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RESPONSE OF FOLIAR SPRAY OF CALCIUM AND MAGNESIUM ON SILKWORM (*Bombyx mori* L.) POST HARVEST PARAMETERS

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ABSTRACT
The present Investigation on "Impact of foliar spray of calcium and magnesium on economic traits of *Bombyx mori* L. during summer in Kashmir" was carried out at Temperate Sericulture Research Institute, Mirgund which is located at 3417 N latitude and 7517 E longitudes at an elevation of 1587m above mean sea level. Calcium chloride and magnesium sulphate were used as foliar spray for supplementing calcium and magnesium. The experiment consisted of separate and combined foliar application of calcium and magnesium and one control. Goshoerami variety was taken as mulberry variety. Experiment was laid in CRD with three replications. Foliar Spray was done twice, first one month after June pruning and second 15 days after first spray. Calcium as well as magnesium was sprayed in 2 concentrations *viz*, 0.2% and 0.4%. The combined spray of calcium and magnesium was done at 4 concentrations *viz.*, 0.2% Ca^{+} 0.2% Mg, 0.2% Ca+ 0.4% Mg, 0.4% Ca+ 0.2% Mg and 0.4% Ca+ 0.4% Mg. All treatments exhibited improvement in almost all parameters over control. Combined spray of 0.4% calcium and 0.2% magnesium (T8) resulted in significant increase in shell weight recording maximum values of 0.45g. Increased in shell weight over control was recorded to the extent of 28.60 percent. Through combined spray of 0.4% Ca and 0.2%Mg.The study revealed that combined spray of calcium and magnesium (0.4% Ca +0.2% Mg) had significant influence on imperative rearing parameters during summer rearing, thus paving way for popularization of second commercial rearing through combined spray of calcium and magnesium as foliar spray.

KEY WORDS: Foliar Spray, Nutrients, Rearing, Silkworm, Mulberry.

INTRODUCTION

Silk is the most elegant textile in the world with unparalleled grandeur, natural sheen, inherent affinity for dyes, high absorbance, light weight, soft touch, high durability and is thus known as "Queen of textiles". Sericulture is practised in many countries of the world under varied agro climatic conditions with global raw silk production of 1,78,039 MT (Anonymous, 2015). China is the largest producer of silk with a production of 1, 46,000 MT of raw silk (Anonymous, 2014) followed by India with a production of 28,708 MT of raw silk (Anonymous, 2014-2015). Mulberry silkworm is a domesticated and monophagus insect, which feeds only on mulberry for its development. The mulberry leaves mainly contain proteins, carbohydrates, vitamins etc. Such nutritional components in food have direct impact on all genetic traits such as larval weight, cocoon weight, quality and quantity of silk (Ramesha *et al.,* 2010). Based on the nutritional quality, mulberry has a great influence on the silkworm growth, silk yield and disease resistance (Ravi Kumar, 1988). Silkworm nutrition refers to the substances required by silkworm for its growth and metabolic functions, which are obtained from ingested food and other remaining nutritive components, are synthesized through various biochemical pathways (Takano and Arai, 1978; Hamano *et al.*, 1986; Zhang *et al.*, 2002). Significant correlations have been reported between chemical composition of mulberry leaves and cocoon characters. Improvement in larval and cocoon characters of silkworms has been witnessed with the increase in the nutritional status of mulberry leaf (Venkataramu, 1986). Besides, significant and positive correlations have been reported between cocoon yield component traits (larval weight, larval survival, effective rate of rearing, cocoon yield, silk productivity, cocoon weight, shell weight, shell ratio, filament length, fibroin content, pupation rate, pupal weight, rate of moth emergence, fecundity and hatchability) with that of foliar constituents, i.e. leaf moisture, chlorophyll, total carbohydrates, crude protein, nitrogen, potassium, calcium, magnesium and sulphur (Sannapa *et al.,* 2002). Further it has been proved that the nutritional status of mulberry leaves can be improved by enriching them with extra nutrients to increase larval growth and improve cocoon characteristics (Sengupta *et al.,* 1992). Mulberry being a deep rooted, high biomass foliage crop, responds well to foliar nutrition. Foliar application in right time increases level of absorption in specific nutrients during growth and development (Narahari *et al.,* 1997). Foliar application is one of the quicker techniques for improvement of leaf productivity. Plants can effectively up take nutrients when applied as foliar fertilizer sprays. The nutritional status of the mulberry leaves can be improved by enriching them with different nutrients. Venkatesh *et al*. (2012) reported that foliar application is 8 to 10 times more effective than soil application with 90% foliar nutrients present in small root of mulberry within 60

