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EFFECT OF SECONDARY NUTRIENTS ON THE QUANTITY AND QUALITY OF LEAVES OF *TERMINALIA ARJUNA* BEDD

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ABSTRACT

Studies on the effect of different secondary nutrients in different doses on the quantity and quality of leaves of ***Terminalia arjuna*** under 4' x 4' spacing revealed that secondary nutrients have promotary effect in increasing the quantity and quality of leaves of tasar food plant ***T. arjuna***. Among all the treatments under study, foliar application of Magnesium sulphate (2%, w/v) is the best in respect of increasing the quantity and quality of leaves of ***T. arjuna***. Under this treatment, leaf yield increased by 26.20% over control. Chemoassay and bioassay results also confirmed a significant improvement in the quality of leaf by the application of the said treatment.

Keywords: Secondary nutrients, *Terminalia arjuna,* Leaf yield, Chemoassay, Bioassay

INTRODUCTION

Terminalia arjuna is one of the primary food plant of tropical tasar silkworm *Antheraea mylitta* Drury (Jolly *et al*., 1968). Extensive economic plantations (4'x 4' spacing) under Inter State Tasar Project have been raised with this plant for controlled rearing of the above silkworm. Its continuous cultivation in the same field depletes the soil fertility and decreases the quantity and quality of leaves of the tasar food plants. Decrease in quantity and quality of leaf per unit area will lead to decreased quantity and quality cocoon production. Several studies have been carried out to improve the quantity and quality of leaves of tasar food plants through application of major and micronutrients (Sinha *et al.,* 1999, 2002, & 2006). Further, Sinha *et al*., (2009) have carried out a pot experiment to study the effect of secondary nutrients on the leaf yield and biochemical constituents of tasar food plant *T. tomentosa.* Based on the observations of the above experiment, this study has been undertaken with a view to improve the quality and quantity of leaves of *T. arjuna* under 4' x 4' spacing through application of secondary nutrients.

MATERIALS AND METHODS

The experiment was conducted in the experimental field of Central Tasar Research & Training Institute, Nagri, Ranchi on *T. arjuna* plants with 4' x 4' 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 by the method of Hesse (2002). The plot was quite uniform having sandy loam laterite soil with pH 5.3, organic carbon 0.39 % and available potassium 61.0 kg/ha. Secondary nutrient status of the soil is as follows: available calcium, 2.80 C mol (P^+) kg $^{-1}$; available magnesium, 0.96 C mol (P^+) kg $^{-1}$; and available sulphur, 8.60 ppm.

The experiment was laid out in Randomized Block Design with ten treatments in three replications, each replication having 28 plants. The usual package of practices of major nutrients i.e., Nitrogen (150 kg/ha/yr), Phosphorus (50 kg/

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ha/yr), Potassium (50 kg/ha/yr) and Farm Yard Manure (6 MT/ ha) was also followed.

Ten treatments including control are as follows: T_1, Calcium carbonate (3.0 quintal ha^{-1}) as basal application ; T_2, Calcium carbonate (4.0 q ha^{-1}) as basal application ; T_3, Calcium carbonate (5.0 q ha^{-1}) as basal application ; T_4, Calcium sulphate (15 kg ha^{-1}) as basal application ; T_5, Calcium sulphate (20 kg ha^{-1}) as basal application ; T_6, Calcium sulphate (25 kg ha^{-1}) as basal application ; T_7, Magnesium sulphate (1%, w/v) as foliar application ; T_8, Magnesium sulphate (2%, w/v) as foliar application ; T_9, Magnesium sulphate (3 %, w/v) as foliar application and T_{10}, control i.e., without secondary nutrient.

Treatments T_1 to T_6 were applied in single dose in the month of June. Magnesium sulphate was foliarly applied in three split doses starting from May with an interval of 15 days. The effect of these treatments were studied on quantity and quality of leaves of *T. arjuna* during first (July-Aug.) and second (Sept.-Oct.) crops through determination of leaf yield, chemoassay and bioassay. Simple Random Sampling method was followed for collecting the samples for the study under reference. Leaf samples were collected excluding too tender and over mature leaves from each treatment 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. For bioassay, disease free layings of *A. mylitta* were brushed and reared in three replicated batches of 100 worms each following the rearing technique of Jolly *et al*., (1974). Method as suggested by Arunachalam and Bandyopadhyay (1984) was followed to decide the ranking of different treatments of secondary nutrients under study for different parameters.

