



EFFECTIVENESS OF FOLIAR SPRAY OF CALCIUM AND MAGNESIUM ON SILKWORM (*Bombyx mori* L.) REARING AND GRAINAGE 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 longitude 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. Goshorami 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 larval weight and pupation rate recording maximum values of 42.97 and 98%. Increased in these parameters over control was recorded to the extent of 18.00 and 15.54, percent respectively. Reduction in defective cocoon percentage was recorded to the extent of 86.88%, 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

In India Sericulture is a farm-based, labour intensive and commercially attractive economic activity falling under the cottage and small scale sector. It suits multifarious beneficiaries including rural farmers/entrepreneurs and artisans, as it require low investment having potential for relatively higher returns. It provides income and employment to the rural poor especially farmers with small land holdings and the marginalized and weaker sections of the society. Several socio economic studies have affirmed that the benefit cost ratio in sericulture is highest among comparable agricultural crops (Dandin, 2005). Sericulture has an important place in the economy of J&K. The state presents an ideal and fertile land for growth and development of mulberry and bivoltine silkworm rearing. The state produced 115 MT of cocoons in the year 2012-13 (Anonymous, 2012). Though there has been a steady increase in the cocoon production during the past few years, yet the industry has to gain its glorious past and exploit its high economic potential. 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). The leaf

quality depends on various factors viz., mulberry variety, season, irrigation, fertilizer or manure application, temperature, photoperiod, nature and type of soil, water table, pruning, maturity of leaf and method of leaf harvesting (Bongale and Chaluvachari, 1993; Purohit and Kumar, 1996; Rachotaiah *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). Root absorption of some of the nutritive elements in the soil is slow and translocation to shoot is poor under adverse soil conditions. In order to overcome these drawbacks, foliar application of nutrients is imperative. Foliar spray is a way of supplementing the nutrients quickly to improve plant metabolism. It has been used as a means of supplying supplemental doses of major and minor nutrients, hormones, stimulants and other beneficial substances. The plant nutrients which are absorbed through roots can also be absorbed with equal efficacy through foliage and often several times more efficiently than through soil treatment. It minimizes wastage and the quantity to be sprayed is fairly a fraction of what is required for soil application. During the last two decades studies on foliar nutrition has received considerable attention especially in agriculture, horticulture and other foliage crops and The beneficial effects from foliar sprays of nutrients have been well established (Narahari *et al.*, 2001). 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 Goshorami (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-Kashmir. 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	:	Goshorami
No. of worms/treatment/replication	:	100

Foliar spray

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 (Plate-3). 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.

RESULTS

Rearing parameters

Weight of 10 mature larvae (g)

The weight of ten mature/full grown larvae was taken on 5th and 6th day of fifth instar by taking three samples of ten randomly selected silkworms from each replication of each treatment. The average highest value out of the days

was taken as the weight of ten mature larvae.

Larval duration (5th age)

The period from resumption of 5th age till seriposition was taken as 5th age larval duration.

Total larval duration

The period from brushing of newly hatched larvae till seriposition of worms was taken as total larval duration.

Number of worms retained out of third moult

Grainage parameters

Pupation rate (%)

It was calculated using following formula:

$$\frac{\text{Total number of live pupae}}{\text{Total number of cocoons harvested}} \times 100$$

EXPERIMENTAL FINDINGS

The results of the present study entitled, “Impact of foliar spray of Calcium and Magnesium on economic traits of *Bombyx mori* L. during summer in Kashmir” carried out at Temperate Sericulture Research Institute, Mirgund during 2014 are presented below:

Rearing parameters

Results pertaining to rearing parameters i.e. larval weight, 5th age larval duration and total larval duration are presented in Table-1 and illustrated in Fig. 1 to 5.

Larval weight

Data revealed that treatments exhibited significant influence on larval weight with T₈ (42.97g) being significantly higher than T₉ (39.96g), T₇ (39.70g), T₅ (39.60g), T₄ (39.13g), T₂ (38.84g), T₃ (37.92g) and T₁ (36.07g) but at par with T₆ (41.97g). Least values (36.07g)

were recorded in T₁ (control).

As for as cumulative influence of Ca and Mg is concerned T₈ (0.4%Ca + 0.2% Mg with values of 42.97g was at par with that of T₆ (0.2% Ca and 0.2% Mg) with values of (41.97g) and significantly different from other two concentration viz., T₉(0.4% Ca + 0.4% Mg and T₇(0.2%Ca +0.4% Mg).