min of application. Although considerable work has been done in India on the supplementation of nutrients through foliar application under tropical conditions, yet very little work has been done on this aspect under temperate climatic conditions of Kashmir. Further, having been established that foliar application of nutrients improves the quality of leaf considerably, it has become important to explore the possibility of ascertaining effect of such application on mulberry under temperate climatic conditions of Kashmir valley where there is a heavy demand from stake holders for multiple cocoon crops for their improved socio-economic status through income augmentation. But poor quality of mulberry leaf during summer and autumn season comes in the way of popularizing second or third commercial rearing.

MATERIALS & METHODS

The present investigation "Impact of foliar spray of Calcium and Magnesium on economic traits of *Bombyx mori* L. during summer in Kashmir" was carried out at the experimental farm of Temperate Sericulture Research Institute Mirgund, during 2014. Established dwarf plantation of Goshoerami (mulberry variety mostly used for commercial rearing in the region) having uniform growth and vigour was used for the study. Cultural practices were followed as per the package of practices recommended by the Temperate Sericulture Research Institute, SKUAST-K. The material and methods used for the study are presented under the following heads.

Geographical features of the experimental site

The Temperate Sericulture Research Institute, Mirgund is located at 34° 17′ N latitude and 75° 17′ E longitude at an elevation of 1587 m above mean sea level. The institute is 18 km from Srinagar on Srinagar-Uri National Highway No.1-A in Baramulla district and spread over an area of 20 hectares, where various research programmes, trials, covering all the activities pertaining to sericulture are being conducted.

Climate

The climate is Temperate-cum-Mediterranean and of continental type characterized with marked seasonality. The region falls into mid to high altitude temperate zones which are characterized by a sub-microthermic regime where winter is severe extending from 15th December up to mid of March. During winter the valley remains almost covered with snow and temperature often goes below the freezing point.

Experimental details

Total number of treatments: 09

Design of experiment: Complete Randomized Design (CRD)

Treatment details

T_1 = Control
T_2 = 0.2% Ca
T_3 = 0.4% Ca
T_4 = 0.2% Mg
T_5 = 0.4% Mg
T_6 = 0.2% Ca + 0.2% Mg
T_7 = 0.2% Ca + 0.4% Mg
T_8 = 0.4% Ca + 0.2% Mg
T_9 = 0.4% Ca + 0.4% Mg

Number of replications : 03
Silkworm hybrid : SK-6 × SK-31
Mulberry variety : Goshoerami
No. of worms/treatment/replication : 100

Preparation of spray formulation

Calcium chloride and Magnesium sulphate were used as foliar sprays for supplementing Ca and Mg. The formulations were prepared by dissolving Calcium chloride and Magnesium sulphate in distilled water. One percent stock solution of Calcium chloride and Magnesium sulphate were prepared by dissolving 184g of Calcium chloride in 5litres of distilled water and 500g of Magnesium sulphate in 5 litres of distilled water respectively. Using these stock solutions different concentrations of both Calcium chloride and Magnesium sulphate were prepared as:

Ca formulations

Concentration (%)	1% stock solution(ml)	Water (ml)
0.2	1800	7200
0.4	3600	5400

Mg formulations

Concentration (%)	1% stock solution(ml)	Water (ml)
0.2	1800	7200
0.4	3600	5400

Spraying of formulations

Foliar spray of liquid formulations was done twice. First spray was done on 30th day after pruning of mulberry (June pruned) and second after 15 days of first spray at the rate of 600 litres of formulation/hectare/spray. The formulations were sprayed during the morning hours of the day.

Silkworm rearing

Rearing was conducted as per the package of practices recommended by the Temperate Sericulture Research Institute, Mirgund by resorting to three feeds per day. For rearing purpose promising silkworm hybrid for autumn season SK-6 × SK-31 was used. Rearing was conducted as usual up to 3rd stage. From day 1st of 4th age up to seriposition the worms were reared on treated leaf as per the experiment details.

Observations recorded.

