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Influence of Micronutrients on Yield and Yield Attributing Parameters of Mulberry (*Morus spp*.) and Silkworm (*Bombyx mori* L.)

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Abstract

A field experiment was conducted at Department of Sericulture, University of Agricultural Sciences, GKVK, Bengaluru, during 2014 – 2016, to study the impact of soil application of micronutrients along with the organic based nitrogen on yield of mulberry. The experiment consisted of six micronutrients *viz*., Ferrous sulphate (10 kg / ha / year), Manganese sulphate (20 kg / ha / year), Zinc sulphate (20 kg / ha / year), Copper sulphate (1.5 kg / ha / year), Ammonium molybdate (1kg / ha / year) and Borax (2 kg / ha / year). Application of Zinc sulphate (20 kg / ha / year) recorded highest plant height (82.46 cm @ 30 DAP and 163. 47 cm @ 60 DAP), number of branches per plant (19.14 @ 30 DAP and 26.99 @ 60 DAP), Number of leaves / plant (141 @ 30DAP and 219.3 3 @ 60 DAP), leaf area (212.58 dm^2 @ 60 DAP) and leaf yield (65 ton / ha / year). Application of Borax @ 2 kg / ha / year recorded higher V instar larval weight (38.38 g / 10 larvae), single cocoon weight (1.92 g), single pupal weight (1.57 g), single shell weight (0.31 g) and least number of cocoons / skg (521).

Mulberry leaf is the primary feed of domesticated silkworm (*Bombyx mori* L.) to produce raw silk. Mulberry leaf is one of the important commercial crops patronized by the small and marginal farmers for continuous income generation. According to Miyashita (1986), several factors are responsible for successful cocoon crop *viz.,* mulberry leaf (38.2 %), rearing technique (9.3 %) and silkworm race (4.2 %). The bulk of silk goods produced in the world are made up of mulberry silk.

The quality of leaf is dependent on mulberry variety, climatic condition, soil type and its innate fertility, cultivation practices, the fertilizer management and harvesting methods. The soil fertility has a direct bearing on the nutrient status of the leaf.

The intensive cultivation of high yielding mulberry varieties coupled with unbalanced nutrition management has resulted in soil exhaustion. A large quantity of nutrients is absorbed from the soil by the crop. Besides, they are also lost through leaching and fixation. Such depletion of nutrients from the soil reduces the availability of some of the secondary and micronutrients to mulberry which results in reduction of yield and quality of leaf and cocoons. Hence it is imperative to regularly incorporate the secondary and micronutrients to mulberry soil in required quantities and suitable methods.

A field experiment was conducted in an established irrigated V_1 mulberry garden planted at a spacing of 90 × 90 cm at Sericulture Department, UAS, GKVK, Bengaluru. The experiment was laid in RCBD with eight treatments of three replications each. The soil analysis was carried out before commencement of experiment. All cultural practices were followed as per the package of practices for irrigated mulberry garden. Weeding and intercultural operations were carried out after each harvest of the crop (Anonymous, 2010).

Nitrogen was supplied through different sources *viz.,* compost, green manure (*Glyricidia maculata*), castor cake, vermicompost and urea. Micronutrients were applied along with urea, SSP and MoP. Earthing up was done after application of organic manures and fertilizers (Urea, SSP, MoP and micronutrient). Biofertilizers *viz.*, *Azospirillum brasilense* and *Aspergillus awamori* were applied to soil ten days after application of organic manures and inorganic fertilizers, by mixing with FYM. Observations on growth and yield attributes were recorded on 30 and 60 days after pruning. Micronutrients were applied

