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Evaluating the Effects of Macro and Micro Fertilizers on Mulberry Growth, Quality parameters and Nutrient Absorption

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ABSTRACT

A field experiment was conducted during 2018 to 2023. The combined results revealed that treatment T3 followed by T2 exhibited higher values for various parameters such as number of branches per plant, number of leaves per branch, number of leaves per plant, shoot length (cm), leaf yield and stem yield achieving with values of 8.07, 21.17, 178.78, and 128.55 cm for shoot length, as well as 54.84 and 29.59 mt/ha/yr for leaf and stem yield, respectively. Among the ten nutrient levels T2 exhibited significantly higher percentages for nutrient composition such as N, P, K, Ca, Mg and S (3.48, 0.25, 2.21, 0.51, 0.15, and 0.22%) respectively. The same trend was observed for Cu and B (5.11, 101, and 53 ppm). Additionally both T2 and T3 recorded identical values for Zn, Fe, and Mn (47, 101, and 124 ppm).

Regarding crude protein, starch, crude fiberand CHO percentages, T2 demonstrated significantly higher values (22, 11.88, 8, and 14.56%) respectively. In terms of total chlorophyll content T2 and T3 exhibited significantly higher values (3 mg/g). Regarding nutrient uptake, T2 recorded significantly higher values for N, Ca, Mg, and S (484, 73, 22, and 32 kg/ha). The uptake values for P and K were the same (35 and 306 kg/ha) in both T2 and T3. While micronutrient uptake T3 recorded higher values for Cu, Zn, Fe, Mn, and B (73, 666, 1424, 1774, and 743 g/ha). The study showed that T3 and T2 exhibited superior performance in all the parameters of mulberry.

Keyword: V1 mulberry variety; Inorganic fertilizers; Panchagavya; Poshan; macro-micro nutrients.

Significance' statement

The observe on the consequences of macro and micro fertilizers on mulberry increase, pleasant parameters, and nutrient absorption holds massive significance for optimizing sericulture practices. As mulberry is critical for the silk industry, expertise the effect of fertilizers can cause specific and efficient fertilization strategies. The studies objectives to enhance mulberry yield, silk quality, and monetary returns for farmers even as promoting sustainable sericulture via responsible nutrient management practices. The findings will provide valuable insights for stakeholders, contributing to the resilience and prosperity of the silk enterprise inside the region.

I. INTRODUCTION

Soil macronutrients play a vital role in plant growth, with nitrogen and phosphorus being major contributors to deficiencies, accounting for 85-88% and secondary nutrients like calcium and iron contributing to 57% and 45.7% of deficiencies, respectively. Micronutrients also have a significant impact on mulberry leaf yield, with reductions ranging from 52.6% to 53.2% (Shankar, 1997).

Uneven rainfall, heavy rainfall and declining annual rainfall are forcing farmers to grow fewer and more extensive crops. Advanced irrigation techniques are used to ensure mulberry leaf quality and quantity (Sudhakar*et al.,* 2021). There is a noteworthy correlation between the nitrogen content in mulberry leaves and various characteristics of silkworms, such as cocoon and shell weight, as well as the synthesis of silk, which consists of two proteins called fibroin and sericin (Subbarayappa and Bongale, 1997). Phosphorus content is essential as it regulates protein synthesis, cell division, and the development of new tissue. It is also associated with ATP (adenosine triphosphate), an important energy molecule. Low phosphorus content in mulberry leaves can lead to poor growth and economic characteristics in silkworms (Chakrabarti*et al.,* 1997).

Potassium plays a regulatory role and activates starch synthetase, which is important for carbohydrate metabolism. It also affects protein metabolism, the translocation of carbohydrates, and overall productivity and quality of mulberry leaves. Potassium is also involved in disease tolerance in mulberry plants. Additionally, it plays a role in stomatal regulation, as it moves into guard cells and helps open stomatal pores, allowing for the exchange of oxygen, carbon dioxide, and water vapor with the atmosphere (Shree *et al.,* 2005).

Micronutrients like zinc, iron, manganese, copper, boron, molybdenum, and chloride are crucial for mulberry plants in small quantities. They act as metal activators in enzymatic reactions, supporting mulberry growth, development, and yield (Shankar, 1997). Zinc, for instance, enhances pupal weight and silk filament length (Chakrabarti*et al.,* 1997), but excessive zinc levels in mulberry leaves can reduce cocoon yield (Lokanath*et al.,* 1986; Sturgul, 2010). These micronutrients are essential for optimal mulberry plant health and productivity.

