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Soil Drenching and Foliar Application of Nano Fertilizers Improved Quality Traits and Vase Life of *Asparagus densiflorus* cv. 'Sprengeri'

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Abstract

The current study was carried out during September, 2022 to March, 2023 at Chidambaram, Cuddalore District, Tamil Nadu, India. The study examined the impact on enhancing quality and marketability, responding to the urgent demand for sustainable fertilization methods. *Asparagus densiflorus* cv. Sprengeri was a valued ornamental foliage plant, extensively utilised in flower arrangements for its vibrant green leaves and outstanding vase longevity. Nano fertilizers are used as an alternative to conventional fertilizer for its gradual and controlled supply of nutrients in the soil. They could release their active ingredients more precisely in response to environmental cues and biological demands, enhancing soil health by increasing carbon uptake, soil aggregation, water holding capacity, and crop nutrient usage efficiency. The experiment was laid out in a completely randomized design with three replications, incorporating 12 treatments that included nano NPK 4:4:4 soil drenches (1500 ppm, 3000 ppm and 4500 ppm) and Nano urea foliar sprays (0.05% and 0.1%), with a control (water spray). The application of nano NPK 4:4:4 soil drenches at 4500 ppm+nano urea foliar spray at 0.1% markedly enhanced visual scoring, freshness index, chlorophyll content, and vase life, followed by Nano NPK 4:4:4 soil drenches @ 4500 ppm + nano urea foliar spray @ 0.05 %. The lowest values were recorded with control, indicating the enhanced nutrient efficiency and physiological advantages of nano fertilizers. These results highlighted the capacity of nano fertilizers to improve crop quality, mitigate impacts on the environment, and promote economic feasibility.

Keywords: Asparagus, chlorophyll, nano fertilizer, quality traits, vase life

1. Introduction

Cut foliage, referred to as cut greens or florist's greens, is extensively utilized for ornamental purposes, either alone or combined with flowers in floral arrangements and bouquet creation. These leaves are esteemed for their capacity to stay green and maintain their visual appeal for prolonged durations. Evergreen trees featuring green, silver, or variegated foliage are especially favoured, and foliage that produces berries has recently attracted interest. The elevated demand for flowers, particularly during off-peak seasons, frequently results in shortages, presenting consumer difficulties. Cut greenery possesses considerable promise as a substitute for flowers in these circumstances. Nonetheless, its potential is predominantly underexploited. *Asparagus* species are esteemed for their year-round availability and exceptional vase life among cut foliage (Watharkar et al., 2018). *Asparagus densiflorus* cv. Sprengeri, a member of the Liliaceae family originated from Africa. Its flexibility encompasses garlands, wreaths, and bridal bouquets, and when utilized in hanging pots, its cascading branches impart a delicate, natural appearance to interiors (Kumar et al., 2020). Despite its popularity and utility, research on improving its quality and growth through novel agricultural practices remains scant.

The potential of nitrogen fertilizer to markedly enhance agricultural yield is countered by high application rates and low efficiency. Consequently, optimizing nitrogen fertilizer management is essential for attaining agricultural sustainability (Jhansi et al., 2025). The rising demand for nutrients for plants can be met with synthetic fertilizers, but they are costly to produce and harm soil health and microbial populations (Ekka et al., 2024). The unregulated application of chemical fertilizers has resulted in heavy metal deposition in crops and soil and ecosystem damage (Subramani et al., 2023). Poor mineral solubility and mobility, low crop absorption efficiency, soil composition limits, and bioavailable mineral build up in edible parts, which must stay nontoxic, limit traditional fertilizer effectiveness (Dharani et al., 2024). Nano fertilizers are an innovative method for delivering vital nutrients to crops while minimising adverse environmental effects (Sathyasri et al., 2025). In contrast to traditional fertilizers, nano fertilizers demonstrate reduced nutrient leaching and improved nutrient use efficiency (Singh, 2017). These fertilizers are encased in nanoparticles, enhancing nutrient absorption owing to their elevated surface area-to-volume ratio and enhanced reactivity (Tarafdar et al., 2012). Furthermore, nanoparticles can infiltrate plant cells more efficiently, enhancing enzymatic activity, facilitating polysaccharide release, and acting as effective catalysts in metabolic processes (El-Shawa et al., 2022). The utilisation of nano fertilizers has demonstrated an improvement in chlorophyll content, photosynthetic efficiency, overall plant development, and crop quality (Meena and Yadav, 2015). The regulated release mechanism of nano-sized particles guarantees a consistent supply of nutrients, fostering healthy growth and yielding fruits and vegetables with enhanced nutritional value and longer shelf life (Sravani et al., 2024). Nanocalcium foliar application improved fruit firmness, weight and yield of strawberries (Bakic et al., 2025). Additionally, Silicon nano particle spray mitigated salinity stress in carnation (El-Kinany et al., 2025). Despite considerable research that has been undertaken on the use of nano fertilizers in field crops, there is a limited of studies aimed at improving the nutrient management of *Asparagus densiflorus* cv. Sprengeri, despite its widespread application and economic importance, particularly through novel fertilization methods. Addressing this research gap is essential for formulating sustainable and effective fertilizing strategies that can enhance the commercial viability of cut foliage. This study aims to address this gap by assessing the effects of nano NPK 4:4:4 and nano urea on the qualitative traits of *Asparagus densiflorus* cv. Sprengeri offers significant insights for researchers and the floriculture market.

