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Mulberry plant biomass as influenced by foliar spray of nanofertilizers

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Abstract
A field experiment conducted during 2022-23 to study the impact of nanofertilizers on mulberry plant biomass revealed that the foliar application of nanofertilizers significantly enhanced certain growth and yield parameters of mulberry. Among the different doses of nanofertilizers, nano NPK (19:19:19) at 6 g/l emerged as the best treatment by recording longer shoot length (130.56 cm), higher number of leaves per plant (280.37), leaf yield (752.25 g/plant), shoot yield (551.34 g/plant) and total biomass (1303.59 g/plant).

Keywords: Mulberry plant biomass, influenced, recording longer shoot length, nanofertilizers

Introduction

Morus, a genus in the Moraceae family, includes 10 to 16 species of deciduous trees known as mulberries, which are found both in the wild and in cultivation across various regions of the world. Mulberry (*Morus alba* L.) is a fast-growing perennial plant with deep roots that produces a substantial amount of biomass. The mulberry leaf is a crucial economic factor in sericulture as its leaf is the only satisfactory food for the silkworm, *Bombyx mori*. The quality of these leaves is essential for the healthy development of silkworms and for enhancing larval, cocoon, grainage and silk quality. These characteristics are significantly impacted by the nutritional content of the mulberry leaves provided to silkworms (Krishnaswami *et al*., 1971) [5]. Further, 60 per cent of cocoon production costs are attributed to mulberry leaf cultivation (Rangaswami *et al*., 1976) [7]. Consistent soil fertility management, through the continuous replenishment of nutrients with fertilizers and manures, is crucial for maintaining high-quality mulberry leaves. A portion of the applied fertilizers, particularly nitrogenous and phosphatic ones, often becomes unavailable to plants due to leaching, volatilization and fixation. Poor soil conditions can further hinder nutrient absorption and translocation, making foliar application of nutrients essential to mitigate these issues (Qaiyyum and Bari, 1991) [8]. The main purpose of spraying foliar nutrients to mulberry is to enhance essential nutrients as well as biochemical content in a readily available form. It is not only cost effective but also have longer life when compared to conventional fertilizers (Katiyar *et al*., 1995) [4]. Foliar supplementation of nanofertilizers can result in quick absorption and utilisation to meet most of the nutrient requirement. Nanofertilizers are more efficient than traditional fertilizers as they release nutrients based on the needs of the crop. Nanofertilizers, specifically micronutrient combinations, have drawn greater attention (Tarafdar *et al*., 2012) [12]. However, the studies evaluating nutrient use nanomaterials 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 nanofertilizers supplied to mulberry through foliar spray on certain growth and yield parameters of mulberry.

Materials and Methods

A field experiment was conducted at Department of Entomology, University of Agricultural Sciences, Dharwad during 2022-23 in a well-established V-1 mulberry garden. 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) [3].

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 certain growth and yield parameters at 50 days after pruning.

Results and Discussion

Longest shoot length (cm): Significantly longer shoot length of 130.56 cm was recorded in the mulberry sprayed with nano NPK (19:19:19) at 6 g/l over rest of the treatments. It was followed by nano NPK (19:19:19) at 4 g/l (122.52 cm), nano urea at 6 ml/l (118.30 cm), nano NPK (19:19:19) at 2 g/l (114.26 cm) which were on par with nano NPK (19:19:19) at 6 g/l. Whereas, water sprayed and untreated mulberry recorded shoot length of 93.61 and 93.32 cm, respectively which was significantly shorter (Table 1).

Total number of leaves/plant: Total number of leaves per plant were significantly more in nano NPK (19:19:19) at 6 g/l (280.37) as compared to 215.90 leaves per plant in Seri boost at 2.5 ml/l. While, nano NPK (19:19:19) at 4 g/l (267.78), nano urea at 6 ml/l (255.19) and nano NPK (19:19:19) at 2 g/l (233.70) were the next best sprays. Untreated mulberry produced only 180.48 leaves per plant (Table 1).

Leaf yield (g/plant): Leaf yield was more in nano NPK (19:19:19) at 6 g/l (752.25 g/plant) sprayed plants when compared to unsprayed mulberry (563.97 g). While, nano NPK (19:19:19) at 4 g/l, nano urea at 6 ml/l, nano NPK (19:19:19) at 2 g/l were next best by recording leaf yield of 723.45, 713.42 and 691.89 g per plant, respectively which were on par with nano NPK (19:19:19) at 6 g/l. Whereas, Seri boost at 2.5 ml/l recorded leaf yield of 644.76 g per plant (Table 1).

Shoot yield (g/plant): Highest shoot yield of 551.34 g per plant was obtained in plots sprayed with nano NPK (19:19:19) at 6 g/l. It was followed by nano NPK (19:19:19) at 4 g/l (524.19 g), nano urea at 6 ml/l (516.21 g) and nano NPK (19:19:19) at 2 g/l (503.85 g) which were at par. While, water sprayed and untreated mulberry registered lowest shoot yield of 398.72 and 395.81 g per plant, respectively (Table 1).

