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Foliar Application of Magnesium Sulphate and Basal Application of Calcium Carbonate: A New Dimension in Production of Tasar Crops

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An experiment was carried out to boost the production of tasar crops through application of secondary nutrients. Different combinations of secondary nutrients were prepared and its effect was studied on the yield and quality of leaves of tasar food plant *Terminalia tomentosa* W & A with 2.4 m × 2.4 m spacing and cocoon characters of tasar silkworm *Antheraea mylitta* Drury reared on them. Among different combinations of secondary nutrients, foliar application of magnesium sulphate (2%, w/v) and basal application of 3 quintal / ha of calcium carbonate (secondary nutrient combination SM_5) was found to be the best in crop improvement. It improves the quantity and quality of leaves as well as the commercial characters of cocoons. As a result, silk production improves. Under this combination, leaf yield increased by 26.55% in comparison to control. Average increase in moisture, total mineral, crude protein and total carbohydrate was 3.26%, 20.84%, 15.39% and 17.85% respectively as compared with control. Further, bio assay studies revealed that average larval weight, E.R.R., cocoon weight, shell weight and silk ratio percent increased by 11.25%, 25.71%, 20.05%, 35.14% and 12.17% respectively over control which indicates that secondary nutrient combination SM_5 has significant role in improving the production of tasar crops.

Key words: Secondary nutrients combinations, Production, Tasar crops, *Terminalia tomentosa, Antheraea mylitta.*

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Introduction

The quantity and quality of silk produced is directly dependent on the leaf quality, which influences the healthy growth of silkworm larvae and thereby affects the cocoon production. Various studies in the past and present on silkworm nutrition have established that it is the quality of leaf that ultimately reflects on growth and development of the silkworm as well as on overall silk production (Dandin *et al.,* 2003). Secondary nutrients are as important to plants as major nutrients (Pasricha and Sarkar, 2002). Even with adequate use of NPK fertilizers, deterioration in soil fertility is often observed in crops / cropping system which is found to be associated with the deficiency of micro and secondary nutrients. Several studies have been carried out for improvement in tasar crops through application of major and micronutrients (Sinha *et al.*, 1999, 2002, 2009). But no study has so far been undertaken for the improvement of tasar crops through application of secondary nutrients which are the key nutrients responsible for increasing productivity in acidic soils (Sarkar and Singh, 2003). Soils of tasar producing areas are generally acidic. Hence, the present study aims to improve tasar crops through application of secondary nutrients combinations.

Materials and Methods

The experiment was conducted in the experimental field of Central Tasar Research & Training Institute, Nagri, Ranchi on *T. tomentosa* plants with 2.4 m × 2.4 m spacing under rain fed condition during first (July- Aug.) and second (Sept.- Oct.) rearing seasons. Before the layout of the experiment, the fertility gradient of the field was studied following the method described by Hesse (2002). The plot was quite uniform having sandy loam laterite soil with pH

5.4, organic carbon 0.37%, available phosphorus 14.6 kg/ha and available potassium 62.0 kg/ha. Secondary nutrient status of the soil is given below:

Name of secondary nutrients	Status in soil
Available calcium	2.90 Cmol (P^+) kg^{-1}
Available magnesium	0.95 Cmol (P^+) kg^{-1}
Available sulphur	8.70 ppm

The experiment was laid out in Randomized Block Design with ten treatments in three replications, each replication having 24 plants. The usual package of practices of major nutrients i.e., nitrogen (200 kg/ha/yr), phosphorus (50 kg/ha/yr), potassium (50 kg/ha/yr) and farm yard manure (6 MT/ ha) was also followed.

Ten treatments including control are as follows:

Experimental code	Treatments
SM_1	Foliar application of $MgSO_4$ (1.5%, w/v) & basal application of $CaCO_3$ (2 q ha^{-1})
SM_2	Foliar application of $MgSO_4$ (1.5%, w/v) & basal application of $CaCO_3$ (3 q ha^{-1})
SM_3	Foliar application of $MgSO_4$ (1.5%, w/v) & basal application of $CaCO_3$ (4 q ha^{-1})
SM_4	Foliar application of $MgSO_4$ (2%, w/v) & basal application of $CaCO_3$ (2 q ha^{-1})
SM_5	Foliar application of $MgSO_4$ (2%, w/v) & basal application of $CaCO_3$ (3 q ha^{-1})
SM_6	Foliar application of $MgSO_4$ (2%, w/v) & basal application of $CaCO_3$ (4 q ha^{-1})
SM_7	Foliar application of $MgSO_4$ (2.5%, w/v) & basal application of $CaCO_3$ (2 q ha^{-1})
SM_8	Foliar application of $MgSO_4$ (2.5%, w/v) & basal application of $CaCO_3$ (3 q ha^{-1})
SM_9	Foliar application of $MgSO_4$ (2.5%, w/v) & basal application of $CaCO_3$ (4 q ha^{-1})
SM_{10}	Control (without secondary nutrients)

