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IMPACT OF FOLIAR SPRAY OF CALCIUM AND MAGNESIUM ON MULBERRY (VAR. GOESHOERAMI) YIELD 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 34º17′ N latitude and 75º17′ 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. 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 (T_8) resulted in significant increase in fresh weight of 100 leaves, leaf yield, Increased in these parameters over control was recorded to the extent of 51.41, and 55% respectively. 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, Calcium, Goshoerami variety.

INTRODUCTION

Sericulture is practiced 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). 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). Traditionally sericulture in India is practised in five states *viz*. Karnataka, Andra Pradesh, Tamil Nadu, West Bengal and Jammu and Kashmir. Among these West Bengal and Jammu and Kashmir are the oldest silk producing states. 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 1022 MT of cocoons in the year 2014-15 (Anonymous, 2015). 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, and pruning, maturity of leaf and method of leaf harvesting (Bongale and Chaluvachari, 1993; Purohit and Kumar, 1996; Rachotaiah *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). 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).

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.

Keeping in view the importance and impact of foliar spray of Calcium and Magnesium on economic traits of *Bombyx mori* L. The present study was aimed to generate information about leaf quality improvement through foliar leaf supplementation for successful and effective multiple cropping in Kashmir valley

MATERIALS AND METHODS

The present investigation "Impact of Foliar Spray of Calcium and Magnesium on Mulberry (Var. Goeshoerami) yield parameters during summer in Kashmir" was carried out at the experimental farm of Temperate Sericulture Research Institute Mirgund, during August, 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-Kashmir (Anonymous, 2003). 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 programme 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

Mulberry variety : Goshoerami

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.

Observations recorded

Mulberry yield parameters

For each parameter three plants per treatment per replication were taken and average calculated.

Length of the longest branch (cm)

Length of the longest branch was recorded by taking the longest branch after measuring all the branches of plants

by means of a measuring tap.

Average branch length (cm)

Average branch length was calculated by measuring all the branches of plants using a measuring tape and mean calculated, taken as average branch length.

Total shoot length (cm)

Total shoot length was calculated by measuring all the branches of plants in each

Fresh weight of 100 leaves (g)

For fresh weight of 100 leaves composite leaf sample of 100 leaves comprising approximately of equal proportion of tender, medium and coarse leaves were taken early in the morning and weighed on a balance.

Leaf yield (kg)

Leaf yield was recorded after completely harvesting the leaf from a plant.

RESULTS

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:

Plant growth parameters

Results pertaining to growth and yield of Goshoerami *i.e.* longest branch length, average branch length, total shoot length, fresh weight of 100 leaves and leaf yield per plant are presented in Table-1 & 2 and illustrated in Fig. 1 to 7.

Length of longest branch

Results revealed that treatments had no significant effect on the length of longest branch. However longest branch length was recorded in T_8 (100.00cm) and shortest branch length was recorded in T_1 (79.17cm).

So far as combined influence of Ca and Mg is concerned, the values for length of longest branch were higher in combined spray than that of individual sprays of Ca and Mg.

Average branch length

Observations recorded revealed that treatment had no significant effect on the average branch length. However maximum average branch length was recorded in T_8 (82.32 cm) and minimum average branch length was recorded in T_1 (70.08 cm).

So far as combined influence of Ca and Mg is concerned, the value for average branch length was higher than that of individual sprays of Ca and Mg.

TABLE 1: Influence of foliar spray of Ca and Mg on growth of mulberry variety (Goshoerami) after June pruning

Treatment		Length of longest branch (cm)	Average branch length (cm)	Total shoot length (cm)
T_1	Control	79.17	70.08	2174.00
T_2	0.2% Ca	87.50	70.96	2630.70
T_3	0.4% Ca	87.50	73.68	2725.30
T_4	0.2% Mg	81.25	70.48	2553.70
T_5	0.4% Mg	86.67	70.72	2559.00
T_6	0.2% Ca + 0.2% Mg	93.33	74.88	2846.00
T_7	0.2% Ca + 0.4% Mg	87.92	74.48	2801.70
T_8	0.4% Ca + 0.2% Mg	100.00	82.32	3000.00
T_9	0.4% Ca + 0.4% Mg	91.67	74.48	2812.70
F-test		NS	NS	NS

TABLE 2: Influence of foliar spray of Ca and Mg on yield of mulberry variety (Goshoerami) after June pruning

