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Effect of micronutrients on the growth and foliage yield of mulberry var. victoria 1

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Abstract
Sericulture is known as an agro-based cottage industry which plays an important role in improving the rural economy. Nutritive mulberry leaf is responsible for a successful production of good quality cocoon. Due to deficiency of multi micronutrients in mulberry, yield can be reduced up to 50%. The present study was carried out with an objective, to study the influence of micronutrients on the growth parameters and the leaf yield of mulberry. Micronutrients such as Zinc, Iron, Manganese and Copper were foliar applied to V1 mulberry. Among nine treatments, T_5 (0.5% of $ZnSO_4$) recorded maximum leaf length (20.36 cm), leaf area (178.13 cm^2), shoot length (170.34 cm), number of leaves/shoot (22.46), number of shoots/plant (24.89) and ultimately enhanced the leaf yield to 57,413 kg/ha over the control (46,789 kg/ha) and maximum leaf breadth of 12.93 cm measured in T_1 (0.25% of $ZnSO_4$). Biochemical parameters such as chlorophyll (2.58 mg/g), total soluble proteins (18.38 mg/g), and total soluble sugars (15.87%) contents were higher in T_5.

Keywords: Mulberry, micronutrients, foliar application, growth parameters, biochemical parameters, leaf yield

Introduction

Sericulture is the scientific technique and an art of rearing of silkworms under controlled condition. Sericulture is known as agro-based cottage industry which plays an important role in improving the rural economy, engaged around 87.8 lakh persons in the various sectors of sericulture. India has its own pride- the land which produces all four types of silk *viz*., mulberry silk, tasar silk (Trophical and Oak Tasar), muga silk and eri silk, it retains the second place in the production of raw silk next to China. Mulberry plantation covers 2,42,277 ha, total raw silk production of 34,903MT in which mulberry silk contributes 25,818MT; gains an export value of Rs. 1848.96 crore (CSB, 2021-2022). Monophagous silkworm, *Bombyx mori* L. feed on mulberry so, the maximum concern was given to produce the good quality feed to gain exemplary leaf yield of mulberry and superior quality silk.

The different factors responsible for a successful production of good quality cocoon are, nutritive mulberry leaf (38.2%), climate (37.0%), rearing technique (9.3%), silkworm race (4.2%), silkworm eggs (3.1%) and other factors (8.2%) (Miyashita, 1986) [15]. All plants in the Earth requires 17 essential nutrients, in which carbon, hydrogen and oxygen were taken from air and water. Due to intensified cropping, fast growing, high yielding varieties and continuous pruning of mulberry, rapid exhaustion of nutrients occurs. There is a need to meet out the nutrient's requirement.

Based upon the soil sample analysis macro nutrients requirement of mulberry was fulfilled but micronutrient requirement was an unthoughtful one. Generally, Indian soils are deficient in micronutrients content, at present about 48.1% of Indian soils are deficient in micronutrients (Gupta, 2005) [8]. Due to deficiency of micronutrients in mulberry, yield can be reduced up to 50% (Geetha *et al.* 2017) [7].

The farmers were not aware about hunger signs of micronutrients and the role of critical elements. Mulberry was a foliage crop, its better and good to provide the micronutrients as foliar spray as well as the crop respond quickly to foliar application than soil application of nutrients (Singh *et al.*1994) [21].

Materials and Methods

The study of "Significant impact of micronutrients on the yield of foliage in mulberry" was carried in the experimental farm of Department of Entomology, Annamalai University, Tamil Nadu during 2022 – 2024. Randomized Block Design (RBD) was followed with nine treatments and three replications, Victoria-1 (V1) mulberry was planted at 3'×3'; bottom pruned by leaving 20 cm from the ground level, macronutrients were applied in the form of urea, single super phosphate, and muriate of potash (NPK 350: 140: 140 kg/ha/year). Micronutrients concentration of 0.25 % and 0.5% was prepared by dissolving the appropriate micronutrients zinc, iron, manganese and copper in water @ 2.5 g/ lit of water and 5g/ lit of water, the requisite spray solution volume is 500lit/ ha (Kar *et al*., 2017) [11]. Foliar application of micronutrients was done at 20-25 days after pruning (DAP) (Kumar *et al*., 2020) [12]. Soil properties of experimental plot was analysed (Table 1.)