Basal application of calcium carbonate was done in single dose in the month of June. Magnesium sulphate was applied foliarly on *T. tomentosa* plants in three split doses starting from May with an interval of 15 days. The effect of these treatments was studied during first (July - Aug.) and second (Sept. - Oct.) crops through bio assay, chemo assay and leaf yield determination. For bio assay studies, disease free layings of *Antheraea mylitta* were brushed and reared in three replicated batches of 100 worms each following the rearing technique suggested by Jolly *et al.*, (1974). For chemo assay, Simple Random Sampling method was followed for collecting the leaf samples excluding too tender and over mature leaves from treatment and control in three replications. All the biochemical constituents of leaves except moisture were determined on oven dry basis. Moisture, total mineral, total carbohydrate and crude fibre were estimated by the method of AOAC (1955). Kjeldahl's method as described by Vogel (1978) was followed for the determination of total nitrogen. Crude protein was calculated by multiplying the estimated value of nitrogen content by 6.25.

Results and Discussion

The leaf yield and percent increase in leaf yield of two crops have been presented in Table 1. It is evident from the table that there has been significant increase in leaf yield (26.55%) over control for secondary nutrient combination SM_5 (foliar application of magnesium sulphate, 2%, w/v & basal application of calcium carbonate 3q ha^{-1}). The increase in leaf yield due to application of magnesium sulphate and calcium carbonate may be due to the fact that magnesium sulphate is involved in the formation of chlorophyll and activation of enzymes (Gunther, 1981). Similar trends of increased yield of potato (21.00 to 41.60%) and tea (20.20%) have been reported by Sarkar and Singh (2003) by the application of magnesium sulphate and sulphur respectively. Calcium carbonate provides calcium to the soil in available form to plants. Calcium is extremely important mineral in plant nutrition. It increases the uptake of nutrient. It is required for the growth of the meristematic tissues and for the functioning of the root tip. It also maintains the shape of the cells. Our findings also corroborates with the findings of Sarkar and Singh (2003) who also reported that basal application of 2-4 q ha^{-1} of calcium carbonate increased the yield of soya bean to the tune of 26.70%.

Table 2 shows the effect of different combinations of secondary nutrients on the chemical constituents of *T. tomentosa* leaves. It is evident from the table that application of secondary nutrients combinations has improved the quality of leaf. Except crude fibre, contents of moisture, crude protein, total carbohydrate and total mineral were significantly higher in treated plant leaves than control. Among different combinations of secondary nutrients, SM_5 is found to be the best in improving the leaf quality. Under this treatment average increase in moisture, total mineral, crude protein and total carbohydrate was 3.26%, 20.84%, 15.39% and 17.85% respectively as compared with control. The increase in chemical constituents may be due to the beneficial role of secondary nutrients in

Table 1. Effect of different combinations of secondary nutrients on the leaf yield of *T. tomentosa*

Treatment	Leaf yield of *T. tomentosa* (kg/ha)			% Increase over control
	Crop I	Crop II	Average	
SM_1	8914.60	9587.40	9251.00	6.59
SM_2	9082.80	9587.40	9335.10	7.56
SM_3	9755.60	10024.72	9889.80	13.95
SM_4	9419.20	10024.72	9721.96	12.02
SM_5	10764.80	11202.12	10983.46	26.55
SM_6	10092.00	10428.40	10260.20	18.22
SM_7	9251.00	9991.08	9621.04	10.85
SM_8	9755.60	10361.12	10058.36	15.89
SM_9	8914.60	9923.80	9419.20	8.53
SM_{10} (control)	8258.62	9099.62	8678.81	-
C.D. at 5%	434.54	367.03	468.47	-

Table 2. Effect of different combinations of secondary nutrients on the chemical constituents of *T. tomentosa*

Treatment	Moisture (%)		Total mineral (%)		Crude fibre (%)		Crude Protein (%)		Total carbohydrate (%)	
	Crop I	Crop II	Crop I	Crop II	Crop I	Crop II	Crop I	Crop II	Crop I	Crop II
SM_1	72.61	71.35	8.93	8.52	11.70	12.80	12.81	13.19	15.32	15.69
SM_2	72.70	71.43	9.00	8.58	11.80	12.85	12.94	13.25	15.41	15.80
SM_3	73.29	71.96	9.42	8.99	11.90	13.00	13.31	13.75	16.01	16.47
SM_4	73.11	71.80	9.29	8.87	11.85	12.95	13.25	13.56	15.83	16.27
SM_5	74.45	73.00	10.25	9.80	12.10	13.25	14.25	14.69	17.20	17.80
SM_6	73.68	72.31	9.70	9.27	12.00	13.15	13.69	14.06	16.42	16.92
SM_7	73.00	71.70	9.22	8.79	11.95	13.00	13.13	13.50	15.72	16.14
SM_8	73.46	72.12	9.55	9.12	11.90	13.10	13.50	13.85	16.20	16.68
SM_9	72.79	71.51	9.06	8.65	11.85	12.95	13.00	13.31	15.50	15.90
SM_{10} (control)	72.00	70.80	8.50	8.10	11.60	12.70	12.38	12.69	14.70	15.00
C.D. at 5%	0.44	0.49	0.28	0.23	N.S.	N.S.	0.28	0.30	0.54	0.59

