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ENHANCING THE MULBERRY LEAF QUALITY AND YIELD THROUGH FOLIAR APPLICATION OF NANOFERTILIZERS

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ABSTRACT　　A field experiment was conducted in a well established mulberry garden with V1 variety during 2021-22 and 2022-23 to investigate the effects of nanofertilizer applications at 35 and 45 days after pruning on mulberry leaf quality and yield. The analysis of combined data from the study revealed that, foliar spraying of nanofertilizers had a significant impact on mulberry leaf quality and yield. Notably, among the various nanofertilizers applied, nano N.P.K. (19:19:19) at 6 g/l stood out as the most effective treatment. It exhibited superior results with higher values for leaf chlorophyll (SPAD value of 39.98), total sugars (15.86%), soluble proteins (13.76%) and leaf yield (747.94 g/plant) compared to all other treatments.

Key words : Leaf quality and yield, Mulberry, Nanofertilizers, Nano NPK (19:19:19), Pruning.

Introduction

Silkworm, *Bombyx mori* L., is a monophagous insect that drives almost all required nutrients for its growth and development from mulberry leaf. Mulberry (*Morus alba* L.) is a perennial plant with deep roots, grows quickly and produces a large amount of biomass. Its leaf is the only satisfactory food for the mulberry silkworm. The quality and quantity of these leaves not only influence the growth and development of silkworm larvae but also impact cocoon production, making the quality of mulberry leaves a critical factor in the success of the sericulture industry, shaping its economic viability (Choudhury *et al.*, 1991). The quality of mulberry leaves is important for the healthy growth of the silkworms as well as for increasing larval, cocoon, grainage and silk quality. These traits are greatly influenced by the nutritional status of mulberry leaves fed to silkworms (Krishnaswami *et al.*, 1971).

Mulberry leaf quality is affected by several factors including variety, agronomic practices, biotic and abiotic components. However, with the prolonged uptake of nutrients, seasonal variations and nutritional imbalance,

variations in crop performance are observed. Soil fertility management by continuously replenishing nutrients with fertilizers and manures may consistently produce viable and high-quality mulberry leaves over time. It has been found that a portion of the added fertilizers, particularly nitrogenous and phosphatic fertilizers, are unavailable to the plants soon after their application in soil due to a variety of factors such as leaching, volatilization, fixation and so on. Under adverse soil conditions, root absorption is slow and translocation to shoot is poor. In order to avoid or minimize the severity of such conditions, foliar application of nutrients is imperative (Qaiyyum and Bari, 1990).

Several workers have reported the improved nutritive parameters like increased moisture, sugars, protein and chlorophyll contents in mulberry through foliar application of micronutrients. Mulberry as a foliage crop responds well to timely application of foliar sprays (Geetha *et al.*, 2016). Increase in the moisture content of mulberry leaves and retainment of leaf freshness for longer periods was observed upon foliar application of Zinc as $ZnSO_4$ (Lokanath and Shivashankar, 1981). Mulberry leaves

treated with some compounds like nanoparticles, ultimately influence the economic traits such as silk yield, larval and cocoon parameters. However, the studies evaluating nutrient use nano-materials as fertilizers have been biased towards micronutrients, mainly zinc, copper, manganese and iron. Hence, the present study has been aimed to know the impact of nano-fertilizers supplied to mulberry through foliar spray on leaf quality and yield.

Materials and Methods

An experiment was conducted in a well established mulberry garden with V-1 mulberry variety grown as per package of practices to know the effect of nanofertilizers on mulberry leaf quality and yield at Department of Entomology, University of Agricultural Sciences, Dharwad during 2021-22 and 2022-23. The experiment was laid out in Randomized Block Design with 10 treatments replicated thrice. Mulberry plants were raised by using recommended fertilizers and other management practices (Dandin *et al*., 2000). Recommended package of practice (FYM- 20 tons/ha/year, N: P: K: - 350: 140: 140 kg/ha/year) was uniformly applied to all the treatment plots. Nanofertilizers were sprayed to mulberry as per the treatment details at 35 and 45 days after pruning. From each replication, three plants were selected randomly and tagged for recording observations on leaf quality parameters and yield at 50 days after pruning.