Estimation of growth parameters of mulberry

Growth parameters of mulberry such as leaf length (cm), leaf breadth (cm), leaf area (cm^2), shoot length (cm), number (no.) of leaves/ shoot, no. of shoots/ plant, and leaf yield (kg/ha/yr) were estimated at 60 DAPS (Kumar *et al.*, 2020) [12]; each of parameter was recorded, treatment wise and mean value was calculated.

Leaf area (cm^2) = l × b × 0.67 (k); whereas k is constant. (Arunkumar, 2020) [2]

Estimation of biochemical parameters of mulberry

Leaf samples were collected from top, middle and bottom of plants from the respective treatments, at 60 DAP leaf samples were taken to analysis biochemical parameters (Nazar *et al.*, 2019) [16].

Estimation of moisture content

Fresh leaf weight was weighed for each treatment, leaves were oven dried at 70° C for 48 hrs to measure the oven dried weight of mulberry leaves (Ahmed *et al.,* 2017) [1].

$$\text{Moisture content (\%)} = \frac{\text{Fresh leaf weight} - \text{Oven dry weight}}{\text{Fresh leaf weight}} \times 100$$

Estimation of chlorophyll content

0.1 g of fresh leaves were weighed and ground with pestle and mortar in 2 ml of 80% acetone and 0.5 g of magnesium carbonate was added, and centrifuged at 5000 rpm for 5 mins and acetone was added to supernatant and volume of 10 ml was made up, 80% acetone was used as a blank. Blank followed by samples were fed to spectrophotometer and read at 645 nm then at 663 nm, absorbance value was recorded for respective samples (Kumari *et al.*,2018) [13] and total chlorophyll content was calculated using the formula,

$$\text{Chlorophyll content (mg/ g)} = \frac{(A_{663} \times 7.01 + A_{645} \times 17.76) \times V}{\text{Weight of sample (g)}} \quad \text{(Sarangthem, 2011)}$$

V is the final volume of the extract in ml

Estimation of total soluble proteins

Total soluble protein content was measured by colorimetric method described by Lowry *et al.*, 1951 [14] in the leaf samples, test samples for each treatment was prepared by following the standard procedure, samples were fed to spectrophotometer and read at 660 nm, absorbance values were plot in graph and protein value was expressed in mg/ g.

Estimation of total soluble sugars

Lane and Eynon' s method, were adopted to determine the total soluble sugars in nine treatments leaf samples. Titre value was noted at end point when blue colour changes to bright orange and the value was expressed in per cent (Chandraju *et al.*, 2014) [4].

Statistical analysis

The experiment followed RBD, nine treatments with three replications. The raw data for each parameter was recorded at their appropriate time. The data were statistical analysed using OPSTAT software.

Results and Discussion

Influence of micronutrients on the growth parameters of mulberry

Leaf length of 20.36 cm was measured maximum in T_5 (0.5% of $ZnSO_4$) and the least value of 17.28 cm was measured in control (T_9). Leaf breadth was maximum in T_1 which measured 12.93 cm, wherein mulberry plants were sprayed with 0.25% of $ZnSO_4$, control recorded the minimum value of 10.06 cm. The maximum leaf area of 178.13 cm^2 was observed in mulberry leaves which were fortified with 0.5% of $ZnSO_4$ (T_5); T_9 had recorded 119.95 cm^2. The maximum and minimum shoot length of 170.34 and 157.65 cm was noted in T_5 and T_9 respectively (Table 2.).