Copper is vital for enzyme function and is found in chloroplast proteins (Shankar, 1997). To address copper deficiency in small grains and vegetable crops, effective methods include foliar applications or incorporating copper before planting (Apurba*et al.,* 2017). Boron plays a crucial role in plant processes such as cell growth, cell wall development, protein synthesis, carbohydrate translocation, phenol metabolism, auxin activity, crop yield, and potassium-calcium ratio regulation. Boron also interacts with nitrogen, phosphorus, potassium, and calcium in plants. Higher crop yields often require increased boron levels (Shankar, 1997; Heckman, 2000).

Continuous crop harvesting can deplete soil micronutrient concentrations, particularly when leaf yield is high (Singhvi*et al.,* 2002). Micronutrients like boron, manganese, copper, iron, molybdenum, and zinc are required in trace amounts but have a significant impact on maximizing yields. Optimizing all nutrients is crucial for optimal crop production, considering the specific functions of micronutrients and their role in microbial growth processes (Hansch and Mendel 2009.,McCauley *et al.,* 2009). Micronutrients have diverse roles in plant growth, including cell wall development, protein synthesis, chlorophyll formation, water absorption, disease resistance, and enzymatic reactions. For instance, feeding silkworm larvae with leaves enriched in nickel (Ni) and zinc (Zn) increases cocoon weight. Zinc chloride-enriched mulberry leaves also influence silk gland protein synthesis, haemolymph composition, and cocoon economics. Thus, a continuous supply of micronutrients is essential to achieve the desired quantity and quality of mulberry leaves for successful silkworm cocoon production.

II. METHODOLOGY

A field experiment was conducted at the Regional Sericultural Research Station, Central Silk Board, Salem, Tamil Nadu, India, from 2018 to 2022. The study aimed to investigate the significance of micronutrients on mulberry growth, moisture, and yield. The V1 mulberry variety was used with 3'×3' plant spacing. A randomized block design (RBD) with three replications and ten treatments was implemented.After 52-60 days of growth/pruning, ten plants were randomly selected from each replication for measurements. Parameters measured included plant height, shoot length, number of shoots per plant, leaf yield, stem yield, and number of leaves per branch and plant (Fisher & Yates, 1963). Soil and leaf nutrients analysed by following standard protocols.

Treatment details:

T1: 100 % RDF (350:140:140 kg NPK/ha/yr)
T2: 100 % RDF + 30 kg /ha/yr micronutrients -soil application
T3: 100 % RDF + 25 kg /ha/yr micronutrients -soil application
T4: 100 % RDF + 20 kg /ha/yr micronutrients -soil application
T5: 100 % RDF + 0.5% micronutrients (Zn, Fe, Mn) + 0.2% Borax- foliar application
T6: 100 % RDF + 0.25% micronutrients (Zn, Fe, Mn) + 0.1% Borax- foliar application
T7: 100 % RDF + 0.7% Poshan - foliar application
T8: 100 % RDF + 3% panchagavya- soil application
T9: 100 % RDF + 5% panchagavya - soil application
T10: Absolute control

Micro and macro nutrients applied in mulberry garden in the form of $ZnSO_4$, $FeSO_4$, $MnSO_4$,Borax, Ammonium Sulphate (Nitrogen-N), Single super phosphate (Phosphorus-P), Murate of Potash (Potash-K).

Preparation of Panchagavya:

Panchagavya is an organic product that has the potential to promote plant growth and enhance immunity. To prepare Panchagavya, various ingredients are combined in specific proportions. These include fresh cow dung (7 kg), cow urine (3 liters), cow milk (2 liters), curd (2 liters), cow ghee (1 kg), sugarcane juice (3 liters), coconut water (3 liters), banana paste made from 12 fruits, and water (10 liters). The ingredients are mixed in a plastic drum placed in a shaded area and covered with a wire mesh to prevent houseflies from laying eggs. The mixture is stirred thirty times in a clockwise and counterclockwise direction, twice daily. After 18-20 days, the Panchagavya stock solution is ready for use. The prepared Panchagavya stock solution can be applied to the soil at 3% and 5% concentrations for soil application.

Poshan (0.7%):

CSRTI, Mysuru has developed a foliar spray with a balanced multi-nutrient formulation for healthy mulberry growth and silkworm nutrition. A single spray is recommended 25-30 days after pruning/picking to address nutrient deficiencies effectively.

III. RESULT AND DISCUSSION

Pooled Data of 5-crops

The growth, yield and quality parameters of V1 mulberry variety differed significantly with respect to application of different doses of fertilizers.