plant metabolism. Magnesium activates enzymes and sulphur is involved in the formation of amino acids essential for protein synthesis (Pasricha and Sarkar, 2002). Calcium is an important mineral for plant nutrition. It enhances the uptake of nitrogen in the form of nitrates and helps in protein synthesis (Das and Chaudhary, 2007). This may be the reason for increase in chemical constituents of leaves.

Influence of different combinations of secondary nutrients on the commercial characters of *Antheraea mylitta* Drury reared on *T. tomentosa* has been presented in Table 3. It is evident from the table that feeding silkworm with leaves of secondary nutrient combinations treated plants has a favourable effect on the larval weight, effective rate of rearing (E.R.R.), cocoon weight, shell weight and silk ratio (S.R.) percent. This result corroborates with the findings of Shankar *et al.,* (1994). They reported that secondary nutrients play an important role in silkworm larval growth, cocoon weight and silk quality. Among different combinations of secondary nutrients, SM_5 is found to be the best in improving the commercial characters of *A. mylitta* D. Under this treatment average larval weight, E.R.R., cocoon weight, shell weight and silk ratio percent increased by 11.25%, 25.71%, 20.05%, 35.14% and 12.17% respectively in comparison to control. Bose *et. al*., (1995) reported that mineral contents stimulate the metabolic activities in silkworm resulting in quantitative improvement of cocoon and silk. Gunther (1981) concluded that about 300 enzymatic reactions are influenced by Mg ions. When magnesium is passed on to the silkworms, it accelerates the growth of silkworms through orientation of physiological activities. Moreover, sulphur is known to have an important role in the synthesis of

Table 3. Influence of different combinations of secondary nutrients on the commercial characters of cocoons reared on *T. tomentosa*

Treatment	Wt of late 5th stage larva (g)		E.R.R. (%)		Cocoon weight (g)		Shell weight (g)		Silk Ratio (%)	
	Crop I	Crop II	Crop I	Crop II	Crop I	Crop II	Crop I	Crop II	Crop I	Crop II
SM_1	39.90	40.48	36.00	39.67	12.72	12.86	1.62	1.76	12.74	13.66
SM_2	40.10	40.60	37.00	39.00	12.84	12.96	1.64	1.78	12.77	13.70
SM_3	41.12	41.72	38.67	41.33	13.60	13.74	1.66	1.80	12.20	13.09
SM_4	40.80	41.40	37.67	40.33	13.37	13.51	1.65	1.79	12.32	13.34
SM_5	43.20	43.80	42.33	45.67	14.39	14.53	1.92	2.08	13.33	14.31
SM_6	41.80	42.44	39.33	42.00	14.12	14.26	1.72	1.88	12.18	13.18
SM_7	40.60	41.20	36.67	40.67	13.20	13.40	1.65	1.79	12.50	13.35
SM_8	41.40	42.08	38.67	42.00	13.83	13.97	1.70	1.78	12.27	12.74
SM_9	40.20	40.84	36.33	39.67	12.95	13.09	1.65	1.71	12.72	13.07
SM_{10} (control)	38.80	39.40	33.00	37.00	11.94	12.06	1.42	1.54	11.87	12.77
C.D. at 5%	1.24	1.15	2.26	2.49	0.55	0.67	0.25	0.21	1.47	1.06

amino acids, proteins and vitamins. This may be the reason for improvement in commercial characters of cocoons due to the application of magnesium sulphate. Further, results of Viswanath and Krishnamurthy (1982) is similar to our findings who have reported that silkworm larvae fed with Mg sprayed leaves resulted in better cocoon yield and cocoon weight. Results of Loknath and Shivshankar (1986) also support our findings. They observed that when leaves fortified with magnesium (1.25 kg/ha) were fed to mulberry silkworms, it favourably influenced the cocoon yield and shell quality Subburathinam and Chetty (1991) and Subburathinam *et. al.,* (1993) also reported that enrichment of mulberry leaves with calcium results in improvement of the commercial characters of cocoons.

From the present study it is, therefore, inferred that foliar application of magnesium sulphate (2%, w/v) and basal application of 3 quintal / ha of calcium carbonate (secondary nutrient combination SM_5) is very effective in boosting the production of tasar crops. This treatment brings improvement in quality and quantity of leaves of *T. tomentosa* which significantly enhances the yield and commercial characters of cocoons of *A. mylitta*. Thus increasing the production and productivity of tasar silk.

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