Total biomass (g/plant): Total biomass was significantly higher in nano NPK (19:19:19) at 6 g/l (1303.59 g), followed by nano NPK (19:19:19) at 4 g/l (1247.64 g). The order of superiority for the rest of the treatments was found to be nano urea at 6 ml/l (1229.63 g), nano NPK (19:19:19) at 2 g/l (1195.74 g), nano urea at 4 ml/l (1144.92 g), Seri boost at 2.5 ml/l (1114.11 g), nano urea at 2 ml/l (1072.73 g) and urea at 2.5 per cent (1017.34 g). While, total biomass was significantly lower in water sprayed (969.75 g) and untreated mulberry (959.78 g) (Table 1).

Table 1: Effect of foliar application of nanofertilizers on mulberry growth and biomass

Treatments	Longest shoot length (cm)	Total number of leaves/plant	Leaf yield (g/plant)	Shoot yield (g/plant)	Total biomass (g/plant)
T_1: Nano urea @ 2 ml/l	105.76^{bcd}	207.41^{ef}	625.59^{cdef}	447.14^{e}	1072.73^{f}
T_2: Nano urea @ 4 ml/l	112.04^{bc}	231.85^{d}	660.35^{bcd}	484.57^{cd}	1144.92^{de}
T_3: Nano urea @ 6 ml/l	118.30^{abc}	255.19^{c}	713.42^{ab}	516.21^{b}	1229.63^{bc}
T_4: Nano NPK (19:19:19) @ 2 g/l	114.26^{abc}	233.70^{d}	691.89^{abc}	503.85^{bc}	1195.74^{cd}
T_5: Nano NPK (19:19:19) @ 4 g/l	122.52^{ab}	267.78^{b}	723.45^{ab}	524.19^{b}	1247.64^{b}
T_6: Nano NPK (19:19:19) @ 6 g/l	130.56^{a}	280.37^{a}	752.25^{a}	551.34^{a}	1303.59^{a}
T_7: Urea @ 2.5 %	101.43^{cd}	198.15^{f}	603.28^{def}	414.06^{f}	1017.34^{g}
T_8: Seriboost @ 2.5 ml/l	107.69^{bcd}	215.90^{e}	644.76^{bcde}	469.35^{d}	1114.11^{ef}
T_9: Absolute control	93.61^{d}	181.44^{g}	571.03^{ef}	398.72^{f}	969.75^{gh}
T_{10}: Untreated control	93.32^{d}	180.48^{g}	563.97^{f}	395.81^{f}	959.78^{h}
S.E.M (±)	5.98	3.52	26.57	7.3	17.35
C.V.	9.43	11.14	10.46	9.21	9.72

Values within a column followed by same letters are not-significant at P=0.05 by DMRT.

The results clearly demonstrate a significant increase in the growth and yield of mulberry with the foliar application of nanofertilizers, specifically 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. The effectiveness of nanofertilizers can be attributed to their ability to bypass root uptake by being applied directly to the foliage, allowing plants to quickly absorb nutrients through their leaves. The smaller particle size and larger surface area of nanofertilizers enable deeper penetration into leaf tissues, facilitating faster nutrient uptake. Physiological activities of plants *viz*., cell division and differentiation, expansion of cell, formation of cell wall enhanced by nanofertilizers might have led to longer shoot length, higher number of leaves per plant, leaf yield, shoot yield and total biomass. The present findings are in agreement with Merghany *et al.* (2019) [6] who recorded highest plant height (101.4 and 87.11 cm), number of leaves (22.67 and 15) in cucumber sprayed with 6 ml nano NPK during first and second season, respectively. Significantly higher shoot height (96.63 cm), number of leaves per plant (157.15) and leaf yield (460 g/plant) of mulberry was observed upon foliar application of nano zinc oxide 50 ppm (Nithya *et al*., 2018) [7]. Combined application of nano Zn + Cu at 500 ppm each to mulberry resulted in highest shoot length (202.33 cm), total number of leaves per plant (326.93), leaf yield (1000.47 g/plant), shoot yield (893.30 g/plant) and total biomass (1873.67 g/plant) (Choudhury *et al*., 2019) [2]. Further, earlier reports by Bose *et al*. (1995) [1], Sundareswaran *et al*. (1997) [11] and Rashmi *et al*. (2006) [10] on increase in yield contributing parameters such as shoot length and number of leaves per plant which might also have increased leaf yield and total biomass of mulberry are in confirmity with present findings.

Conclusion

Present study revealed that 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 growth and biomass. Consequently, these nanofertilizers present promising and valuable recommendations for farmers after further confirmation.

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