Treatment		Fresh weight of 100 leaves (g)	Leaf yield plant^{-1} (kg)	Improvement in Fresh weight of 100 leaves over control (%)	Improvement in Leaf yield over control (%)
T_1	Control	315.55	2.09	0.00	0.00
T_2	0.2% Ca	367.77	2.41	16.55	14.00
T_3	0.4% Ca	370.00	2.53	17.26	20.00
T_4	0.2% Mg	343.33	2.240	8.80	7.00
T_5	0.4% Mg	364.44	2.33	15.49	11.00
T_6	0.2% Ca + 0.2% Mg	475.55	3.21	50.71	53.00
T_7	0.2% Ca + 0.4% Mg	370.00	2.59	17.26	23.00
T_8	0.4% Ca + 0.2% Mg	477.77	3.27	51.41	55.00
T_9	0.4% Ca + 0.4% Mg	422.22	2.96	33.80	41.00
$CD_{(p<0.05)}$		83.227	0.617		

Total shoot length

Observations recorded revealed that treatment had no significant effect on the total shoot length. However, maximum total shoot length was recorded in T_8 (3000.00 cm) and minimum total shoot length was recorded in T_1 (2174.00 cm).

So far as combined influence of Ca and Mg is concerned, the value for total shoot length using combined spray were higher than that of individual sprays of Ca and Mg.

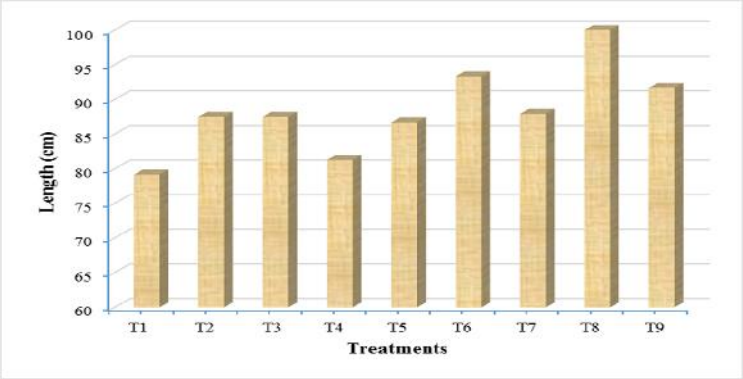

FIGURE 1: Influence of foliar spray on length of longest branch (cm)

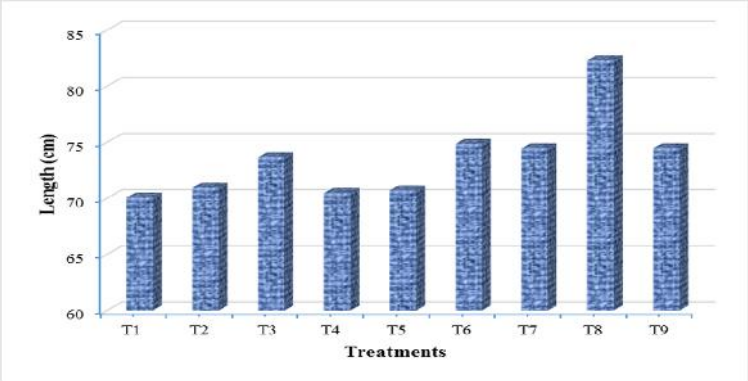

FIGURE 2 : Influence of foliar spray on average branch length (cm)

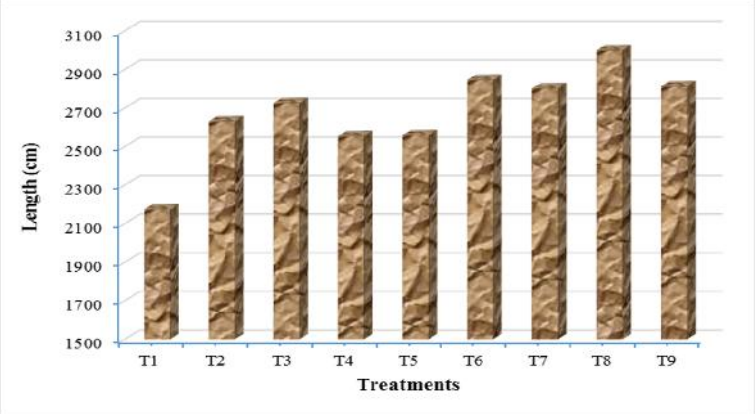

FIGURE 3: Influence of foliar spray on total shoot length (cm)