TABLE I

Influence of micronutrients on yield attributing parameters of mulberry

Treat-ments	Plant height (cm)		Number of branches / Plant		Number of leaves/ plant		Internodal distance (cm)	
	30 DAP	60 DAP	30 DAP	60 DAP	30 DAP	60 DAP	30 DAP	60 DAP
T1	70.54^{c}	149.07^{d}	15.60^{b}	21.95^{d}	121.00^{bc}	190.33^{cd}	6^{a}	4.87^{a}
T2	76.34^{b}	154.07^{bcd}	16.00^{b}	23.42^{cd}	135.00^{ab}	202.33^{bc}	5.75^{ab}	4.89^{a}
T3	79.55^{ab}	158.14^{abc}	17.07^{b}	25.85^{ab}	135.33^{a}	201.33^{c}	5.6^{ab}	4.89^{a}
T4	77.75^{ab}	155.23^{bcd}	16.30^{b}	23.95^{bcd}	117.67^{c}	190.33^{cd}	5.26^{b}	4.84^{a}
T5	82.46^{a}	163.47^{a}	19.14^{a}	26.99^{a}	141.00^{a}	219.33^{a}	5.16^{b}	4.74^{a}
T6	77.94^{ab}	152.58^{cd}	18.47^{a}	24.33^{bc}	133.00^{ab}	187.00^{d}	5.58^{ab}	4.43^{a}
T7	76.13^{b}	155.62^{bc}	17.07^{b}	23.00^{cd}	131.33^{ab}	199.33^{cd}	5.50^{ab}	5.06^{a}
T8	79.07^{ab}	159.93^{ab}	18.57^{a}	24.00^{bcd}	144.33^{a}	214.00^{ab}	5.61^{ab}	4.79^{a}
F – Test	*	*	*	*	*	*	*	
S.Em±	1.61	1.95	0.45	0.68	4.30	3.86	0.16	0.13
C. D.@ 5%	4.88	5.92	1.37	2.07	13.03	11.71	0.48	NS

to soil as basal dose, T1 - RDF (300:120:120 kg/ha/ year) + FYM @ 20 t/ha/year (control), T2 -100 per cent recommended N through 20 per cent each of compost, *Glyricidia maculata*, castor cake, vermicompost and urea + 10 kg each of *Azospirillum brasilense* + *Aspergillus awamori* bio- fertilizer + remaining P, K through chemical fertilizer + Recommended FYM (20 t/ha), T3 - T2 + $FeSO_4$ 7 H_2O @10 kg / ha / year, T4 - T2 + $MnSO_4$ H_2O @ 20 kg / ha / year, T5 - T2 + $ZnSO_4$ $7H_2O$ @ 20 kg / ha / year, T6 - T2 + $CuSO_4$ 5 H_2O @ 1.5 kg / ha / year, T7 - T2 + $(NH_4)_6$ Mo_6O_{24}.4 H_2O@ 1kg / ha / year, T8 - T2 + Borax @ 2 kg / ha / year.

The supply of micronutrients along with different sources of nitrogen and recommended dose of P and K and six micronutrients *viz.,* Fe, Mn, Zn, Cu, Mo and B, resulted in better growth of mulberry. This may be due to balanced nutrition, role of micronutrients, in various physiological processes and favorable nutrient interaction. Micronutrients are metal activators in enzyme system, participate in redox reactions

TABLE II

Influence of micronutrients on yield of mulberry

Treatments	Leaf area (dm^2) 60 DAP	Leaf yield / plant (g) 60 DAP	Leaf yield (ton / ha / year)
T1	154.16^{g}	930.33^{e}	57.42^{d}
T2	167.77^{f}	974.13^{cd}	60.12^{c}
T3	181.52^{d}	1024.47^{b}	63.26^{b}
T4	175.41^{e}	969.33^{d}	59.83^{c}
T5	212.58^{a}	1054.33^{a}	65.07^{a}
T6	185.24^{c}	984.00^{c}	60.73^{c}
T7	206.35^{b}	1010.56^{b}	62.38^{b}
T8	180.22^{c}	1048.33^{a}	64.66^{a}
F – Test	*	*	*
S.Em±	1.38	6.07	0.38
C. D.@ 5%	4.18	18.41	1.15