Mulberry growth parameters:

Among the ten nutrient levels tested, treatment T3 (RDF + Fe, Zn, Mn, B - 25 kg/ha/yr) with soil application recorded significantly higher values for various mulberry growth parameters, including the number of branches per plant (8.20), shoot length (128.55 cm), number of leaves per branch (21.17), and number of leaves per plant (178.78). Treatment T2 (RDF + Fe, Zn, Mn, B - 30 kg/ha/yr) showed comparable results for these parameters (8.07 branches, 127.23 cm shoot length, 21.13 leaves per branch, and 173 leaves per plant). The control group (T10) had the lowest values for all the mentioned mulberry growth parameters (6 branches, 70 cm shoot length, 12 leaves per branch, and 83 leaves per plant)(Fig: 1a & 1b). Similar findings were reported by Kasiviswanathan and SitaramaIyengar., 1965; Bose and Bindroo, 2009 respectively (Table:1)

Mulberry yield parameters:

Among the ten nutrient levels tested, T3 (RDF + Fe, Zn, Mn, B - 25 kg/ha/yr) with soil application had significantly higher leaf and stem yield (54.84 MT/ha/yr and 29.59 MT/ha/yr). T2 (RDF + Fe, Zn, Mn, B - 30 kg/ha/yr) showed similar results (54.45 MT/ha/yr and 29.50 MT/ha/yr) respectively. No significant differences were observed between these treatments, except compared to the control group (Fig:2& Table:1). Similar findings were reported by Kasiviswanathan and SitaramaIyengar., 1965; Dootson 1976; SanthoskumarMagadum*et al.,* 2020; Vinodkumar*et al.,* 2020.

Quality parameters:

Among the ten nutrient levels tested, T5 (100% RDF + 0.5% micronutrients (Zn, Fe, Mn) + 0.2% Borax - foliar application) showed relatively higher leaf and stem moisture content, with values of 74.66% and 70.68% respectively. T7 (100% RDF + 0.7% Poshan - foliar application) demonstrated similar results, with leaf and stem moisture content of 74.51% and 70.43% respectively. No significant differences were observed between these treatments(Table: 01). Similar findings were reported by Radha, 2013; Dutta *et al.,* 2007; Nazar*et al.,* 2019; Shilpashree and Subbarayappa, 2015; Murali*et al.,* 2006; Shashidhar 2009.

Nutrient content:

Among the ten nutrient levels tested, T2 (RDF + Fe, Zn, Mn, B - 30 kg/ha/yr) with soil application recorded significantly higher percentages of nutrient composition, including N, P, K, Ca, Mg, and S (3.48%, 0.25%, 2.21%, 0.51%, 0.15%, and 0.22% respectively). Similar trends were observed for micronutrients such as Cu and B (5.11 ppm, 101 ppm). T3 (RDF + Fe, Zn, Mn, B - 25 kg/ha/yr) demonstrated comparable results with percentages of N, P, K, Ca, Mg, and S (3.40%, 0.25%, 2.18%, 0.50%, 0.15%, and 0.22%) respectively (Table:2). In terms of micronutrients (5.10 ppm, 52 ppm), while Zn, Fe, and Mn had the same values (47 ppm, 101 ppm, and 124 ppm) in both T2 and T3 respectively. T10, the control group, exhibited lower values in percentage of nutrient composition for N, P, K, Ca, Mg, and S (0.81%, 0.03%, 0.93%, 0.06%, 0.03%, and 0.01%) and micronutrients Cu, Zn, Fe, Mn, and B (4.75 ppm, 9.63 ppm, 17 ppm, 9.33 ppm, and 4.60 ppm) respectively. No significant differences were observed between the treatments, except for the control group(Fig:3). Similar findings were reported by Bose and Bindroo, 2009; Arokiyaraj,*et al.,* 2016.

Bio-chemicals content:

Among the ten nutrient levels tested, T2 (RDF + Fe, Zn, Mn, B - 30 kg/ha/yr) with soil application showed significantly higher percentages of crude protein, starch, crude fiber, and CHO (22%, 11.88%, 8%, and 14.56% respectively). T3 (RDF + Fe, Zn, Mn, B - 25 kg/ha/yr) exhibited similar results with percentages of crude protein, starch, crude fiber, and CHO (21%, 11.83%, 7.96%, and 14.46% respectively). T10, the control group, recorded lower values in the mentioned biochemical compositions (5.1%, 4.70%, 4.48%, and 5.35% respectively). Regarding total chlorophyll content, both T2 and T3 showed significantly higher values of 3 mg/g, while T10 had a lower value of 0.31 mg/g(Fig:4a& 4b). Similar observation recorded by Vishwanath 1979; Faruque Ahmed *et al.*, 2018; Sabina *et al.*, 2012.