Zinc is involved in the synthesis of tryptophan as a cascade increase the tissue growth and development of mulberry and foliar formulation of major and micro nutrients increased shoot length of mulberry was reported by Ahmed *et al.*, (2017). Kumar *et al.,* (2020) [1, 12] reported that foliar application of 1 % of $ZnSO_4$ increased the shoot length of mulberry; deficiency of zinc reduced the crop yield significantly. Kar *et al.,* (2017) [11] reported that foliar application of nutrient composite [$(NH_4)_2SO_4$ + KH_2PO_4 + KCl (5.0 mM) + $MgSO_4.7H_2O$ + $ZnSO_4.7H_2O$ + $(NH_4)6Mo_7O_{24}.4H_2O$)] on mulberry enhanced the yield such as total leaf area, number of shoots plant^{-1}, number of leaves plant^{-1} and shoot length.

Number of leaves per shoot were found maximum in T_5 with a count of 22.46 and minimum count was recorded in T_9 (Control) with 16.89 leaves/ shoot. The highest number of shoots per plant of 24.89 was recorded in T_5 (0.5 % of $ZnSO_4$) and least count of 18.76 in control. Ultimately, T_5 – 0.5 % of $ZnSO_4$ resulted in the maximum leaf yield of mulberry with 57,413 kg/ha and T_9 (control) gave a minimum yield of 46,789 kg/ha. (Table 3.). Kumar *et al.*, (2020); Kar *et al.*, (2017) [11, 12] reported that fortification of zinc to mulberry enhanced the leaves count per plant. Reddy *et al.*, (2011) [18]; Rajegowda and Raju (2011); Hasani *et al.*, (2012) [9, 17]; Gangadharan and Ramamoorthy (2017) [6] stated that foliar application of micronutrients increases the leaf yield of mulberry significantly. Bose and Bindroo's (2009) [3] found that application of zinc at the rate of 10 kg/ ha to mulberry increase the leaf yield by 34.76 per cent. Which are earlier reports support the present investigations.

Influence of micronutrients on the biochemical parameters of mulberry

Moisture content

Moisture content of mulberry was observed non-significant among treatments (Table 4.), which was supported by Shilapashree *et al.*, (2015) who reported that neither combined nor individual application of micronutrients have impact on the moisture status of mulberry.

Chlorophyll content (CC), Total soluble proteins (TSP), and total soluble sugars (TSS)

The maximum chlorophyll content (CC), Total soluble proteins (TSP), and total soluble sugars (TSS) were observed in T_5 (2.58 mg/g), (18.38 mg/g) and (15.87%) respectively followed by T6 and the least content of CC, TSP, and TSS found in control (T_9) (Table 4.) Shilpashree *et al.*, (2015) [20] reported that fortification of mulberry with $ZnSO_4$ had a positive impact on the CC, TSP, and TSS. Nazar *et al.,* (2019) [16] reported that soil application of $ZnSO_4$, $FeSO_4$, $MnSO_4$ and $MgSO_4$ significantly increased the physiological and biochemical parameters in mulberry.

Heckmann (2009) [10] reported that application of Zn and Boron on mulberry enhanced the crude protein and crude fibre content which are earlier reports supports the present findings.

Conclusion

From the study, its conclusion that mulberry responds to foliar fortification of micronutrients such as zinc sulphate, ferrous sulphate, manganese sulphate and copper sulphate influenced the growth cum biochemical parameters by the application of 0.5 % of zinc sulphate. As the soil sample analysis represent that required micronutrients were present below the critical level, foliar application of micronutrients fulfil the immediate need and enhanced the leaf yield in mulberry.