TABLE III

Influence of micronutrients application on growth and cocoon yield of silkworm

Treatments	V instar larval weight (g10)	Single cocoon weight (g)	Single pupal weight (g)	Single shell weight (g)	Shell ratio (%)	No. of cocoons/kg
T1	34.87 [e]	1.63 [b]	1.26[d]	0.25 [c]	15.33 [b]	612.00 [a]
T2	34.92 [e]	1.80 [a]	1.51[ab]	0.29 [b]	15.26 [b]	554.00 [b]
T3	37.38 [b]	1.9 [a]	1.57[a]	0.30 [a]	15.70 [b]	523.00 [e]
T4	34.92 [e]	1.82 [a]	1.33[d]	0.26 [bc]	16.14 [b]	549.00 [c]
T5	36.28 [c]	1.81 [a]	1.45[c]	0.29 [b]	16.33 [a]	553.00 [b]
T6	35.59 [d]	1.83 [a]	1.51[b]	0.30 [a]	16.30 [a]	544.00 [d]
T7	36.06 [cd]	1.91 [a]	1.55[ab]	0.29 [b]	15.18 [b]	523.00 [e]
T8	38.38 [a]	1.92 [a]	1.57[a]	0.31 [a]	16.14[a]	521.00 [f]
F – Test	*	*	*	*	*	*
S.Em±	0.01	0.01	0.01	0.01	0.58	0.58
C. D.@ 5%	0.02	0.02	0.02	0.04	2.38	2.38

besides playing an essential role in carbohydrate metabolism and sugar translocation (Sinha, 2006). Among the different micronutrients, application of $ZnSO_4$ @ 20 kg / ha / year (T5) recorded maximum plant height (82.46 cm @ 30 DAP and 163. 47 cm @ 60 DAP), number of branches per plant (19.14 @ 30 DAP and 26.99 @ 60 DAP), number of leaves / splant (141 @ 30 DAP and 219.33 @ 60 DAP), leaf area (212.58 dm^2 @ 60 DAP) and leaf yield (65 ton/ ha / year) which is on par with application of Borax (64.66 ton / ha / year) @ 2 kg / ha / year (T8) (Table I). This may be due to Zinc which is a major constituent of many enzymes (carbonic anhydrase, alcoholic dehydorgenase, superoxide dismutase) in mulberry plant and plays a dominant role in adjusting various physiological activities. It helps in the formation of growth hormones and is involved in nitrogen and protein metabolism and formation of starch (James, 1973; Yeasmin *et al.,* 1995; Vishwanath *et al*., 1997).

The improvement in mulberry leaf quality due to application of micronutrients also reflected in better performance of silkworm. Application of micronutrients recorded significant variation with respect to growth and cocoon yield of silkworm. Among different micronutrients applied individually, supplementation of Borax @ 2 kg / ha / year (T8) recorded higher V instar larval weight (38.38 g /10 larvae), single cocoon weight (1.92 g), single pupal weight (1.57 g) and single shell weight (0.31 g) followed by application of $FeSO_4$ @ 10 kg / ha / year (T3) (Table III). The increase in weight of worms might be due to the fact that micronutrients are involved in better utilization and assimilation of nutrients (Bose *et al.,* 1994). The importance of micronutrients in silkworm nutrition was also observed by Sinha, 2006. The number of cocoons/kg indirectly indicates the size of cocoons, which differed significantly due to application of micronutrients. The silkworm fed with leaves which received Borax @ 2 kg / ha / year (T8) recorded 521 cocoons/kg, followed by application of $FeSO_4$ @ 10 kg / ha / year (523 cocoons / kg), Ammonium molybdate @ 1kg / ha /year (523 cocoons / kg) as compared to T1 (612 cocoons / kg). The significant improvement in silkworm growth and cocoon yield may be due to better nutritive value of leaves resulting in higher cocoon yield (Vishwanath and Krishnamurthy, 1984 and Vijaya *et al.,* 2009).

From the present experiment, it can be inferred that soil application of micronutrients *viz.,* Fe, Mn, Zn, Cu, Mo and B along with recommended dose of N (organic based), P and K can potentially influence growth, quality and yield of mulberry and silkworm.

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