Results and Discussion

The leaf yield and percent increase in leaf yield of two crops are given in Table 1. Results indicate that there has been significant increase in leaf yield over control in case of all the secondary nutrients, the highest being 26.20 % over control for treatment T_8 (foliar application of magnesium sulphate, 2%, w/v) followed by T_2 (basal application of calcium carbonate, 4 q ha^{-1}). In treatment T_2 leaf yield increased by 18.20 % over control. The increase in leaf yield due to the application of magnesium sulphate may be due to the fact that magnesium and sulphur are involved in the formation of chlorophyll and activation of enzymes (Gunther, 1981 and Tandon, 2002). 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. The increase in leaf yield of *T. arjuna* due to the application of calcium carbonate (T_2) is mainly due to the fact that calcium carbonate provides calcium to the soil in available form to plants. Calcium is extremely important mineral in plant nutrition. 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 cell. Our findings also corroborates with the findings of Sarkar and Singh (2003) who also

Table 1. Mean leaf yield of *Terminalia arjuna* under different treatments of secondary nutrients in kg/ha.

Treatment	Leaf yield (kg/ha)			Increase in leaf yield over control in %
	Crop I	Crop II	Average	
T_1	36667.60 de	38686.00 de	37676.80 fg	12.00
T_2	39022.40 b	40502.56 b	39762.48 b	18.20
T_3	37273.12 d	38887.84 d	38080.48 ef	13.20
T_4	36331.20 e	38349.60 e	37340.40 g	11.00
T_5	37340.40 d	38686.00 de	38013.20 ef	13.00
T_6	38349.60 c	39695.20 c	39022.40 c	16.00
T_7	38013.20 cd	38686.00 de	38349.60 e	14.00
T_8	41780.88 a	43126.48 a	42453.68 a	26.20
T_9	38013.20 c	39897.04 c	38955.12 d	15.80
T_{10} (Cont.)	32967.20 f	34312.80 f	33640.00 h	-
CD at 5%	370.42	412.28	510.20	-

Note: Figures with different alphabets differ significantly.

Table 2. Influence of different treatments of secondary nutrients on the commercial characters of tasar silkworm *A. mylitta*

Treatment	Weight of late 5^{th} stage larva (g.)	E.R.R. (%)	Cocoon Weight (g)	Shell Weight (g)	SR (%)
T_1	41.25 cd	52.00 c	13.44 de	2.07 de	15.40 c
T_2	42.50 b	54.33 b	14.17 b	2.23 b	15.73 b
T_3	41.40 cd	52.33 c	13.58 cd	2.10 cde	15.46 bc
T_4	40.75 d	52.00 c	13.20 e	2.03 e	15.38 c
T_5	41.10 cd	52.00 c	13.56 de	2.09 de	15.41 bc
T_6	41.70 c	52.67 bc	13.92 bc	2.18 bc	15.66 bc
T_7	41.40 cd	52.00 c	13.68 cd	2.11 cde	15.42 bc
T_8	43.40 a	56.00 a	14.70 a	2.47 a	16.80 a
T_9	41.50 cd	52.33 c	13.90 bc	2.15 bcd	15.46 bc
T_{10} (Cont)	38.00 e	50.00 d	12.00 f	1.80 f	15.00 d
CD at 5%	0.78	1.98	0.34	0.08	0.32

Note: Average values are based on two crops data.

Figures with different alphabets differ significantly.

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%.

Effects of different treatments on the commercial characters of *A. mylitta* are presented in Table 2. It is evident from the table that feeding silkworm with leaves of secondary nutrients treated plants has a favourable effect on the full grown 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) who also observed improvement in silkworm larval growth, cocoon weight and silk quality due to application of secondary nutrients. Among the ten treatments under study, treatment T_8 is the most effective in

Table 3. Chemical constituents of *Terminalia arjuna* leaves as influenced by different treatments of secondary nutrients

