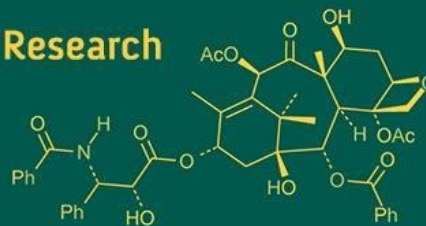


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Effect of foliar application of different sources of nutrients on growth of Jambheri seedlings in secondary nursery stage

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Abstract

The field experiment conducted at the Centre of Excellence for Citrus, College of Agriculture, Nagpur, during the academic year 2022-23, investigated the effect of foliar application of various nutrient sources on the growth performance of jambheri (*Citrus jambhiri* Lush.) seedlings in the secondary nursery stage. The experiment was laid out in a randomized block design with nine treatments and three replication. Results indicated that in the secondary nursery, treatment T₆ (Nano DAP at 200 ppm) significantly enhanced shoot length, seedling diameter, buddable seedlings, and leaf area compared to the control. The number of leaves per seedling was significantly higher in both T₆ and T₃ (Nano urea at 150 ppm) treatments, while the number of shoots per seedling was maximized in T₃. Budding success and time required for sprouting were not significantly affected by treatments. Overall, Nano DAP at 200 ppm (T₆) demonstrated superior performance across most growth parameters, highlighting its potential for enhancing jambheri seedling growth in the secondary nursery stage.

Keywords: Jambheri, rootstock, foliar, nutrients, growth, secondary nursery

1. Introduction

Citrus rootstocks play a vital role in commercial citrus cultivation across all major citrus-growing regions (Bowman & Joubert, 2020) [6]. *Citrus jambhiri*, commonly known as rough lemon, holds paramount importance as a rootstock for mandarin varieties within the citrus genus, particularly in the Vidarbha region of Maharashtra and its surroundings. Rootstock selection is critical, impacting graft compatibility, resilience to environmental stressors such as drought and frost, and overall plant performance like, seedling growth, tree vigour, fruit yield etc. (Ahmed *et al.*, 2006) [2]. Rootstocks play a pivotal role in nutrient and water uptake, influencing crop yield and fruit quality (Al-Jaleel *et al.*, 2005) [3]. Additionally, they contribute significantly to plant tolerance against pathogens like Citrus tristeza virus (CTV), Phytophthora, nematodes, and salinity stress (Singh *et al.*, 2019) [16].

Nitrogen is indispensable for fruit trees, influencing shoot growth and fruit quality. Using foliar spraying of some nutrients such as nitrogen stimulate plant growth and compensate for the deficiency in these elements, which accelerates the fruit size, diminished leaf size, and overall stunted tree growth. Phosphorus is vital for various physiological processes, including plant growth, photosynthesis, and energy storage. Potassium is crucial for maintaining cell turgor, regulating water balance, facilitating photosynthesis, and mitigating respiration (Conley *et al.*, 2009) [8].

The integration of nanotechnology in agriculture represents a significant breakthrough, offering efficient and cost-effective fertilization solutions. Nano-fertilizers, characterized by their high surface area and ability to encapsulate and slowly release nutrient ions, hold promise for enhancing crop productivity (Naderi and Danesh-Shahraki 2013) [13].

They improve nutrient utilization efficiency, stimulate photosynthetic activity, mitigate toxicity risks, and streamline fertilization practices by reducing the need for multiple applications. In nursery management, the judicious application of diverse fertilizers and micronutrients is imperative for fostering robust seedling growth and ensuring the establishment of healthy plant stocks. This study aims to evaluate the most effective nutrient source for *Citrus jambhiri* (rough lemon) seedlings during their early growth stages with the

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goal of optimizing fertilization techniques for better seedling establishment and long-term crop success.

2. Materials and Methods

The experiment is entitled “Effect of foliar application of different sources of nutrients on growth of Jambheri seedlings in secondary nursery”. The study will be conducted internally during the years 2022-23 at the research field located in the Centre of Excellence for Citrus, Bharatnagar, Nagpur. The experimental setup comprises different water-soluble nutrient sources applied foliarly. Treatments include T₁-Nano urea (100 ppm), T₂-Nano urea (150 ppm), T₃-Nano urea (200 ppm), T₄-Nano-di-ammonium phosphate (DAP) (100 ppm), T₅-Nano DAP (150 ppm), T₆-Nano DAP (200 ppm), T₇-19:19:19 (1%), T₈-Urea (1%), and T₉-Control (water spray). A total of nine treatments will be evaluated using 60 *Jambheri* seedlings. Observations will be recorded on the 150th day post-transplanting. Key growth parameters, including the number of shoots per seedling, number of leaves per seedling, shoot length, seedling diameter, number of buddable seedlings, leaf area, budding success, and time required for sprouting, will be meticulously documented.

3. Results and Discussion

3.1 Effect of foliar application of different sources of nutrients on growth of *jambheri* seedlings in secondary nursery.

The effect of foliar application of nano-fertilizers on the growth of *Jambheri* seedlings was assessed through several growth parameters including the number of shoots per seedling, number of leaves per seedling, shoot length, seedling diameter, number of buddable seedlings, leaf area, budding success, and the time required for sprouting, as presented in Table 1.

3.1.1 Number of shoots

The data with respect to the effect of foliar application of different sources of nutrients on growth of shoot length, Significantly maximum number of shoots per seedling (5.22) was observed with Nano Urea 200 ppm (T₃), which was statistically at par with Nano DAP 200 ppm (T₆), Nano Urea 150 ppm (T₂), and Nano Urea 100 ppm (T₁), recording 5.00, 4.89, and 4.78 shoots respectively. The minimum number of shoots (2.33) was recorded in control (T₉).