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

Leaf moisture (%) : Ten leaves from each replication were plucked separately from top, middle and bottom portion of the plants and stored in polythene bags to prevent the loss of moisture. Fresh weight was taken and leaves were oven dried at 70°C for 3 h and dry weight was taken. Moisture content was estimated by using the below mentioned formula.

Leaf chlorophyll (SPAD value) : Leaf chlorophyll was measured from three tagged plants in each replication using SPAD meter by selecting three leaves at top, middle and bottom position.

Total sugars (%) : Mulberry leaf samples were collected from each treatment and were washed thoroughly with distilled water. About two grams of leaf sample was weighed accurately and cut into small pieces and grounded finely in a mortar and pestle in 80 per cent alcohol. After grinding, it was filtered through Whattman No. 1 filter paper and made up to 50 ml volume with alcohol. Dark coloured alcohol extracts of the tissues pose a great problem in analytical procedures. Therefore, clarification was done using saturated solution of neutral

lead acetate, excess of which was precipitated by disodium hydrogen phosphate. Total sugars was estimated as suggested by Somogyi (1952).

Soluble proteins (%) : The soluble protein content of the leaf samples was estimated by following the procedure of Lowry *et al*. (1951).

Leaf yield (g/plant) : Leaves from the three selected plants in a replication were harvested and weighed separately at 50 days after pruning.

Results and Discussion

Considering the pooled data of both the seasons, foliar application nano fertilizers *viz*., nano NPK (19:19:19) at 6 g/l, nano NPK (19:19:19) at 4 g/l and nano urea at 6 ml/l had a significant impact on leaf quality and yield of mulberry as compared to seriboost at 2.5 ml/l and untreated mulberry at 50 days after pruning (Table 1). The leaf moisture was numerically higher in nano NPK (19:19:19) at 6 g/l (76.43%), but did not differed significantly from the rest of the treatments and water sprayed mulberry (69.43%). Significant enhancement of leaf chlorophyll was noticed upon spraying nano NPK (19:19:19) at 6 g/l (39.98). It was followed by nano urea at 6 ml/l (38.15), nano NPK (19:19:19) at 2 g/l (37.83), nano NPK (19:19:19) at 4 g/l (37.75) and nano urea at 4 ml/l (36.28) which were on par with nano NPK (19:19:19) at 6 g/l. While, seriboost at 2.5 ml/l recorded SPAD value of 35.46 and it was less in unsprayed (31.55) and water sprayed mulberry (30.96). Nano NPK (19:19:19) at 6 g/l increased the total sugars (15.86 %) over seriboost at 2.5 ml/l (14.16 %). It was followed by nano NPK (19:19:19) at 4 g/l (15.57 %) and nano urea at 6 ml/l (15.26 %) which were on par with nano NPK (19:19:19) at 6 g/l. Significantly lower total sugars was recorded from water sprayed (13.09 %) and unsprayed mulberry (13.03 %) (Table 1).

Soluble proteins were significantly higher in nano NPK (19:19:19) at 6 g/l treatment (13.76 %) as against 12.31 per cent in seriboost at 2.5 ml/l. It was followed by nano NPK (19:19:19) at 4 g/l (13.49 %) and nano urea at 6 ml/l (13.38 %) and were on par with nano NPK (19:19:19) at 6 g/l. Soluble proteins was less in water sprayed (11.24 %) and unsprayed mulberry (11.16 %). The overall performance revealed that, the leaf yield of mulberry was significantly increased upon spraying of nano NPK (19:19:19) at 6 g/l (747.94 g/plant), followed by nano NPK (19:19:19) at 4 g/l (719.43 g/plant) and nano urea at 6 ml/l (710.46 g/plant) and were on par with nano NPK (19:19:19) at 6 g/l. While, leaf yield was significantly lower in unsprayed (568.85 g/plant) and water sprayed mulberry (565.65 g/plant) (Table 1).

Table 1 : Influence of nanofertilizers on mulberry leaf quality and yield (pooled data of 2021-22 and 2022-23).