Post harvest parameters:

Cocoon yield/10000 larvae by number:-

This was calculated using following formula:

$$\frac{\text{Number of cocoons harvested}}{\text{Number of worms retained out of third moult}} \times 10000$$

Cocoon yield/10000 larvae by weight

This was calculated using following formula:

$$\frac{\text{Weight of cocoons harvested}}{\text{Number of worms retained out of third moult}} \times 10000$$

Single cocoon weight (g)

Twenty male and twenty female cocoons were selected randomly from each replicate and weighed to obtain average weight of a single cocoon.

Single shell weight (g)

Pupae from above lot were separated from cocoons and shells were weighed to get single shell weight.

Shell ratio (%)

The ratio between shell and cocoon from the above lot was determined by following formula:

$$\frac{\text{Shell weight}}{\text{Cocoon weight}} \times 100$$

RESULTS

Post harvest parameters

The result pertaining to post-cocoon parameters are presented in Table 5 & 6 and illustrated in Fig.

Cocoon yield /10000 larvae by number

Observations recorded revealed that treatments had no significant influence on the cocoon yield by number. However maximum number of cocoons were recorded in T_8 (9064.30) and minimum numbers of cocoons were recorded in T_1(7300.00). So for as combined influence of Ca and Mg is concerned, the value for number of cocoons was higher than that of individual sprays of Ca and Mg.

Cocoon yield/10000 larvae by weight

Treatments exhibited no significant influence on the cocoon yield by weight. However maximum yield of cocoons was recorded in T_8 (17.73 kg) and minimum yield of cocoons was recorded in T_1 (12.20 kg).

So for as combined influence of Ca and Mg is concerned, the value for yield of cocoons was higher than that of individual sprays of Ca and Mg.

TABLE 1: Influence of foliar spray of Ca and Mg on yield of silkworm *Bombyx mori* L. during summer rearing

Treatment		Yield by number/ 10000 larvae	Yield by weight/ 10000 larvae (kg)
T_1	Control	7300.00	12.20
T_2	0.2% Ca	7328.60	13.26
T_3	0.4% Ca	7457.10	13.84
T_4	0.2% Mg	7457.10	13.79
T_5	0.4% Mg	7842.90	14.76
T_6	0.2% Ca + 0.2% Mg	9000.00	17.00
T_7	0.2% Ca + 0.4% Mg	8164.30	14.97
T_8	0.4% Ca + 0.2% Mg	9064.30	17.73
T_9	0.4% Ca + 0.4% Mg	8228.60	16.08
$CD_{(p<0.05)}$		NS	NS

TABLE 2: Influence of foliar spray of Ca and Mg on post harvest characters of silkworm *Bombyx mori* L. during summer rearing

Treatment		Single cocoon weight (g)	Single shell weight (g)	Shell ratio (%)	Improvement in shell weight over control (%)
T_1	Control	1.80	0.35	19.52	0.00
T_2	0.2% Ca	1.90	0.38	20.04	7.04
T_3	0.4% Ca	1.91	0.38	19.99	8.24
T_4	0.2% Mg	1.95	0.40	20.41	13.05
T_5	0.4% Mg	1.95	0.40	20.36	13.05
T_6	0.2% Ca + 0.2% Mg	1.99	0.42	21.33	20.26
T_7	0.2% Ca + 0.4% Mg	1.96	0.41	20.89	15.45
T_8	0.4% Ca + 0.2% Mg	2.07	0.45	21.88	28.60
T_9	0.4% Ca + 0.4% Mg	1.97	0.41	20.75	15.45
	$CD_{(p<0.05)}$	NS	0.053	NS	

Single cocoon weight (g)

Observations recorded revealed that treatments had no significant effect on single Cocoon weight. However maximum single cocoons weight was recorded in T_8(2.07g) and minimum single cocoon weight was recorded in T_1(1.80g).

So for as combined influence of Ca and Mg is concerned, the values for single cocoon weight were higher than that of individual sprays of Ca and Mg.