Table 1: Soil properties of experimental plot

Sl. No	Soil property	Content
1	Textural class	Clay loam
2	pH	7.24
3	Electrical Conductivity-EC (ds/m)	1.35
4	Cation Exchange Capacity-CEC (cmol/kg)	14.32
5	Organic Carbon - OC (g/kg)	2.31
6	Available N (kg/ha)	164.56 (Low)
7	Available P (kg/ha)	11.13 (Medium)
8	Available K (kg/ha)	187.41 (High)
9	Zn (mg/kg) *	1.02
10	Fe (mg/kg) *	3.12
11	Mn (mg/kg) *	0.90
12	Cu (mg/kg) *	0.97

* Below the critical limit

Table 2: Effect of micronutrients on growth parameters of leaf and shoot in mulberry

Treatments	Leaf Length (cm)	Leaf Breadth (cm)	Leaf Area (cm^2)	Shoot Length (cm)
T_1- 0.25% of $ZnSo_4$	19.82	12.93	176.83	169.86
T_2- 0.25% of $FeSo_4$	19.51	11.68	157.23	169.64
T_3- 0.25% of $MnSo_4$	18.53	11.27	144.09	167.97
T_4- 0.25% of $CuSo_4$	18.42	12.06	153.28	168.85
T_5- 0.5% of $ZnSo_4$	20.36	12.68	178.13	170.34
T_6- 0.5% of $FeSo_4$	19.86	12.21	167.32	170.11
T_7- 0.5% of $MnSo_4$	19.02	11.76	154.34	168.91
T_8- 0.5% of $CuSo_4$	18.46	11.09	141.26	167.89
T_9- Control	17.28	10.06	119.95	157.65
CD(p=0.05)	0.088	0.067	0.255	0.257
SEd	0.041	0.031	0.119	0.120

Mean value of three replications

Table 3: Effect of micronutrient on number of shoots, leaves and leaf yield of mulberry

Treatments	No. of leaves/ Shoot	No. of shoots/ Plant	Leaf yield (kg/ ha/yr)
T_1- 0.25% of $ZnSo_4$	21.41	23.06	55498
T_2- 0.25% of $FeSo_4$	20.98	22.37	54686
T_3- 0.25% of $MnSo_4$	19.79	21.64	54129
T_4- 0.25% of $CuSo_4$	17.68	19.79	50531
T_5- 0.5% of $ZnSo_4$	22.46	24.89	57413
T_6- 0.5% of $FeSo_4$	21.94	23.68	56107
T_7- 0.5% of $MnSo_4$	18.56	20.45	52641
T_8- 0.5% of $CuSo_4$	17.14	19.28	49178
T_9- Control	16.89	18.76	46789
CD(p=0.05)	0.091	0.094	4.766
SEd	0.42	0.044	2.229

Mean value of three replications

Table 4: Effect of micronutrients on biochemical parameters of mulberry

Treatments	Moisture content (%)	Chlorophyll content (mg/g)	Total soluble proteins (mg/g)	Total soluble sugars (%)
T_1- 0.25% of $ZnSo_4$	74.83	2.45	17.43	14.91
T_2- 0.25% of $FeSo_4$	74.60	2.4	17.06	14.73
T_3- 0.25% of $MnSo_4$	74.30	2.37	16.81	14.38
T_4- 0.25% of $CuSo_4$	74.07	2.28	15.76	13.54
T_5- 0.5% of $ZnSo_4$	75.65	2.58	18.38	15.87
T_6- 0.5% of $FeSo_4$	75.27	2.49	17.92	15.06

T_7- 0.5% of $MnSo_4$	74.17	2.31	16.23	13.72
T_8- 0.5% of $CuSo_4$	74.00	2.24	15.08	13.17
T_9- Control	73.20	2.19	14.04	12.56
CD(p=0.05)	NS	0.026	0.078	0.668
SEd	0.917	0.012	0.036	0.312

Mean value of three replications; NS – Non, significant

Experimental plot

Micronutrients used
I.ZnSO4, II. Fe SO4, III. MnSO4, IV. CuSO4

Foliar application of Micronutrients

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