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DOI: https://doi.org/10.22271/chemi.2020.v8.i2u.8951

Abstract
A field experiment was conducted to study the effect of soil application of zinc, iron and manganese on mulberry at Department of Sericulture, University of Agricultural Sciences, GKVKBengaluru-65 during 2018-19. Among the different treatments, T5 (350:140 NPK kg/ha/year + FYM 20 t/ha/year + micronutrient formulation of Zn, Fe and Mn @ 6 kg/acre) recorded significantly higher plant height (169.50 and 211.61 cm), shoot height (65.15 and 170.56 cm), number of shoots/plant (30.11 and 30.17), shorter internodal distance (5.13 and 5.14 cm), number of leaves/plant (548.67 and 567.56), leaf area (283.52 and 310.45 cm²), leaf yield (947.20 and 1040.81 g/plant) and leaf dry matter (359.05 and 552.05 g/plant) on 45th and 75th DAP in V1 mulberry. Compared to other treatments all the above-mentioned parameters found least in the control.

Keywords: Mulberry, micronutrient formulation (Zn, Fe and Mn), growth and yield parameters

Introduction
Mulberry is a robust, perennial deep-rooted high biomass producing foliage crop, being the sole source of nourishment from which the mulberry silkworm (Bombyx mori L.) derives nearly 70 per cent of protein for silk synthesis. This plant protein is get converted into silk protein in that silkworm body. The several factors are responsible for successful cocoon crop viz., silkworm egg (3.15%), silkworm race (4.2%), rearing technique (9.3%), local weather (37.0%), mulberry leaf (38.2%), and other factors (6.6%) (Miyashita, 1986) [4]. It is clear that mulberry leaf plays a dominant role in cocoon production as the only source of nutrition to the silkworm. Silkworm larval growth and cocoon yield are mainly influenced by nutritional quality of mulberry leaf (Shankar, 1999) [7].

Micronutrients are involved in several metabolic activities of mulberry plant that are responsible for quality leaf production and stimulate metabolic activity in silkworm which in turn leads to better rearing performance and silk quality. As mulberry is grown for its foliage and harvested for five to six times a year, requirement of nutrients is high and balanced application of required nutrients is essential. Since available literature on the soil application of micronutrients and its effect on quality and quantity of mulberry leaf and development of silkworm and cocoon quality is scanty, the present investigation was taken up with the effect of soil application of Zn, Fe and Mn on growth and yield of mulberry.

Materials and Methods
A field experiment was conducted at Department of Sericulture, UAS, GKVKBengaluru-65 during 2018-19 in established mulberry garden with Victory 1 variety planted at a spacing of (90 +150) x 60 cm (paired row system). Physicochemical properties of the experimental site were analysed. The soil was clay loam in texture, having 7.75 pH, EC 0.29 dSm⁻¹, 0.44 percent organic carbon, 220.15 kg ha⁻¹ available N, 35.30 kg ha⁻¹ available P₂O₅, 175.17 kg ha⁻¹ available K₂O. The experiment was laid out in randomized complete block design (RCBD) and replicated thrice with 7 treatments. The treatment details are given below.
The current study is in agreement with the results of Sowmya and Narayanaswamy (2015) who recorded higher number of shoots (19.14 @ 30 DAP and 26.99 @ 60 DAP) with the application of zinc sulphate (20kg/ha/year).

**Result and Discussion**

**Growth parameters of V1 mulberry**

**Plant height (cm)**

The significant plant height of 169.50 and 211.61 cm was recorded on 45th and 75th days respectively after pruning (DAP) in T3 (T1+micronutrient formulation @6 kg/acre), which was on par with T7 (T1+micronutrient formulation @ 8 kg/acre) (163.17 and 208.56 cm) and T8 (T1+micronutrient formulation @ 7 kg/acre respectively) (161.78 and 206.22 cm). The shorter plant height of 129.05 cm (45th DAP) and 172.88 cm (75th DAP) was recorded in T1 (100% Recommended dose of NPK + FYM) (control) (Table 1).