5th age larval duration

Treatments did not exhibit any significant influence on 5th age larval duration. However minimum larval duration was recorded in T₈ (228.20h) and maximum duration was recorded in T₁(245.84h).

So far as combined influence of Ca and Mg is concerned, the duration of 5th age was lesser as compared to that of individual sprays of Ca and Mg.

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

Treatment		Larval weight (g)	5 th age larval duration (hrs)	Total larval duration (hrs)	Improvement in Larval weight over control (%)
T ₁	Control	36.07	245.84	704.84	0.00
T ₂	0.2% Ca	38.84	238.56	697.56	7.00
T ₃	0.4% Ca	37.92	232.99	691.99	5.00
T ₄	0.2% Mg	39.13	232.59	691.59	8.00
T ₅	0.4% Mg	39.60	232.49	691.49	9.00
T ₆	0.2% Ca + 0.2% Mg	41.97	229.78	688.78	16.00
T ₇	0.2% Ca + 0.4% Mg	39.70	231.44	690.44	10.00
T ₈	0.4% Ca + 0.2% Mg	42.97	228.20	687.20	18.00
T ₉	0.4% Ca + 0.4% Mg	39.96	230.23	689.23	10.00
CD _(p<0.05)		2.076	NS	NS	

Total larval duration

Treatments did not exhibit any significant influence on the total larval duration. However minimum total larval duration was recorded in T₈ (687.20h) and maximum duration was recorded in T₁(704.84h). So far as combined influence of Ca and Mg is concerned, the value for total larval duration was lesser as compared to that of individual sprays of Ca and Mg.

Improvement in larval weight over control

The data revealed that T₈ and T₆ with larval weight of 42.97 and 41.97g respectively recorded an increase in larval weight to the extent of 18.00% and 16.00% respectively over control which recorded larval weight of 36.07g.

Grainage parameters

Results pertaining to grainage parameters are presented in Tables-2 and illustrated in Fig. 5 to 8.

Pupation rate

Data revealed that treatments exhibited significant influence on pupation rate with T₈ (98.00%) being significantly higher than T₁ (84.82%), T₂ (84.94%), T₃ (87.00%), T₄ (88.88%), T₅ (92.61%) and T₇ (94.78%) but at par with T₉ (95.60%) and T₆ (97.30%). Least value (84.82%) was recorded in T₁ (control). So far as cumulative influence of Ca and Mg is concerned, T₈ (0.4% Ca and 0.2% Mg) with values of (98.00%) was at par with T₉(0.4% Ca + 0.4% Mg) at (95.60%) and 0.2% Ca + 0.2% Mg (97.30%) but significantly higher than T₇(0.2% Ca + 0.4% Mg) (94.78%).

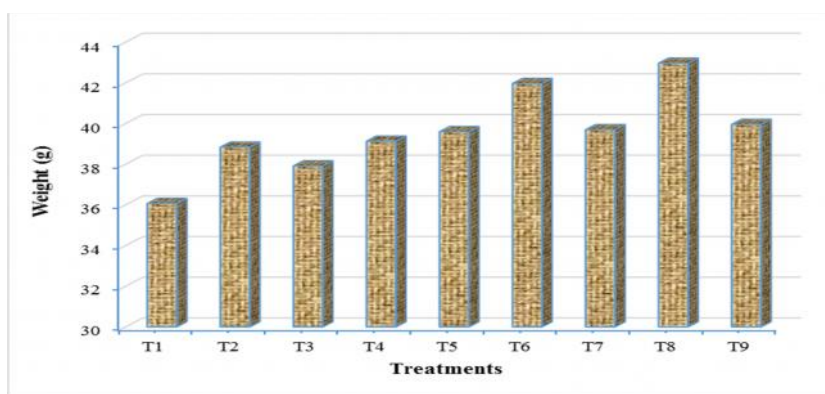


FIGURE 1 : Influence of foliar spray on larval weight (g)