Nutrient uptake

Among the nutrient levels tested, T2 (RDF + Fe, Zn, Mn, B - 30 kg/ha/yr) with soil application had higher nutrient uptake of N (484 kg/ha), Ca (73 kg/ha), Mg (22 kg/ha), and S (32 kg/ha). T3 (RDF + Fe, Zn, Mn, B - 25 kg/ha/yr) showed similar uptake values for N (474 kg/ha), Ca (72 kg/ha), Mg (21 kg/ha), and S (31 kg/ha). T2 and T3 had equivalent P (35 kg/ha) and K (306 kg/ha) uptake. For micronutrient uptake, T3 exhibited higher values for Cu (73 g/ha), Zn (666 g/ha), Fe (1424 g/ha), Mn (1774 g/ha), and B (743 g/ha). T2 had similar uptake for Cu (72 g/ha), Zn (658 g/ha), Fe (1400 g/ha), Mn (1765 g/ha), and B (728 g/ha)(Table:3). Similar observation recorded by YounusWani*et al.*, 2016; Younus*et al.*, 20I7; Narayanaswarny and Shankar 2003.

IV. CONCLUSIONS

The results of the study inferred that, application of micronutrients had no positive influence on the mulberry growth, yield parameters and moisture percentage. While mulberry growth, yield, moisture and leaf nutrients composition showed positive result with Treatment-T2 and T3. There is no significant difference between the treatments except T10 (control). At the end of study concluded that T3 and T4 (RDF with 25 and 20 kg/ha/ya micronutrients) and T5 and T6 foliar spray of micronutrients can recommend for mulberry garden to get quality leaf.

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Author's contribution:

The first author, a research scholar, conducted the entire set of experiments under the guidance of the second author.

Author's Declaration:

We, the authors of this research paper, declare that we have no conflicts of interest to disclose regarding the research, its findings and integrity of the work.

Ethical statements: Not applicable

Table 1. Effect of micronutrient application on mulberry growth, moisture and yield parameters

Tr.	Shoot length (cm)	Leaf yield (mt/ha/yr)	Stem yield (mt/ha/yr)	Leaf moisture (%)	Stem moisture (%)
T1	109.93	48.54	23.11	74.40	70.34
T2	127.27	54.45	29.50	74.66	70.26
T3	128.55	54.84	29.59	74.59	70.68
T4	122.87	54.94	27.02	74.31	70.43
T5	116.87	52.98	24.50	74.40	70.39
T6	114.33	52.65	24.41	74.40	70.37
T7	106.33	51.21	24.36	74.02	70.30
T8	107.27	49.71	22.84	74.09	70.22
T9	106.73	48.94	24.48	74.09	70.18

T10	70.20	16.92	12.14	72.28	70.22
F-value	20.83	34.04	1.53	0.16	0.02
Sig.	0.00	.00	0.20	1.00	1.00

Table 2. Effect of micronutrient application on mulberry leaf macro, secondary nutrients composition

Tr.	N	P	K	Ca	Mg	S
	%					
T1	3.05	0.21	2.11	0.47	0.14	0.14
T2	3.48	0.25	2.21	0.51	0.15	0.22
T3	3.40	0.25	2.18	0.50	0.15	0.22
T4	2.94	0.23	2.04	0.40	0.15	0.19
T5	3.21	0.22	1.99	0.38	0.15	0.16
T6	3.00	0.22	1.92	0.37	0.14	0.15
T7	2.80	0.20	1.98	0.38	0.14	0.12
T8	2.74	0.21	1.86	0.35	0.14	0.10
T9	2.81	0.21	1.94	0.36	0.13	0.10
T10	0.81	0.03	0.93	0.06	0.03	0.01
F-value	99.43	192.48	41.782	58.92	14.99	56.73
Sig.	0.00	0.00	0.00	0.00	0.00	0.00

Table 3. Effect of micronutrient application on mulberry macro, secondary and micro-nutrients uptake

Tr.	N	P	K	Ca	Mg	S	Cu	Zn	Fe	Mn	B
	Kg/ha						g/ha				
T1	364.46	27.68	251.31	56.80	15.84	16.59	55.81	187.16	316.60	183.30	183.73
T2	483.66	34.61	306.52	71.82	20.99	31.11	72.22	657.71	1399.98	1764.59	743.48
T3	474.22	34.75	306.42	71.76	21.73	30.83	72.53	666.39	1424.07	1773.52	728.34
T4	388.37	31.03	271.81	54.02	20.61	25.72	67.36	514.27	1113.13	1320.56	611.49
T5	343.38	25.87	238.79	46.21	17.69	19.18	59.78	393.00	603.50	1071.05	502.67
T6	340.26	25.76	231.20	44.59	17.09	17.94	59.36	390.62	616.75	955.49	465.94
T7	341.93	25.29	244.55	45.97	17.31	14.67	55.59	389.89	628.68	941.25	454.58
T8	316.92	24.20	216.60	40.82	15.75	11.43	56.51	186.26	334.37	188.91	159.84
T9	326.17	24.67	226.28	42.41	15.16	11.67	57.86	194.90	351.09	196.08	151.24
T10	38.29	1.64	43.49	3.16	1.50	0.65	5.88	45.60	81.40	44.64	22.03
F-value	30.15	21.69	14.07	20.08	19.25	25.87	15.47	66.22	81.56	66.09	34.25
Sig.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