Similar results were observed by Patil et al. (2001) who reported that the effect of soil application of zinc sulphate at 25 kg/ha significantly increased the plant height (189.95 cm). The results are in conformity with the study of Singhvi et al. (2003) who recorded maximum plant height of 196.75 cm as influenced by the application of seriboot at a concentration of 2.5 ml/lit in two sprays.

**Highest shoot height (cm)**

The significant shoot height of 65.15 and 170.56 cm was recorded on 45th and 75th DAP in T5, which was on par with T1 (62.06 and 168.45 cm) and T6 (59.56 and 164.11 cm). The lowest shoot height of 50.89 cm (45th DAP) and 133.17 cm (75th DAP) was recorded in T1 (control) (Table 1). In the present investigation T1 has recorded significant shoot height (65.15 and 170.56 cm) which is on par with Shilpashree and Subbarayappa (2015) who recorded higher shoot height (1.71m) with the application of ZnSO4 at 20 kg ha-1. Similarly, Geetha et al. (2016) recorded higher shoot length (153.5cm) in the treatment (T9 or 0.5% ZnSO4 + 1.0% FeSO4 + 0.1% Citric acid+ 0.2% Boric acid + 0.5% MnSO4 + 0.01% Na2MoO4).  

**Number of shoots/Plant**

The number of shoots/plant of V1 mulberry variety was influenced significantly by soil application of micronutrient formulation. Higher number of shoots/plant were noticed in T3 (30.11 and 30.17) which was on par with T7 (27.11 and 30.06) and T8 (26.33 and 29.56) recorded on 45th and 75th DAP. Least number of shoots were recorded in T1 (20.50 and 21.67) (Table 1).

The current study is in agreement with the results of Sowmya and Narayanaswamy (2015) who recorded higher number of shoots (19.14 @ 30 DAP and 26.99 @ 60 DAP) with the application of zinc sulphate (20kg/ha/year).

**Internodal distance (cm)**

The significant shortest internodal distance was recorded in T3 (5.13 and 5.14 cm) which was on par with T5 (5.16 and 5.17 cm) and T6 (5.19 and 5.20 cm) compared to other treatments (T2, T3 and T4) recorded on 45th and 75th DAP whereas, longer internodal distance was recorded in T1 (5.69 and 5.42 cm) (Table 1).

The results are supported by Nithya et al. (2018) who noticed that the reduction in the internodal distance in mulberry apparently is due to the supply of adequate inorganic fertilizers to the plants which increased number of internodes and in turn gave rise to more number of leaves and leaf area per plant. The results of the present study are similar with the findings of Sowmya and Narayanaswamy (2015) who recorded shorter internodal distance (4.43 cm) by application of zinc sulphate at 20kg/ha/year.

**Table 1:** Effect of soil application of micronutrient formulation (Zn, Fe and Mn) on growth parameters of V1 mulberry at 45th and 75th DAP

| Treatments | Plant height (cm) | Highest shoot height (cm) | No. of shoots/plant | Internodal distance (cm) |
|------------|------------------|---------------------------|---------------------|-------------------------|
|            | 45 DAP | 75 DAP | 45 DAP | 75 DAP | 45 DAP | 75 DAP | 45 DAP | 75 DAP | 45 DAP | 75 DAP |
| T1         | 129.05 | 127.88 | 50.89 | 53.17 | 20.50 | 21.67 | 3.69 | 5.42 |
| T2         | 133.89 | 182.25 | 55.11 | 145.61 | 21.45 | 23.72 | 5.59 | 5.39 |
| T3         | 138.28 | 182.72 | 56.00 | 147.00 | 23.11 | 23.95 | 5.49 | 5.36 |
| T4         | 147.95 | 184.55 | 56.50 | 148.17 | 24.61 | 24.39 | 5.41 | 5.29 |
| T5         | 169.50 | 211.61 | 65.15 | 170.56 | 30.11 | 30.17 | 5.13 | 5.14 |
| T6         | 161.78 | 206.22 | 59.56 | 164.11 | 26.33 | 29.56 | 5.19 | 5.20 |
| T7         | 163.17 | 218.56 | 62.06 | 168.45 | 27.11 | 30.06 | 5.16 | 5.17 |
| T8         | 169.50 | 211.61 | 65.15 | 170.56 | 30.11 | 30.17 | 5.13 | 5.14 |
| T9         | 172.88 | 214.56 | 66.06 | 172.66 | 31.11 | 31.17 | 5.18 | 5.18 |