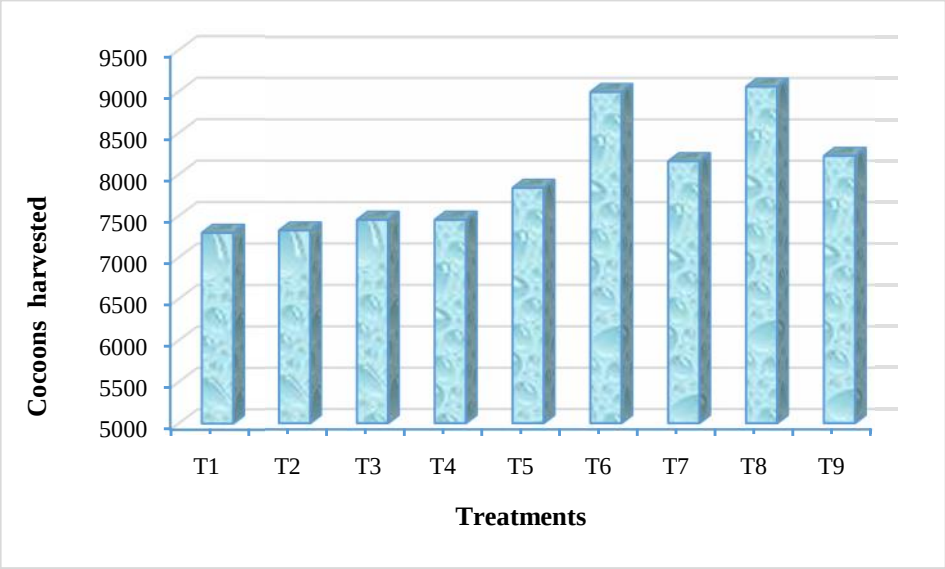

FIGURE 1: Influence of foliar sprays on yield by number per 10000 larvae

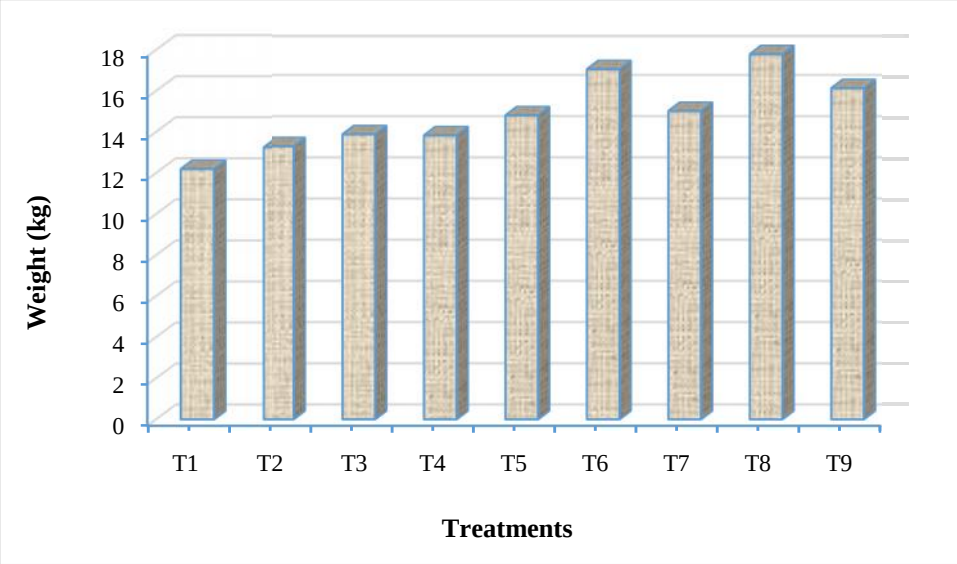

FIGURE 2: Influence of foliar sprays on yield by weight per 10000 larvae

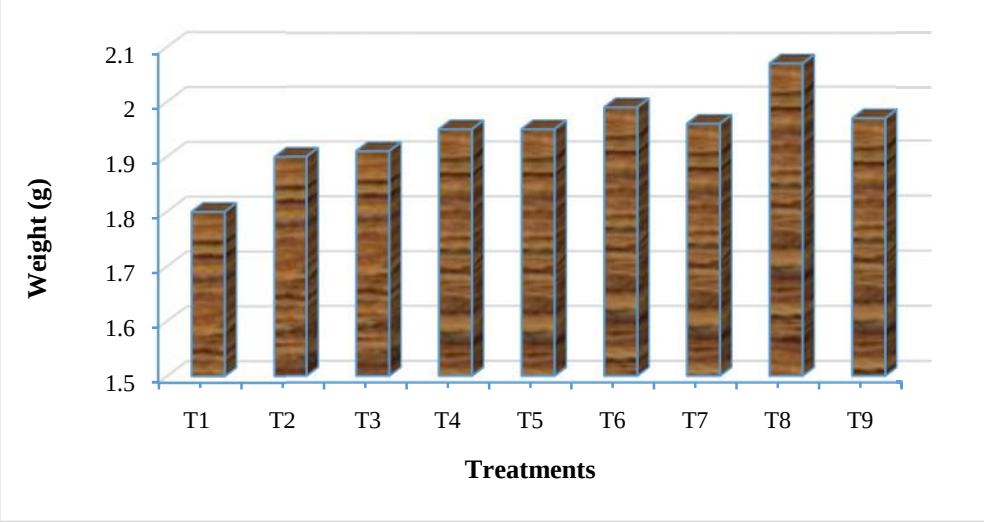

FIGURE 3: Influence of foliar sprays on single cocoon weight

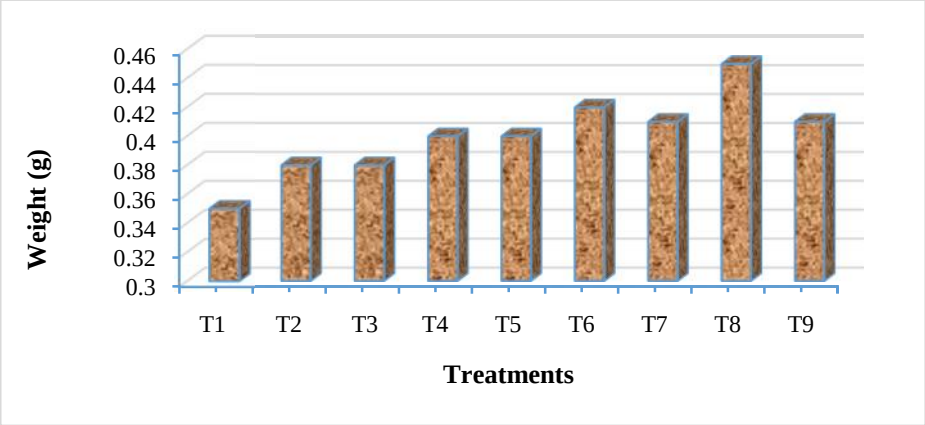

FIGURE 4: Influence of foliar sprays on single shell weight

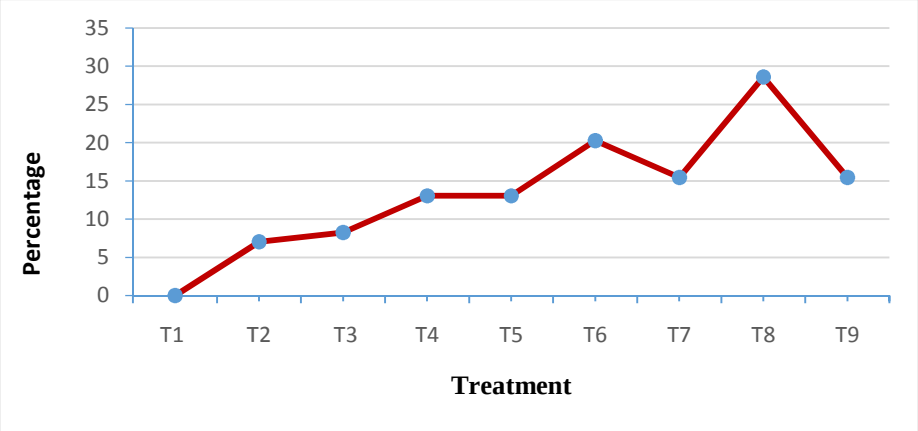

FIGURE 5: Improvement in shell weight over control

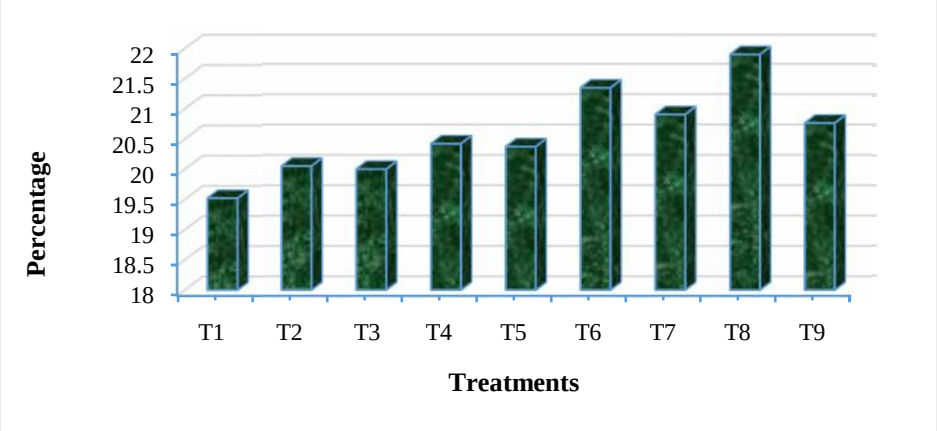

FIGURE 6: Influence of foliar sprays on shell ratio

Single cocoon weight (g)

Observations recorded revealed that treatments had no significant effect on single Cocoon weight. However maximum single cocoons weight was recorded in T_8(2.07g) and minimum single cocoon weight was recorded in T_1(1.80g).

So for as combined influence of Ca and Mg is concerned, the value for single cocoon weight was higher than that of individual sprays of Ca and Mg.

Single shell weight (g)

Treatments exhibited significant effect on shell weight with T_8 (0.45g) being significantly higher than T_3 (0.38g), T_2 (0.38g) and T_1 (0.35g) but at par with T_6 (0.42g), T_7 (0.41g), T_9 (0.41), T_5 (0.40) and T_4 (0.40) respectively.