The increased shoot number may be attributed to enhanced nutrient mobilization, photosynthesis, and assimilate translocation by Nano Urea 200 ppm. These results align with findings by Mustafa *et al.*, (2022) ^[12] on Mandarin.

3.1.2 Seedling diameter

The maximum seedling diameter (0.87 cm) was recorded with Nano DAP 200 ppm (T₆), which was statistically at par with T₅ (0.83 cm) and T₃ (0.77 cm). The lowest diameter (0.43 cm) was observed in control (T₉). Nano-nutrient application may promote cell wall extensibility, elongation, and increased IAA synthesis leading to thicker stems

(Sebastian *et al.*, (2020) ^[15]. Similar results were reported by Kumar *et al.*, (2012) ^[11] and Al-Jilhaw & Merza (2020) ^[4].

3.1.3 Shoot length

The treatment with T₆ T₆ (Nano DAP 200 ppm) recorded the highest shoot length (26.77 cm), statistically at par with T₃ (26.54 cm), T₂ (25.51 cm), T₅ (24.99 cm), and T₄ (24.70 cm). Minimum shoot length (18.14 cm) was found in control (T₉).

This increase may be due to improved nitrogen availability enhancing photosynthesis and membrane permeability. These findings agree with Dubey *et al.*, (2003) ^[9], Chaurasiya *et al.*, (2005) ^[7], and Kumar *et al.*, (2012) ^[11].

3.1.4 Number of leaves

The maximum number of leaves per plant (84.44) was recorded in both T₆ (Nano DAP 200 ppm) and T₃ (Nano Urea 200 ppm), while the minimum (19.55) was recorded in control (T₉). The increased leaf number may be attributed to combined nitrogen and phosphorus availability enhancing branch formation and leaf development. These results are supported by Sebastian *et al.*, (2020) ^[15] and Patel *et al.*, (2022) ^[14].

3.1.5 Leaf area

Treatment T₆ (Nano DAP 200 ppm) recorded the highest leaf area per seedling (22.85 cm²), followed by T₃ (22.31 cm²), T₅ (21.62 cm²), and T₂ (21.19 cm²). The lowest leaf area (16.48 cm²) was observed in control (T₉). Nano DAP enhances physiological functions, promoting better water and nutrient uptake, which results in larger leaves. Similar findings were reported by Khalaf *et al.*, (2023) ^[10] and Mustafa *et al.*, (2022) ^[12]. Climatic conditions also affect the leaf area of seedling (Bhusari and Gaikwad 2025) ^[5]

3.1.6 Buddable seedlings

The highest percentage of buddable seedlings (83.44%) was recorded in T₆ (Nano DAP 200 ppm), followed by T₅ (80.00%) and T₄ (76.67%), with the lowest (55%) in control (T₉). Nano DAP stimulates cell division, shoot elongation, and water uptake, which favors higher buddable seedling production. This observation concurs with Abobatta *et al.*, (2023) ^[1].

3.1.7 Budding success

The treatment T₆ (Nano DAP 200 ppm) recorded the highest budding success (78.06%), whereas the lowest (64.24%) was observed in control (T₉). This can be attributed to improved seedling vigor and graft union compatibility under nano-nutrient treatments.

3.1.8 Time required for sprouting

Earliest sprouting (43.78 days) was recorded in T₆ (Nano DAP 200 ppm), while the longest time (48.66 days) was taken in control (T₉). Nano DAP likely accelerated physiological activities, leading to faster sprouting.

Table 1: Effect of foliar application of different sources of nutrients on growth of *jambheri* seedlings in secondary nursery

Treatment	Number of shoots	Seedling diameter (cm)	Shoot length (cm)	Number of leaves	Leaf area (cm ²)	Buddable seedling (%)	Budding success (%)
T ₁ -Nano Urea-100 ppm	4.78	0.70	23.97	62.00	19.83	70.00	71.49
T ₂ -Nano Urea-150 ppm	4.89	0.73	25.51	69.44	21.19	73.33	72.70
T ₃ -Nano Urea-200 ppm	5.22	0.77	26.54	84.43	22.31	75.00	73.71
T ₄ -Nano DAP-100 ppm	4.33	0.73	24.70	76.56	20.70	76.67	73.89
T ₅ -Nano DAP-150 ppm	4.45	0.83	24.99	77.44	21.62	80.00	75.32
T ₆ -Nano DAP-200 ppm	5.00	0.87	26.77	84.44	22.85	83.33	78.06
T ₇ -19:19:19-1%	3.67	0.70	20.38	53.44	19.80	68.33	68.32
T ₈ -Urea-1%	3.11	0.63	20.90	53.33	19.06	66.67	65.20
T ₉ -Control-Water spray	2.33	0.57	18.14	42.89	16.48	55.00	64.24
SE (m) ±	0.189	0.035	0.883	1.660	0.588	2.291	5.04
CD at 5%	0.561	0.104	2.623	4.932	1.746	6.806	NS

4 Conclusion

Foliar application of nano-fertilizers significantly improved the growth of Jambheri seedlings. Among all treatments, Nano DAP 200 ppm was most effective, resulting in maximum shoot growth, seedling diameter, leaf area, budding success, and early sprouting except in number of shoots which having nano-DAP. It is recommended for enhancing seedling quality and budding efficiency in secondary nurseries.

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