.34 g), the highest single shell weight (52.17-54.47 cg), shell ratio (23.05-23.27%), and pupal weight (1.73-1.80 g), respectively. Although shell percent was non-significant over all the treatments, in view of the extent of labor consumption, the slight increase in cocoon characters in shoot feeding to young and leaf feeding to grown up worms are kept behind the shoot feeding throughout the larval period and thus shoot feeding had cocoon characters better by 2.77% for cocoon size, 7.22% for single cocoon weight, 7.19% for single shell weight and 7.05% for pupal weight over leaf feeding. Hence, shoot feeding is highly preferable for getting higher qualitative yield of cocoons.

Table 2. Cocoon characters of J_{12} x C_{12} silkworm strain reared on Kanva-2 following different feeding methods during autumn in Dhunibeshi, 2001

Feeding methods	Cocoons/liter (no.)	Single cocoon wt (g)	Single shell wt (cg)	Shell (%)	Pupal wt (g)
Leaf throughout the larval period	63.00 ± 0.89 b	2.11 ± 0.13 b	48.67 ± 1.63 c	23.05 ± 1.19	1.62 ± 0.12 b
Leaf to young + shoot to late ages	66.00 ± 0.89 a	2.10 ± 0.06 b	48.50 ± 1.76 c	23.04 ± 0.74	1.62 ± 0.05 b
Shoot to young + leaf to late ages	61.00 ± 0.89 c	2.34 ± 0.08 a	54.67 ± 1.97 a	23.27 ± 0.85	1.80 ± 0.07 a
Shoot throughout the larval period	61.33 ± 0.52 c	2.26 ± 0.11 a	52.17 ± 2.32 b	23.05 ± 0.49	1.73 ± 0.09 a
CV (%)	1.30	4.38	3.80	3.70	5.25
F- test	**	**	**	Ns	**

Same letters in a column are not significantly different by DMRT, Ns non-significant (P > 0.05), ** highly significant (P < 0.01), ± Values indicate standard deviation

The yield and price of the cocoon is shown in Table 3. Both yield and price of cocoon per box were calculated and analyzed to be the highest (P < 0.01) in shoot feeding throughout larval period (41.76 kg/box and Rs. 7294.93/box) and shoot to the young and leaf to the grown up ages (42.92 kg/box and Rs. 7547.15/box), respectively (Table 3). Thus, the shoot feeding resulted higher yield and price by 8.31% and 8.79% over leaf feeding, respectively. These figures prove that shoot feeding is highly preferable over leaf feeding.

Table 3. Yield and price of the cocoon of J_{12} x C_{12} silkworm strain reared on Kanva-2 following different feeding techniques during autumn rearing in Dhunibeshi, 2001

Feeding methods	Cocoon yield (kg/box)	Monetary return (Rs/box)
Leaf throughout the larval period	38.56 ± 2.31 b	6705.28 ± 248.23 b
Leaf to young + shoot to late ages	38.79 ± 1.02 b	6755.90 ± 263.99 b
Shoot to young + leaf to late ages	42.92 ± 1.54 a	7547.15 ± 278.18 a
Shoot throughout the larval period	41.76 ± 2.15 a	7294.93 ± 318.55 a
CV (%)	4.52	3.94
F- test	**	**

Same letters in a column are not significantly different by DMRT, ** highly significant (P < 0.01), ± Values indicate standard deviation