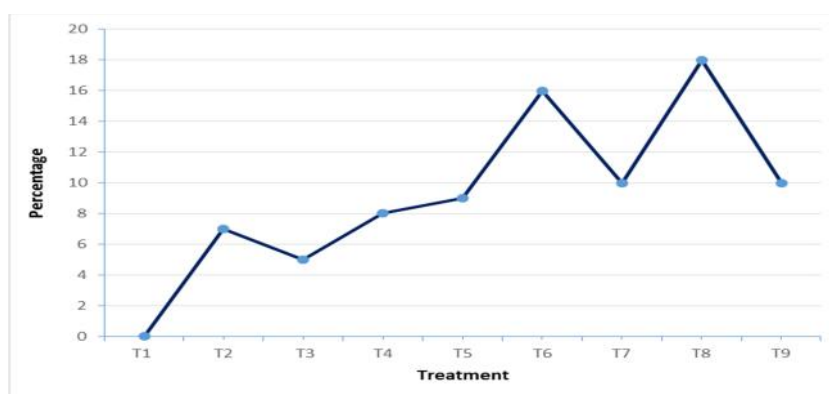


FIGURE 2: Improvement in larval weight over control

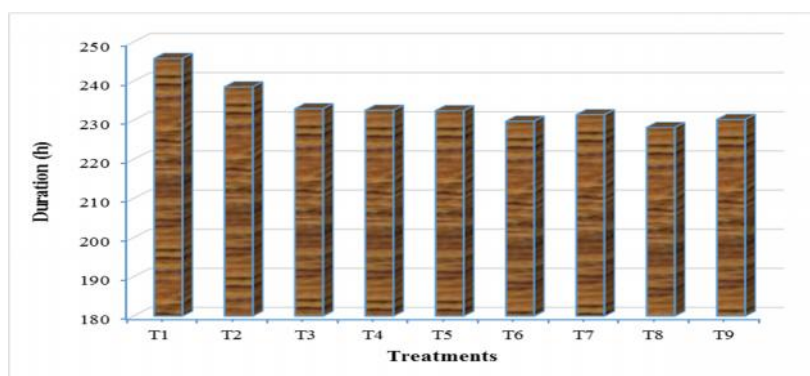


FIGURE 3: Influence of foliar spray on 5th age larval duration

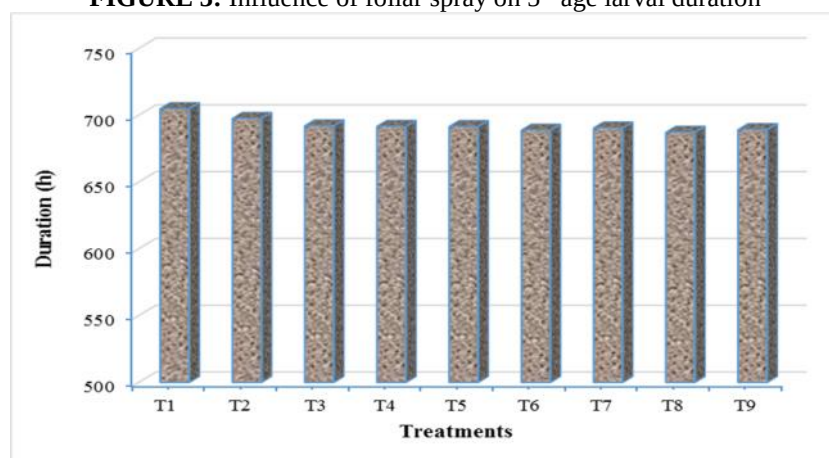


FIGURE 4 : Influence of foliar spray on total larval duration

TABLE 2: Influence of foliar spray of Ca and Mg on grainage parameters of silkworm *Bombyx mori* L. During summer rearing

Treatment		Pupation rate (%)	Defective cocoon (%)	Improvement in pupation rate over control (%)	Reduction in defective cocoon percentage over control (%)
T ₁	Control	84.82 (9.21)	15.17 (3.89)	0.00	0.00
T ₂	0.2% Ca	84.94 (9.22)	15.06 (3.88)	0.14	0.76
T ₃	0.4% Ca	87.00 (.33)	13.00 (3.60)	2.57	14.32
T ₄	0.2% Mg	88.88 (9.43)	11.11 (3.33)	4.79	26.77
T ₅	0.4% Mg	92.61 (9.62)	7.38 (2.71)	9.19	51.38
T ₆	0.2% Ca + 0.2% Mg	97.30 (9.86)	2.69 (1.62)	14.71	82.25
T ₇	0.2% Ca + 0.4% Mg	94.78 (9.73)	5.21 (2.21)	11.74	65.64
T ₈	0.4% Ca + 0.2% Mg	98.00 (9.90)	1.99 (1.39)	15.54	86.88
T ₉	0.4% Ca + 0.4% Mg	95.60 (9.78)	4.39 (2.08)	12.71	71.06
CD _(p<0.05)		2.458 (0.128)	2.459 (0.528)		

Defective cocoon percentage

Results revealed that treatments exhibited significant influence on reduction in defective cocoon percentage with T₈ (1.99%) being significantly lower than T₇ (5.21%), T₅(7.377), T₄(11.11%), T₃(13.00%), T₂(15.06%) and T₁(15.17%) but at par with T₆(2.69%) and T₉(4.39%).