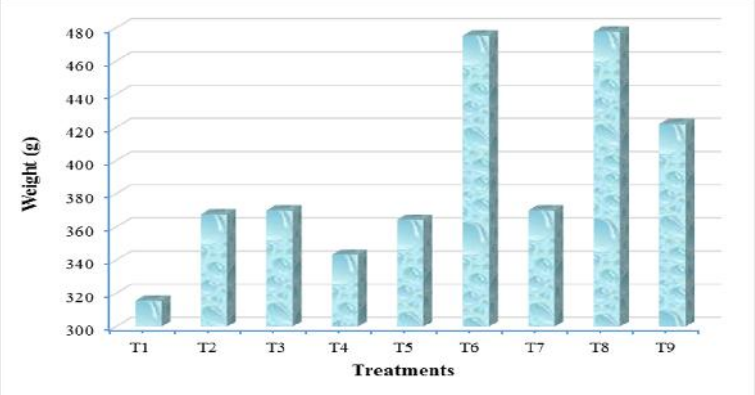

FIGURE 4: Influence of foliar spray on fresh weight (g) of 100 leaves

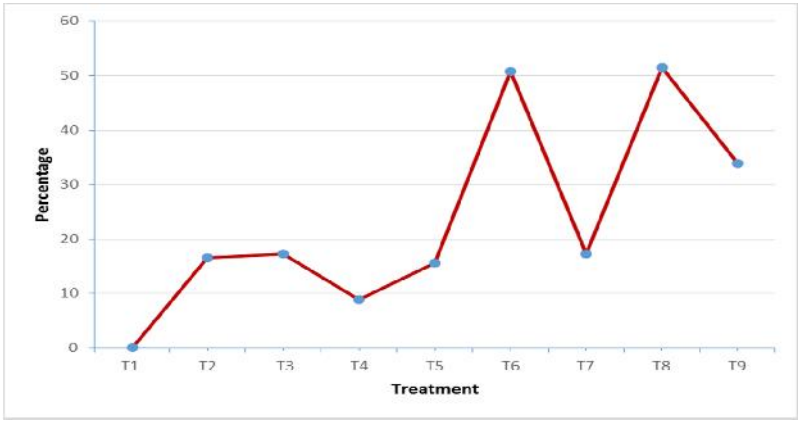

FIGURE 5 : Improvement in fresh weight of 100 leaves over control

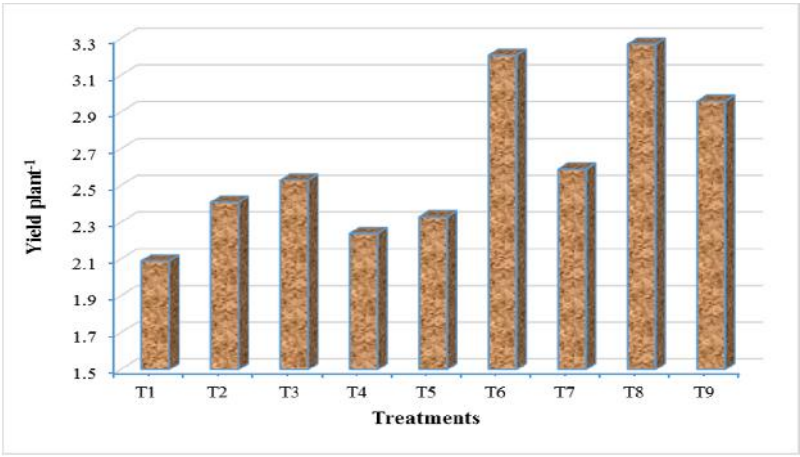

FIGURE 6 : Influence of foliar spray on leaf yield plant^{-1}

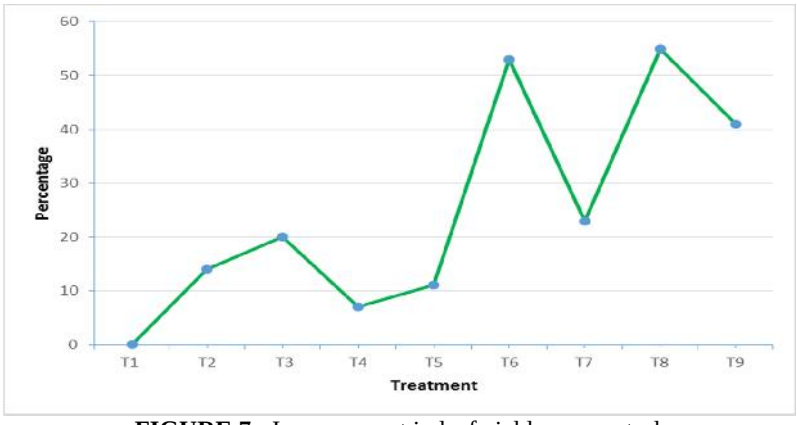

FIGURE 7 : Improvement in leaf yield over control

Fresh weight of 100 leaves (g)