Treatment	Moisture (%)	Crude protein (%)	Total carbohydrate (%)	Crude fibre (%)	Total mineral (%)
T_1	71.64 cd	13.31 bc	15.45 cd	10.20 a	7.28 de
T_2	72.22 b	14.04 ab	15.99 b	10.40 a	7.53 b
T_3	71.75 cd	13.45 abc	15.56 cd	10.30 a	7.33 cd
T_4	71.45 d	13.06 c	15.28 d	10.10 a	7.20 e
T_5	71.74 cd	13.44 bc	15.54 cd	10.20 a	7.32 cde
T_6	72.02 bc	13.75 abc	15.80 bc	10.30 a	7.44 bc
T_7	71.83 bcd	13.56 abc	15.63 bcd	10.20 a	7.38 cd
T_8	72.98 a	14.38 a	16.70 a	10.50 a	7.82 a
T_9	72.00 bc	13.75 abc	15.79 bc	10.30 a	7.43 bc
T_{10} (Cont.)	70.50 e	11.88 d	14.40 e	10.00 a	6.80 f
CD at 5%	0.44	0.93	0.40	NS	0.12

Note: Average values are based on two crops data.
Figures with different alphabets differ significantly

Table 4. Scores allotted to different treatments of secondary nutrients for leaf yield, commercial characters of cocoons and chemical constituents of leaves

Treatment	Leaf yield	Commercial characters							Chemical constituents			Total score	Rank
		Larval weight	ERR	Cocoon weight	Shell weight	Silk ratio	Moisture	Crude protein	Total carbo	Crude fibrehydrate	Total mineral		
T_8	0.13	0.20	0.25	0.17	0.17	0.25	0.20	0.25	0.20	1.00	0.17	2.99	I
T_2	0.25	0.40	0.50	0.33	0.33	0.50	0.40	0.38	0.40	1.00	0.33	4.82	II
T_6	0.38	0.60	0.63	0.42	0.42	0.63	0.50	0.50	0.50	1.00	0.42	6.00	III
T_9	0.50	0.70	0.75	0.42	0.50	0.63	0.50	0.50	0.50	1.00	0.42	6.42	IV
T_7	0.63	0.70	0.75	0.58	0.67	0.63	0.60	0.50	0.60	1.00	0.58	7.24	V
T_3	0.69	0.70	0.75	0.58	0.75	0.63	0.70	0.50	0.70	1.00	0.58	7.58	VI
T_5	0.69	0.70	0.75	0.75	0.75	0.63	0.70	0.63	0.70	1.00	0.67	7.97	VII
T_1	0.81	0.70	0.75	0.75	0.75	0.75	0.70	0.63	0.70	1.00	0.75	8.29	VIII
T_4	0.88	0.80	0.75	0.83	0.83	0.75	0.80	0.75	0.80	1.00	0.83	9.02	IX
T_{10}	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	11.00	X

increasing the larval weight, effective rate of rearing, cocoon weight, shell weight and silk ratio percentage followed by treatment T_2. Under treatment T_8 i.e., foliar application of magnesium sulphate (2 %, w/v), larval weight, effective rate of rearing, cocoon weight, shell weight and silk ratio percent increases by 14.21 %, 12.00 %, 22.50 %, 37.22 % and 12.00 % 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 enzyme 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 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 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 silk ratio percentage. In treatment T_2 (basal application of Calcium carbonate, 4.0 q ha^{-1}), larval weight, effective rate of rearing, cocoon weight, shell weight and silk ratio percentage increased by 11.84 %, 8.66 %, 18.08 %, 23.89 % and 4.87 % respectively as compared with control. These findings are similar to the findings of Subburathinam and Chetty (1991) and Subburathinam *et. al.,* (1993) who also reported that enrichment of mulberry leaves with calcium results in improvement of the commercial characters of cocoons.

Table 3 shows the average chemical composition of *T. arjuna* leaf under different treatments of secondary nutrients. It is evident from the table that application of secondary nutrients has improved the quality of leaf. Except crude fibre, contents of moisture, crude protein, total carbohydrate and total mineral are significantly higher in treated plant leaves than control. Maximum increase in chemical constituents of leaves has been observed in treatment T_8 followed by T_2. The increase in chemical constituents may be due to the beneficial role of secondary nutrients in plant metabolism. Magnesium activates a number of 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).

Data in Table 4 indicate the scores allotted to the different treatments of secondary nutrients under study for leaf yield, commercial characters of cocoons and chemical constituents of leaves by the method of Arunachalam and Bandyopadhayay (1984) where lower values signify higher ranking. It is evident from this table that among different treatments of secondary nutrients, treatment T_8 (foliar application of magnesium sulphate, 2%, w/v) is the best among all treatments in respect of all the characters under study.

From the present study it is, therefore, inferred that among all treatments of secondary nutrients under study, treatment T_8 i.e., foliar application of magnesium sulphate (2%, w/v) is the best for increasing the quantity and quality of leaves of *T. arjuna*.

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