(a)

(b)

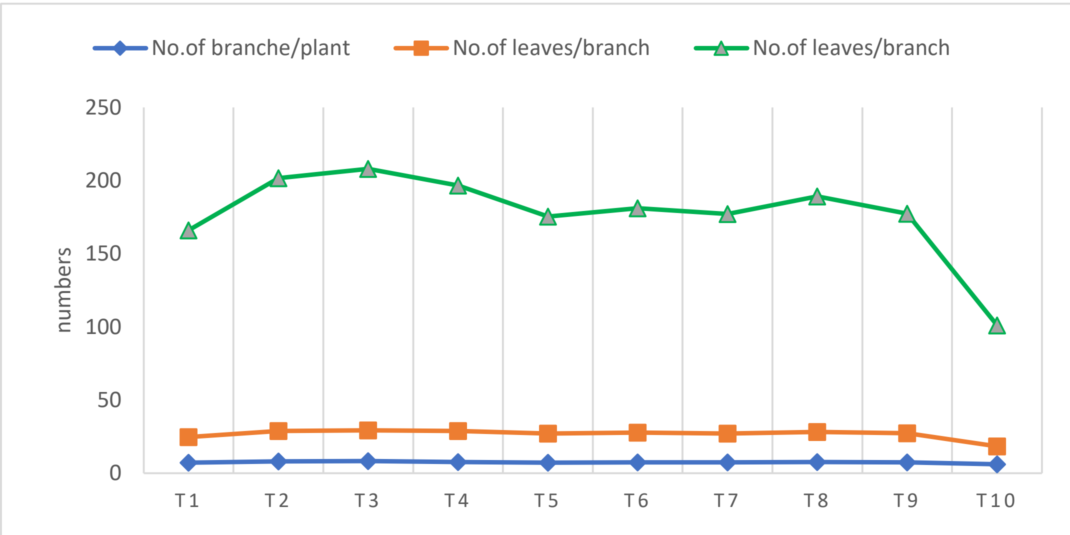


Fig 1: (a) Experimental mulberry garden. **(b)** Mulberry growth parameters influenced by micronutrients