So far as cumulative influence of Ca and Mg is concerned T₈(0.4%Ca + 0.2% Mg) with values of (1.99%) was significantly lower than T₇(0.2% Ca + 0.4% Mg) (5.21%) but at par with T₆(0.2% Ca + 0.2% Mg) (2.69%) and T₉(0.4% Ca + 0.4% Mg) (4.39%).

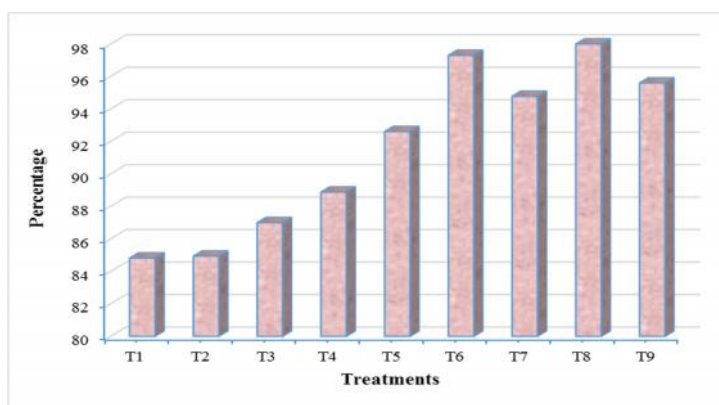


FIGURE 5 : Influence of foliar sprays on pupation rate

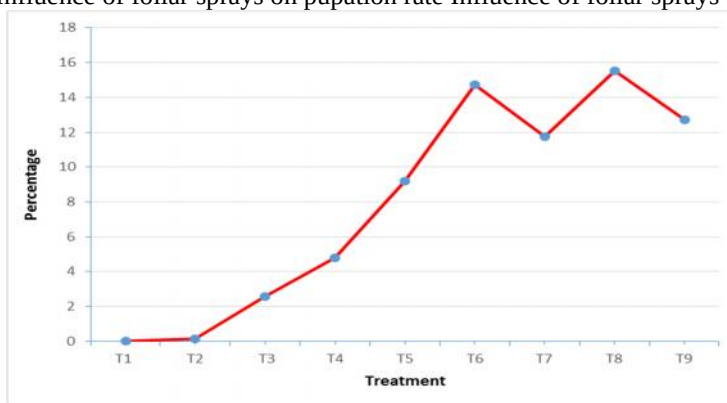


FIGURE 6: Improvement in pupation rate over control

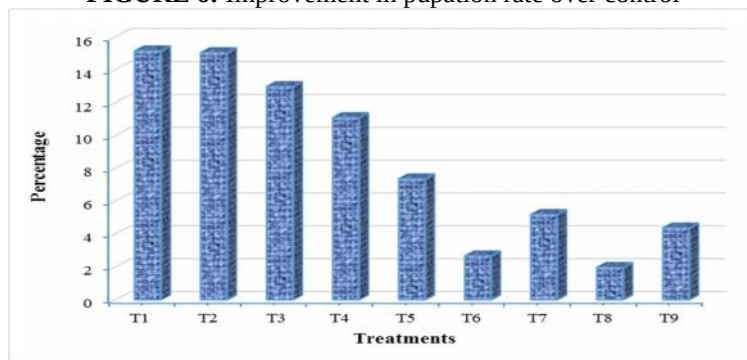


FIGURE 7: Influence of foliar sprays on defective cocoon

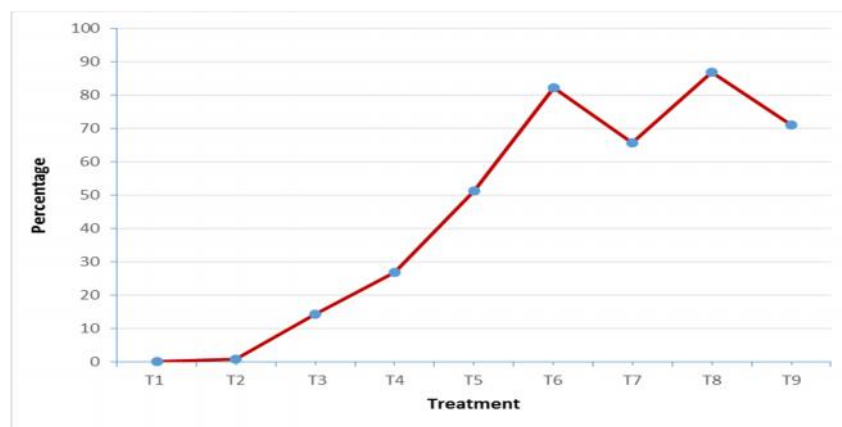


FIGURE 8: Reduction in defective cocoon percentage over control

Improvement in pupation rate over control

The data revealed that T₈ and T₆ with pupation rate of 98.00 and 97.297% respectively recorded an increase in pupation rate to the extent 15.54 and 14.71% respectively over control which recorded pupation rate of 84.82%.

Reduction of defective cocoon percentage over control

The data revealed that T₈ and T₆ with defective cocoon percentage of 1.99 and 2.69% respectively recorded reduction in defective cocoon percentage to the extent 86.88 and 82.25% respectively over control which recorded defective cocoon percentage of 15.17%.

DISCUSSION

The importance of mulberry leaf quality on growth, development and health of the silkworm has been greatly stressed by various workers (Yokoyama, 1963, Dandin and Kumar 1989; Bongale *et al.*, 1991). Foliar applications provide instant nourishment to the plants which not only enhance the growth rate of plant but also boost their productivity and biochemical content in a readily available form. These sprays are not only cost effective but also have a longer life as compared to solid bio-fertilizers and chemical fertilizers (Katiyar *et al.*, 1995). Foliar application in right time increases level of absorption of specific nutrients during growth and development (Narahari *et al.*, 1997). The present study entitled "Impact of foliar spray of Calcium and Magnesium on economic traits of *Bombyx mori* L. during summer in Kashmir" was conducted to evaluate the influence of foliar spray of calcium and magnesium on silkworm rearing and grainage parameters. The parameters studied during the course are discussed as under:

Rearing parameters