So for as cumulative influence of Ca and Mg is concerned, Ca at 0.4% and 0.2% Mg(0.45g) was at par with all treatments i.e. 0.2% Ca and 0.2% Mg(0.42g), 0.4% Ca and 0.4% Mg(0.41g) & 0.2% Ca and 0.4% Mg(0.41g).

Improvement in single shell weight over control

The data revealed that T_8 and T_6 with single shell weight of 0.45 g and 0.42g recorded an increase of 28.60 and 20.26% respectively over control (0.352 g).

So for as combined influence of Ca and Mg is concerned, the value for single shell weight were higher than that of

individual sprays of Ca and Mg.

Shell ratio (%)

Results revealed that treatments had no significant influence on the shell ratio. However highest values of shell ratio (21.88%) were recorded in T_8 followed by T_6 (21.33%) and least values were recorded in T_1 (19.52%).

So for as combined influence of Ca and Mg is concerned, the values for shell ratio (%) were higher than that of individual sprays of Ca and Mg.

DISCUSSION

Foliar spray of Ca and Mg had no significant influence on yield by number and by weight. However maximum yield of 9064.30 cocoons was recorded in T_8 (0.4% Ca + 0.2% Mg). Further maximum yield by weight (17.73 kg) was recorded in T_8 (0.4% Ca + 0.2% Mg). However maximum (2.071 g) single cocoon weight was recorded with T_8 (0.4% Ca + 0.2% Mg). Foliar spray of Ca and Mg did not have any significant influence on the single cocoon weight. However maximum (2.071 g) single cocoon weight was recorded with T_8 (0.4% Ca + 0.2% Mg).Shell weight is an important parameter because quality silk production mainly depends upon the cocoon shell. The results of present study showed statistically significant increase in single shell weight. Maximum (0.4526 g) single shell weight was recorded in T_8 (0.4% Ca + 0.2% Mg). This can be attributed to the enzymatic reactions influenced by magnesium. Gunther (1981) while working on similar lines reported that about 300 enzyme reactions are influenced by Mg ions. When Mg is passed on the silkworm it accelerates the growth of silkworm through orientation of physiological activities which have resulted in higher larval weight and in turn increase the shell weight. This result corroborate with the findings of Zaman *et al*. (1996) who reported that mulberry leaves enriched with 0.2%N and 0.15%Mg increased cocoon shell weight by 94%. These findings are in agreement with the findings of Subburathinam and Chetty (1991) have also reported that enrichment of mulberry leaves with calcium chloride improve the Cocoon characters. Chakravarthy and Medda (1978) also reported an increase in shell weight in the cocoon due to supplementation of salts; viz, calcium chloride and potassium nitrate.

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