Observations recorded revealed that treatments had significant effect on fresh weight of leaves with T_8 (477.77g) being significantly higher than T_7 (370.00 kg), T3 (370.00g), T_2 (367.77g), T_5 (364.44g), T4 (343.33g) and T_1 (315.55g) but at par with T_6 (475.55g) and T_9 (422.22g).

So far as cumulative influence of Ca and Mg is concerned, Combined spray of 0.4%Ca + 0.2%Mg (477.77g) was at par with 0.2% Ca + 0.2% Mg(475.55g) & 0.4% Ca + 0.4% Mg (422.22 g) but significantly higher than 0.2% Ca + 0.4% Mg(370.00g).

Leaf yield (kg)

Treatments recorded significant influence on leaf yield with T_8 (3.27 kg) being significantly higher than T_7 (2.59 kg), T_3 (2.53 kg), T_2 (2.41 kg), T_5 (2.33 kg), T_4 (2.40 kg) and T_1 (2.09 kg) but at par with T_6 (3.21 kg) and T_9 (2.96 kg).

So far as cumulative influence of Ca and Mg is concerned, combined spray of 0.4%Ca and 0.2%Mg (3.27g) was at par with 0.2% Ca and 0.2% Mg (3.21g) & combined spray of 0.4% Ca and 0.4% Mg (2.96g).

Improvement in fresh weight of 100 leaves over control

The data revealed that T_8 and T_6 with weight of 477.77 and 475.55 kg recorded an increase of 51.41 and 50.71 percent respectively over control with weight of (315.55 kg).

Improvement in leaf yield over control

The data revealed that T_8 and T_6 with leaf yield of 3.27 and 3.21 kg recorded an increase of 55.00 and 53.00 percent respectively over control with weight of (2.09 kg).

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 plant growth parameters. The study of growth parameters is one of the indices to know the degree of growth and therefore, observations on most of the growth parameters were taken into consideration. The length of the longest branch is one of the important factors which contribute to the better leaf yield. Though the values recorded for longest branch length showed statistically non-significant effect. The maximum value for longest branch length (100 cm) was recorded with combined spray of 0.4%, Ca and 0.2% Mg. The results regarding average branch length did not show any significant difference among the treatments. However maximum value for average branch length (82.320 cm) was recorded in T_8 (0.4% Ca + 0.2% Mg). Also the values recorded for total shoot length did not show any significant difference among the treatments. However maximum total shoot length (3000 cm) was recorded in T_8 (0.4% Ca + 0.2% Mg). Foliar spray of nutrients had a significant influence on the fresh weight of 100 leaves and leaf yield per plant. Maximum fresh weight (477.77 g) was recorded in T_8 (0.4% Ca + 0.2% Mg). It was statistically at par with T_6 and T_9 and significantly higher than the rest of the treatments. Similarly leaf yield per plant was maximum (3.267 kg) in T_8 (0.4%Ca+0.2%Mg) which too was statistically at par with T_6 and T_9. Hamada (1956) reported that the leaf yield in mulberry depends on the length of shoot and leaf weight. Combined spray of Ca and Mg has resulted in improvement in leaf yield. The findings of the present study are in conformity with the findings of Vishwanath (1996) who reported significantly higher leaf yield in mulberry by combined spray of $ZnSO_4$, $MgSO_4$ and $FeSO_4$. Shankar and Shivashankar (1994) too have reported improvement in leaf yield by the application of Ca, Mg and S. This can be attributed to cumulative influence of calcium and magnesium as calcium is a part of the structure of cell wall and membrane which is involved in root elongation, cell division, growth and activation of enzymes. Calcium (Ca) plays an important role in the synthesis of pectin in the middle lamella which provides firmness and rigidity while as magnesium is an constituent of chlorophyll molecule which plays an important role in photosynthesis and apart from this, Mg is of importance mainly as a co-factor and activator for many enzymes and substrate transfer reactions (Gunther, 1981).

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