*Significant at 5%
Leaf area (cm²)
Mulberry raised with the application of micronutrient formulation at 6 kg/acre (T3) recorded significant leaf area per plant (283.52 and 310.45 cm²), which was on par with T1 (268.50 and 291.97 cm²) and T6 (263.83 and 284.45 cm²) on 45th and 75th DAP, compared to other treatments (T4, T5 and T2). However, the lowest leaf area per plant was recorded in T1 (205.11 and 242.28 cm²) (Table 2; Plate 1).

The present investigations are in line with the study of Ahmed et al. (2018) [1] who recorded maximum leaf area (545.5 cm²) by application of Basal + Urea (B+U), Basal + Foliar fertilizer (FF). Similarly, Sowmya and Narayanaswamy (2015) [10] reported that the application of zinc sulphate (20kg/ha/year) recorded maximum leaf area (212.58 dm² @ 60 DAP) and Nithya et al. (2018) [5] recorded maximum leaf area of 96.90 cm² with the foliar application of zinc oxide at 50 ppm.

Leaf yield per plant (g/plant)
Significant results were noticed with regard to leaf yield per plant of V1 mulberry among the different treatments (Table 2; Fig 1). The leaf yield (947.20 and 1040.81 g/plant) recorded on 45th and 75th DAP was significantly higher in T3 which was on par with T7 ((883.58 and 1008.17 g/plant) and T6 ((871.15 and 994.03 g/plant). The lowest leaf yield was recorded in T1 (620.45 and 730.67 g/plant).

The results are in conformity with the earlier studies of Yokoyama (1975) [11] who reported that mulberry leaf yield depends on the number and length of the shoots, internodal distance and number and weight of leaves per plant. The results of the present investigations are similar with the findings of Singhvi et al. (2003) [9] and Ahmed et al. (2018) [1] who recorded leaf yield of 495.50 and 470.8 gm respectively. Similarly, leaf yield of 13,013 kg/ha/harvest in the treatment (0.5% ZnSO₄+ 1.0% FeSO₄ + 0.1% Citric acid+ 0.2% Boric acid + 0.5% MnSO₄ + 0.01% Na₂MoO₄) was recorded by Geetha et al. (2016) [3].

Leaf dry matter per plant (g/plant)
Among the different treatments, the soil application of micronutrient formulation at 6 kg/acre (T3) recorded statistically superior leaf dry matter (359.05 and 552.05 g/plant), which was on par with T7 (336.41 and 538.06 g/plant) and T6 (319.16 and 503.88 g/plant) on 45th and 75th DAP. The lowest was recorded in T1 (216.03 and 326.61 g/plant) (Table 2; Fig 2).

The present investigation where in T3 has recorded higher leaf dry matter is in line with the results of Channal (1978) [2] who recorded higher leaf dry matter with foliar application of 0.5 per cent ferric chloride in sunflower.

The growth and yield parameters of V1 mulberry increased due to involvement of micronutrients (Zn, Fe and Mn) in a single formulation in chlorophyll formation which might have helped to influence physiological activity of plants viz., cell division, meristematic activity in apical tissue, expansion of cell and formation of cell wall which in turn enhanced the growth and yield parameters.