Foliar application of Ca and Mg had a significant influence on the larval weight. Maximum of larval weight (42.86 g) was recorded with T₈ (0.4% Ca + 0.2% Mg) which was at par with T₆ and significantly higher than rest of the treatments. The value recorded for 5th age larval duration showed non-significant difference among the treatments. However T₈ (0.4% Ca + 0.2% Mg) recorded the least larval duration i.e. 228.20 h. The findings regarding total larval duration also did not show any significant difference among the treatments. However lowest (687.20 h) total larval duration was recorded in T₈ (0.4% Ca + 0.2% Mg). All the above three rearing parameters i.e. reduction in 5th age larval duration, total larval duration and Increase in larval weight may be

attributed to enrichment in elemental composition of mulberry leaves due to foliar spray of Ca and Mg which in turn had stimulated the metabolic activities in silkworm thus fulfilling the requirement of nutrients both qualitatively and quantitatively. These results corroborates with the findings of Shankar *et al.* (1994) who observed that application of Ca, Mg and S leads to improvement in larval growth. Ashfaq *et al.* (1998), Rasool (1995), Zaman (1995), Tariq (1993), Ishtiaq and Akhtar (1992) also concluded that silkworm larvae fed on leaves treated with different nutrients gained significantly more weight as compared to those fed on untreated leaves. The results are in conformity with those of Bose *et al.* (1994) who observed enhanced larval weight while studying the effect of foliar application. The results are in accordance with Chakravarthy and Medda (1978) who got increase in larval body weight in the silkworm due to supplementation of salts; viz, calcium chloride and potassium nitrate.

Grainage parameters

The results of present study show significant effect on pupation rate among the treatments. Maximum rate of pupation (98.00%) was recorded in T₈ (0.4% Ca + 0.2% Mg). Foliar spray of nutrient had a profound influence on reducing defective cocoons. Lowest defective cocoon percentage (1.99%) was recorded in T₈ (0.4% Ca + 0.2% Mg). These results are in agreement with the findings of Shankar *et al.* (1994) who showed that pupation rate was higher when microelements (Fe, Zn and Mg) were used up to 20 kg/ha/year. This can be attributed to stimulation of the metabolic activity of the silkworm due to Ca, Mg and Fe, as envisaged by Horie *et al.* (1967) resulted in shorter larval duration and increased pupation rate.

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