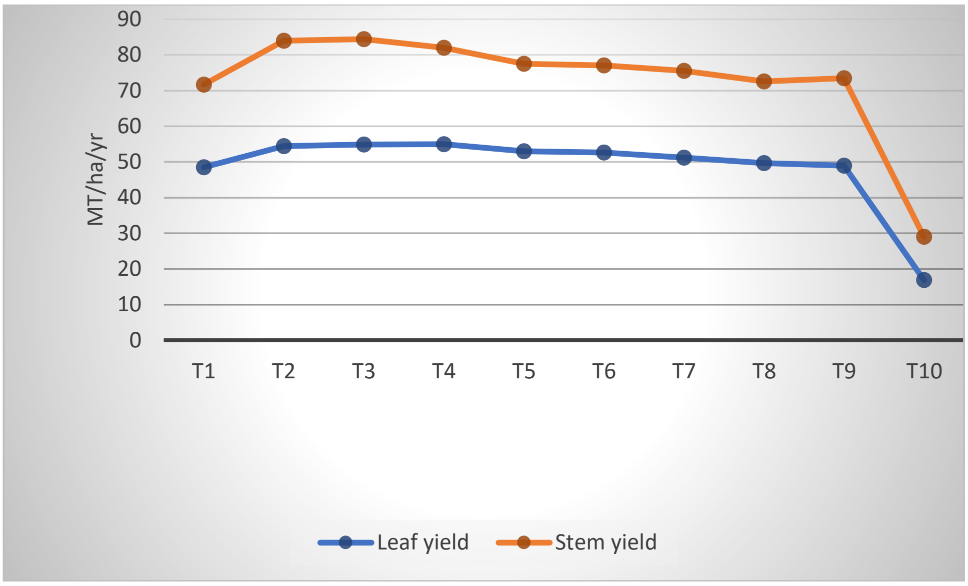


Fig 2: Mulberry yield fluctuation by micronutrients application

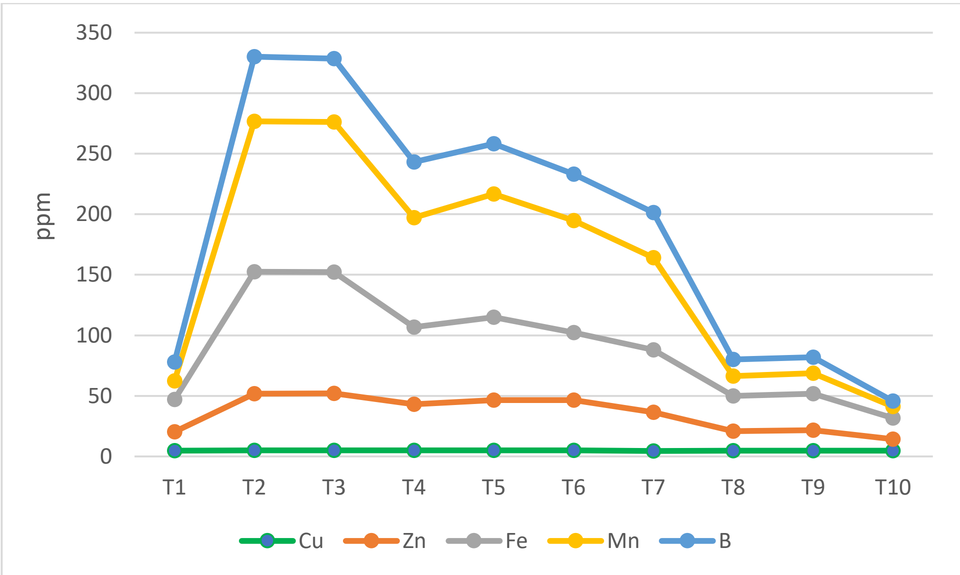
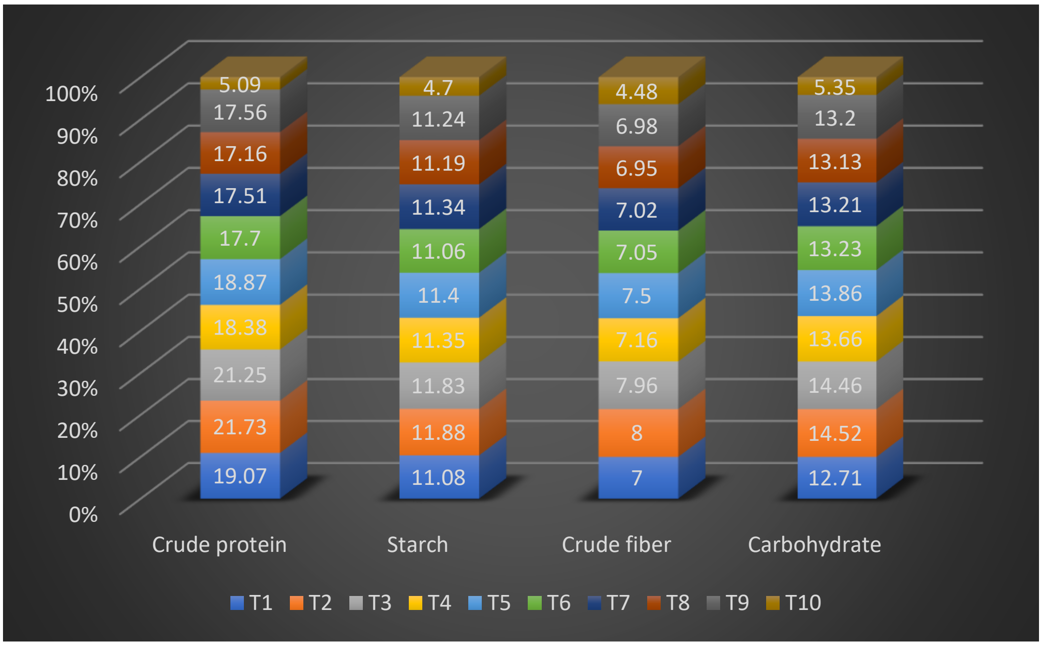


Fig 3: Micronutrients composition in mulberry leaf

(a)



(b)