It was clear that feeding shoots throughout the larval period produced the highest silk gland weight. The pupation rate (97.55%) of silkworms was also the highest with shoot feeding throughout the larval period followed by leaf feeding to young and shoot feeding to grown up ages (97.14%). Similarly, shoot feeding throughout the larval period showed the best cocoon characters including number of cocoons, single cocoon weight, single shell weight, shell percent, and pupal weight along with the highest yield and market value of the cocoon. Hence, the result of the present study i.e. leaf vs. shoot feeding is in agreement with the works of different authors. Transferring neonate silkworms to mulberry twigs/entire shoots till ripening has many fold advantages viz., conservation of resources; marked decrease in leaf to cocoon ratio, short larval duration, less labor requirement, and thus, reduction in the cost of cocoon production with increase in body building matter of young worms, effective rearing rate, and higher cocoon yield. The space is remarkably decreased under shoot feeding method to 300–350 square feet as against 360–480 square feet in leaf feeding mainly due to three dimensional distribution of the larvae in the bed and effective utilization of available space, better aeration of the rearing beds, and therefore, more worms could be reared in the same area in shoot feeding (Krishnaswami *et al.*, 1988; Shekharappa *et al.*, 1993). In view of the extent of labor consumption on repeated feeding, even two-time through shoot feeding have been applied in the fifth instar rearing of silkworms against four to five leaf feedings a day (Karaivannov, 1990). This is associated with the characteristics of the shoots that preserve the acceptability, turgidity and palatability of mulberry leaves and increase the feeding efficiency of silkworms. The shoot feeding has been proved cost effectiveness starting from ant brushing to spinning (Siddappaji *et al.*, 1992). In grown up worms rearing, it reduced the labor force by 50% to 60% and amount of leaves by 10% to 25% in the fourth and fifth instars, respectively (Krishnaswami *et al.*, 1988). Placing the top and bottom end of the shoots in the rearing bed alternatively ensures equal mixing of different qualities of leaves (Shekharappa *et al.*, 1993). This being so, the shoot feeding technique established as a common practice and has been adopted for rearing worms throughout the year in India (CSB, 1997). On the other hand in leaf feeding, during preservation, the leaf losses its moisture content, proteins decomposed into amino acids and vitamins decrease gradually ultimately affecting the quality of feed (Himantharaj *et al.*, 1999). Hence, shoot vs. leaf feeding method indicates that the shoot feeding or its incorporation is better than the leaf feeding alone. It is recommended to verify under different climatic conditions.

REFERENCES CITED

APP. 1995. Agriculture perspective plan (APP). Agricultural Project Service Center and John Mellor Associates, Inc. NPC/HMGN and ADB, Kathmandu, Nepal.

Arunachalam, V. 1994. How far can improvement strategies in sericulture be patterned on those in agriculture? *In:* G. Srirama Reddy (ed.) Silkworm Breeding. Proceedings of the National Workshop, 18-19 March 1994. Oxford and IBH Publishing Co., Pvt. Ltd., India.

Benchamin, K.V. and C. S. Nagaraj. 1987. Silkworm rearing techniques. *In:* M. S. Jolly (ed.) Appropriate Sericulture Techniques. International Center for Training and Research in Tropical Sericulture, Mysore-India.

CSB. 1997. New illustrated sericulture reader. Central Silk Board, Banglore, India.

Ghimire, N. 2000. Sericulture: The context in Nepal. Paper presented at the National Workshop of Plant Protection Officers, Department of Agriculture, Kathmandu, Nepal.

Himantharaj, M. T., R. K. Rajan and G. B. Singh. 1999. A simple device for mulberry leaf preservation. Indian Silk. 38 (3): 5-6.

Hirobe, T. 1968. Characterization of silkworm races. Proceedings of International Congress of Genetics.

Krishnaswami, S., M.N. Narasimhanna, S.K. Suryanarayan and S. Kumararaj. 1988. Silkworm rearing. Sericulture Manual-2. FAO, Rome.

Karaivannov, S. 1990. A study of a possibility for a reduced frequency rate of feeding on rearing silkworms in the last age period. Zhivotonov'd Nauki. 27 (7): 114-119).

Shekharappa, B. M., C. S. Gururaj, R. Raghuraman and S. B. Daandin. 1993. Shoot feeding for late age silkworms. Karnataka State Sericulture Development Institute, Banglore, India.

Siddappaji, C., M. R. Muraleedhara and Chikkavenkateshappa.1992. Advantages of rearing silkworms throughout on mulberry shoots. National Conference on Mulberry Sericulture Research Abstract, 10-11 December 1992.

Thapa, R. B. and K. B. Shrestha. 1999. Silkworm rearing technology. Paper presented at the Workshop on Appropriate Sericulture Technology, 19-21 December 1999. Nagarkot, Bhaktapur, Nepal.

Tsuzuku, M. 2000. Naya resham kheti pustika (Chitrankit). JICA (Japan International Cooperation Agency), Kathmandu, Nepal.