Treatments	Leaf moisture (%)	Chlorophyll (SPAD value)	Total sugars (%)	Soluble proteins (%)	Leaf yield (g/plant)
T_1 : Nano urea @ 2 ml/l	71.95 (58.04)	35.05[bcd]	14.10 (22.05)[c]	12.32 (20.55)[cd]	621.53[ef]
T_2 : Nano urea @ 4 ml/l	72.02 (58.09)	36.28[ab]	14.27 (22.19)[c]	12.91 (21.05)[bc]	665.23[cde]
T_3 : Nano urea @ 6 ml/l	75.19 (60.15)	38.15[ab]	15.26 (22.99)[ab]	13.38 (21.45)[ab]	710.46[abc]
T_4 : Nano NPK (19:19:19) @ 2 g/l	74.03 (59.38)	37.83[ab]	14.59 (22.45)[bc]	12.81 (20.97)[bc]	688.57[bcd]
T_5 : Nano NPK (19:19:19) @ 4 g/l	74.55 (59.72)	37.75[ab]	15.57 (23.24)[a]	13.49 (21.54)[ab]	719.43[ab]
T_6 : Nano NPK (19:19:19) @ 6 g/l	76.43 (60.98)	39.98[a]	15.86 (23.46)[a]	13.76 (21.77)[a]	747.94[a]
T_7 : Urea @ 2.5 %	70.13 (56.92)	34.64[bcd]	13.91 (21.89)[c]	11.88 (20.17)[de]	596.90[fg]
T_8 : Seriboost @ 2.5 ml/l	72.51 (58.39)	35.46[bc]	14.16 (22.11)[c]	12.31 (20.54)[cd]	642.04[def]
T_9 : Absolute control	69.43 (56.44)	30.96[d]	13.09 (21.21)[d]	11.24 (19.58)[ef]	565.65[g]
T_{10} : Untreated control	69.65 (56.58)	31.55[cd]	13.03 (21.16)[d]	11.16 (19.51)[f]	568.85[g]
S.Em (±)	NS	1.5	0.21	0.21	16.58
C.V (%)	7.07	7.23	1.66	1.73	10.64

Figures in parenthesis are arcsine transformed values.
Values within a column followed by same letters are not-significant at p=0.05 by DMRT.

Significant variation in mulberry leaf quality and yield was observed due to foliar application of nanofertilizers. Enhanced leaf cholorophyll of mulberry in nano NPK (19:19:19) at 6 g/l and nano urea at 6 ml/l might be due to nitrogen component of the fertilizer which is the primary source of chlorophyll in plant cells. Leaf chlorophyll and nitrogen content are closely associated. When N fertilizer is added to the leaves, the N content rises. Higher N concentration in leaves is related with greater chlorophyll, chloroplast activity and consequently photosynthetic output. Similar findings were also elucidated by Vijaya *et al*. (2009) and Sharma *et al*. (2022). Total sugars and soluble proteins increased in nano NPK (19:19:19) at 6 g/l, followed by nano NPK (19:19:19) at 4 g/l and nano urea at 6 ml/l. This might be due to improved mineralization leading to production of plant growth substances and increased enzyme activity in mulberry. Foliar application of fertilizers increased the uptake of nutrients from soil as foliar fertilization caused the plant to pump more sugars and other exudates from its roots in the rhizosphere (Vijaya *et al*., 2009). Likewise, Wan *et al*. (2023) concluded optimum fertilization of nitrogen increased the activity of enzymes involved in protein synthesis leading to increased protein content and yield. Present findings are in full agreement with Choudhury *et al*. (2019), who observed enhanced leaf quality with increased total sugars (16.33%), soluble proteins (13.79%) and leaf yield (1000.47 g/plant) due to combined foliar application of nano Zn + Cu at 500 ppm each to mulberry when compared to control. Earlier reports made by Raje Gowda *et al*. (2000); Horie and Nishiok (2009) and Kamel (2014) are in close conformity with present findings.

Conclusion

The utilization of nanofertilizers, including nano NPK (19:19:19) and nano urea, plays a crucial role in enhancing both the quality and yield of mulberry. In the present investigation, nano NPK (19:19:19) at 6 g/l, nano NPK (19:19:19) at 4 g/l and nano urea at 6 ml/l exhibited significant enhancements in mulberry leaf quality and yield. Consequently, these nanofertilizers present promising and valuable recommendations for farmers.

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