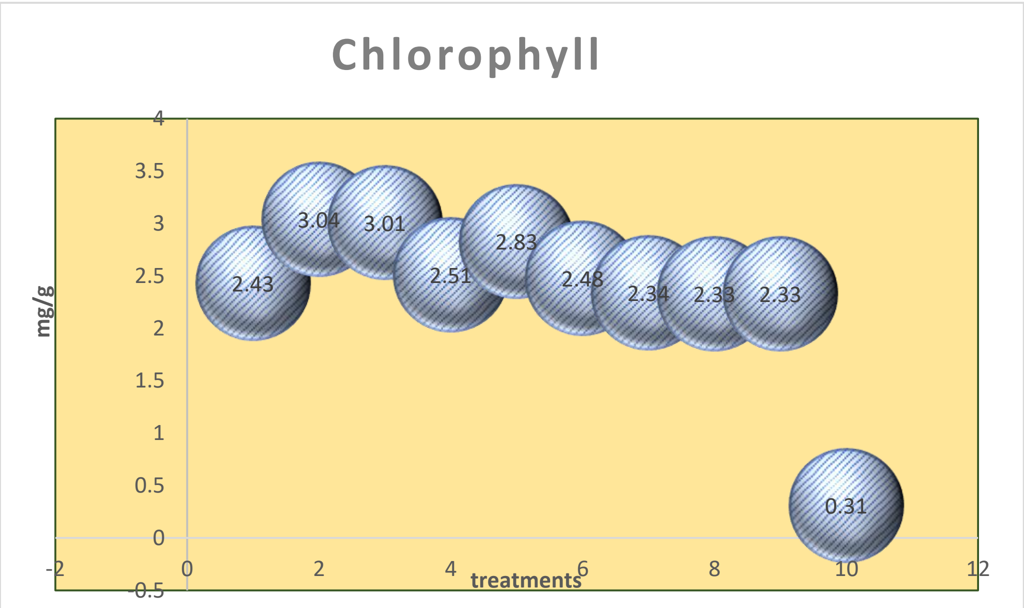


Fig 4:(a) Percentage of crude Protein, Starch, crude fiber and CHO composition in mulberry leaf. **(b)** Quantity of Total chlorophyll composition in mulberry leaf

REFERENCE

[1]. Apurba, K.,Sutradhar, E.,Daniel, Kaiser, J.,Carl, Rosen and John, A., Lamb. (2017).Copper for Crop Production. Nutrient Management, University of Minnesota 1-6.www.extension.umn.edu/agriculture/nutrientmanagement/

[2]. Arokiyaraj, A.,Juliat Mary, P.,Vincentraj, A., Sathya, D. (2016).Macro and Micronutrient Status in Rice Growing Coastal Land Area of Tharangambadi Taluk of Nagapattinam District in Tamil Nadu, India. Int. J. of Scientific & Eng. Res. 7(8), 69-75.

[5]. Bose, P.C., Bindroo, B.B. (2009).Effect of micronutrients on yield of mulberry in sub-tropical region. *Journal of crop and weed*,5(2),142-143.

[6]. Chakrabarti, S.,Subramanyam, M.R.,Singhal,B.K., Datta, R.K. (1997).Nutrientdeficiency management in mulberry. Central Sericultural Research and Training Institute, Mysore, 5-15.

[7]. Dutta, R.N., Jayappa, T., Rajanna, K.LandSindagi, S.S. (2007).Effect ofmicronutrients on seed cocoon floss production. In International Conference on Sericulture Challenges in the 21st Century (Serichal) & the 3rd BACSA meeting,18 -21 September, Vratza, Bulgaria, pp 88.

[8]. Faruque Ahmed, Mohammed Abdul Kader,Rafia Sultana, Oli Ahmed, ShamimAra Begum, and Md.ToufiqIqba(2018).Combined application of foliar fertilizer with basal NPK enhances mulberry leaf yield and silkworm cocoon productivity in calcareous soil.*Journal of South Pacific Agriculture*, (21),18-25.

[9]. Kasiviswanathan, K.,SitaramaIyengar, M.N. (1965).Preliminary observations on varietal-cum- irrigational response to different levels of N on the seasonal and total yield of mulberry leaf.*Indian J. Seric*, 4(4),32-33.

[10]. Lokanath, R., Shivashankar, K. (1986).Effect of foliar application of micronutrients and magnesium on the growth, yield and quality of mulberry *Morus alba* L. *Indian J. Seric.*,25(1),1-5.

[11]. Lokanath, R.,Shivashankar, K.,Kasiviswanathan, K. (1986).Effect of foliar application of magnesium and micronutrients to mulberry on the quality and production of cocoons. *Indian J Seric.*,24(1),40-45.

[12]. Hansch, R., Mendel, R.R. (2009).Physiological functions of mineral micronutrients (Cu, Zn, Mn, Fe, Ni, Mo, B, Cl). *Current Opinion in Plant Biology,* (12), 259-266.

[13] McCauley, A., Jones, C., Jacobsen, J. (2009).Plant nutrient functions and deficiency and toxicity symptoms. Montana State University Extension Service, Bozeman,MT., 16.