Table 2: Effect of soil application of micronutrient formulation (Zn, Fe and Mn) on yield parameters of V1 mulberry at 45th and 75th DAP

| Treatments | No. of leaves/plant | Leaf area (cm²) | Leaf yield (g/plant) | Leaf dry matter (g/plant) |
|------------|---------------------|----------------|----------------------|--------------------------|
|            | 45 DAP | 75 DAP | 45 DAP | 75 DAP | 45 DAP | 75 DAP | 45 DAP | 75 DAP |
| T1         | 426.72 | 445.56 | 426.28 | 620.45 | 730.67 | 216.03 | 326.61 |
| T2         | 445.17 | 467.22 | 422.95 | 754.99 | 935.25 | 246.93 | 370.35 |
| T3         | 465.45 | 486.72 | 239.28 | 810.67 | 942.41 | 260.34 | 388.23 |
| T4         | 487.28 | 488.89 | 251.56 | 818.67 | 960.64 | 274.10 | 398.56 |
| T5         | 548.67 | 567.56 | 283.52 | 947.20 | 1040.81 | 359.05 | 552.05 |
| T6         | 538.95 | 538.33 | 263.83 | 871.15 | 994.03 | 319.16 | 503.88 |
| T7         | 533.83 | 556.83 | 268.50 | 883.58 | 1008.17 | 336.41 | 538.06 |

*Significant at 5%

Plate 1: Effect of soil application of micronutrient formulation on leaf area of V1 mulberry after 45 days of pruning

A) T1-(RDF + FYM)
B) T3-(T1 + micronutrient formulation @ 6 kg/acre)

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Conclusion
The present study has given very encouraging results with micronutrient formulation (Zn, Fe and Mn) at 6 kg/acre on growth and yield of mulberry, there is need to conduct farmers’ field trails with (Zn, Fe and Mn) combination and popularize among sericulture farmers.

References
1. Ahmed F, Kader MA, Sultana R, Ahmed O, Begum SA, Toufiq Iqbal MD. Combined application of foliar fertilizer with basal NPK enhances mulberry leaf yield and silkworm cocoon productivity in calcareous soil. J South Pacific Agric. 2018; 21:18-25.
2. Channal HT. Effect of sulphur and micronutrients (Iron and Zinc) on growth, yield, chemical constituents and oil characteristics of sunflower. M.Sc. (Agri.) Thesis, University of Agricultural Sciences, Bengaluru, 1978.
3. Geetha T, Ramamoorthy K, Murugan N. Effect of foliar application of micronutrients on mulberry (Morus alba L.) leaf yield and silkworm (Bombbyx mori L.) economic parameters. Life Sci. Int. Res. J. 2016; 3(1): 22-26.
4. Miyashita Y. A report on mulberry cultivation and training methods suitable to bivoltage rearing in Karnataka, 1986, 1-7.
5. Nithya BN, Ramakrishna Naika DV, Naveen, Sunil Kumar T. Influence of Nano Zinc Application on Growth and Yield Parameters of Mulberry. Int. J Pure App. Bio Sci. 2018; 6(2):317-319.
6. Patil VC, Angadi SA, Roodagi LI, Angadi SS, Patil RR. Effect of soil and foliar application of micronutrients on growth, yield and quality of mulberry. Proc. Nation. Sem. Mulb. Seri. Res. India, KSSR & DI. Bengaluru, 2001, 127-131.
7. Shankar MA, Anitha P, Rangaswamy BT, Rajegowda. Response of mulberry to application of micronutrients and their impact on cocoon production and grainage parameters. XVIIIth ISC CON., 1999, 12-16.
8. Singhvi NR, Sarkar A, Datta RK. Effect of seriboost on yield attributes, leaf yield of mulberry and some commercial characters of silkworm. Sericologia. 2003; 42(3):407-417.
9. Shilpa Shree KG, Subbarayappa CT. Effect of Micronutrients on Growth and Yield of Mulberry (Morus alba L.) and Silkworm (Bombbyx mori L.). Mysore J Agric. Sci. 2015; 49(2):167-170.
10. Sowmya P, Narayanaswamy TK. Influence of micronutrients on yield and yield attributing parameters of mulberry (Morus spp.) and silkworm (Bombbyx mori L.). Mysore J Agric. Sci. 2015; 50(2):453-456.
11. Yokoyama T. Text Book of Tropical Sericulture. 1st Edn., Japan Overseas Cooperation Volunteers, Tokyo, 1975.