[14]. Murali, C., Sreeramulu, K.R.,Narayanaswamy, T.K.,Shankar, M.A., Sreekantaiah, (2006).Effect of bio-inoculants and organic manures on soil micro flora and fertility status of S36 mulberry garden.Natl. Sem. Soil Health and Water Management for Sustainable Sericulture, 27th and 28th September, Regional Sericultural Research Station (A unit of CSB), Bangalore, India. 90.

[15]. Narayanaswamy, T.K., Shankar, M.A. (2003).Mulberry cultivation: A tool for quality leaf and sustainable cocoon production. Department of Sericulture and Dryland Agriculture Project, University of Agricultural Sciences, Bangalore. 28.

[16]. Nazar, A.,Kalarani, M.K.,Jeyakumar, P., Kalaiselvi, T.,Arulmozhiselvan, K.,Manimekalai, S. (2019).Effect of Micronutrients and Biofertilizers on Growth and Yield of Mulberry (*Morusindica* L.) and Silkworm (*Bombyxmori* L.). *Madras Agric. J.*,106(1-3), 69-73.doi:10.29321/MAJ 2019.000224.

[17]. Radha, R.(2013).Studies on the feeding and nutritional influence on the growth and reproduction of monarch butterfly, *DanausChryssipus* (Insecta:Lepidoptera). *Int.Res.J.Env.Sci.*,(2),7–13.

[18]. Sabina, A.,Taseem, A.,Malik, M.F.,Trag, A.R.,Raies, A. (2012).Comparative silk protein expression of different hybrid varieties of *Bombyxmori*.*Trends in LifeSci.*,(1),12–16.

[19]. SantoshkumarMagadum, Preeti Sharma, ManjuBala, RukhsanaKouser, Ashima Sharma, LobzangDeskit, Farzana Aziz, Jeewan Lal and Sardar Singh (2020).Evaluation of Different Mulberry Plantation Systems for Leaf Yield and Yield Contributing Characters. Int. J. of Current Micro. and Applied Sci., 9(12), 3222-3229.

[20]. Singhvi, N.R.,Kodandaramaiah, J.,Munirathnam Reddy, M.,Katiyar, R.S,Sarkar, A., (2002). “Symptomatological study of nutrient deficiency in mulberry variety V1 under field conditions”, Indian journal of Sericulture, 41 (1), 66-69.

[21]. Shankar, M.A. (1997).Handbook of Mulberry Nutrition. Published by Shetty, G.P., Multiplex, Univ. Agric. Sci., Karnataka Agro Chemicals, Bangalore, 19-75.

[22]. Shashidhar, K.R. (2009). Ph.D. (Sericulture) Thesis. Department of Sericulture University of agricultural sciences Bangalore.

[23]. Shree, M.P., Anuradha, R., Nagaveni, V. (2005).Impact of rust disease on the mineral nutrition of mulberry plants. *Sericologia*, 45(1):115-121.

[24]. Shilpashree, K.G, Subbarayappa, C.T., Doreswamy, S. (2015).Effect of Soil Application of Micronutrients on Quality of Mulberry Cocoon Production. 6(4):830-833. https:// www.rjas.info.

[25]. Sudhakar, P., Kiran Kumar, K.P., VijayaNaidu, B., Babulal (2021).Tree Mulberry: The Future of Tropical Sericulture Farming.*Biotica Research Today*, 3(5), 297-302.

[26]. Sturgul, S.J.(2010).Soil Micronutrients: From B to Z. Proceedings of the 2010 WisconsinCrop Management Conference.http://www.soils.wisc.edu/extension/wcmc,/2010/ppt/Sturgul.pdf.

[27]. Viswanath, A.P.(1979)Effect of foliar spray of micronutrient on the yield and quality of mulberry*Morusalba* L. MSc. Thesis, University of Agricultural science, Bangalore.

[28]. Vinod Kumar Yadav, M., Noble Morrison, Arunakumar, G.S., DhaneshwarPadhan, Praveen Kumar, K.V.,Sivaprasad and Pankaj Tewary (2020).Comparative study on different mulberry spacing and its impact on mulberry leaf yield and silkworm rearing. *J. of Entomology and ZoologyStudies*, 8(1),1110-1115.

[29]. YounusWani, M., Mir, M.R.,Baqual, M.F.,KhandayMehraj. (2016).Role of Micronutrients in Mulberry crop improvement. *Indian. Horti. J*. 6(Special), 92-97.

[30]. YounusWani, M.,Mir, M.R,Baqual, M.F.,KhandayMehraj, Bhat, T.A., Rani, S. (2017). Role of foliar sprays in Sericulture industry. *J. Pharmacognosy and Phytochemistry*., 6(4): 1803-1806.