2. Materials and Methods

2.1. Experimental site and planting materials

The current study was carried out during september, 2022 to march, 2023 at Chidambaram, Cuddalore District, Tamil Nadu, India. The experimental site was situated at 11°40′ North latitude, 79°71′ East longitude, and an altitude of +5.79 m above mean sea level. Healthy three-month-old *Asparagus densiflorus* cv. Sprengeri, each around 10 cm tall, was purchased from Hosur, Tamil Nadu. Following a four-month growth period and division, the planting materials were moved into growing media in a 50% shade net condition.

The growing medium consisted of sand, red soil, farmyard manure, and coir pith in a 1:1:1:1 ratio, contained in black polyethene bags (8×8 inches) equipped with adequate drainage provisions. The plants were grown in a shaded net setting over the entire experimental period. Nano NPK 4:4:4, a protein-lacto-gluconate formulation enhanced with organic and chelated minerals, vitamins, probiotics, seaweed extracts, and humic acid, was procured from Tropical Agro System India Pvt. Ltd. Nano urea, purchased from IFFCO Bazar, was utilized as an additional fertilizer input.

2.2. *Treatments and experimental design*

The experiment used a completely randomized design (CRD) featuring three replications and twelve treatments. T_1: Nano NPK 4:4:4 soil drench at 1500 ppm. T_2: Nano NPK 4:4:4 at 3000 ppm. T_3: Nano NPK 4:4:4 at 4500 ppm. T_4: Nano urea foliar application at 0.05%. T5: Nano urea at 0.1%. T_6: Nano NPK 4:4:4 at 1500 ppm+nano urea at 0.05%. T_7: Nano NPK 4:4:4 at 3000 ppm+nano urea at 0.05%. T_8: Nano NPK 4:4:4 at 4500 ppm+nano urea at 0.05%. T_9: Nano NPK 4:4:4 at 1500 ppm+nano urea at 0.1%. T_{10}: Nano NPK 4:4:4 at 3000 ppm+nano urea at 0.1%. T_{11}: Nano NPK 4:4:4 at 4500 ppm+nano urea at 0.1%. T_{12}: Control (water spray). Nano NPK soil drenches were given in the 1st and 3rd weeks of each month, while nano urea foliar sprays were applied in the 2nd and 4th weeks using a hand sprayer.

2.3. Visual scoring index

A panel of four judges conducted a visual assessment of cut foliage at harvest, evaluating features such as colour, freshness, texture, shape, pattern, and size. The foliage quality was classified into five categories based on their evaluations: "Excellent" for scores from 9.1 to 10, "Very Good" for scores from 8.1 to 9.0, "Good" for scores from 6.1 to 8.0, "Acceptable" for scores from 5.1 to 6.0, and "Unacceptable" for ratings below 5.0. The final score was expressed in numbers.

2.4. Freshness index

The freshness index was evaluated using visual assessments conducted by a panel of ten judges, utilizing the scoring methods established by Ranjithkumar (2022). Leaves were classified into three categories: those exhibiting high freshness received a score of 7, those demonstrating medium freshness received a score of 6, and those with lower freshness received a score of 5. The number of leaves in each category was denoted as X_1, X_2, and X_3, respectively. The Freshness Index was then calculated using the formula and expressed in %.

$$\text{Freshness index (\%)}=[(7\times X_1)+(6\times X_2)+(5\times X_3)/(X_1+X_2+X_3)\times 7]\times 100$$

2.5. *Chlorophyll content*

The chlorophyll content was quantified with a portable Chlorophyll Content Meter (Model CCM–200 plus, Opti Sciences, USA). The mean values from three replications served as the Chlorophyll Content and expressed in mg m^{-2}.

2.6. Assessment of vase life

To assess vase life, ten asparagus cladophylls from each replication of all treatments were immersed in distilled water at ambient temperature. The time from the commencement of the experiment until the observable withering of cut foliage was recorded and the mean vase life was expressed in days.

2.7. *Statistical analysis*

The data collected were subjected to Duncan's Multiple Range Test (DMRT) with agricolae package in R studio at p=0.05 and the graphs were developed using GraphPad Prism version 9.2.0 for Windows, GraphPad Software, Boston, Massachusetts USA.

3. Results and Discussion

3.1. *Visual scoring*

Visual scoring was an essential metric that indicated the aesthetic quality and market potential of ornamental plants. A notable disparity in visual scoring was detected among treatments, with T_{11} attaining the highest score of 9.21, followed by T_8 with a score of 8.90. The control group (T_{12}) achieved the lowest score of 6.29 (Table 1). These results corresponded with those reported by Sowmiya and Karuppaiah (2021) in *Asparagus densiflorus* and Alhasan (2020) in *Ocimum basilicum*. The enhanced efficacy of Nano fertilizer applications was due to their capacity to increase nutrient availability, which facilitated chlorophyll production, photosynthesis, and dry matter accumulation, consequently augmenting total plant development and aesthetic quality (Mahmoodi et al., 2018).

3.2. *Freshness index*

The freshness index was a crucial metric for post-harvest longevity and aesthetic attractiveness, greatly affecting customer choice and marketability. The maximum freshness index (90.70) was noted in T_{11}, closely followed by T_8 (89.38), while the minimum value (78.60) was recorded in the control (T_{12}) (Table 1). The enhancement in freshness index due to nano fertilizer treatments might be attributed to increased nitrogen availability, which promoted cytokinin synthesis and transport to shoots, thereby preserving cellular turgidity and freshness (Chandra et al., 2015). These results reflected the findings of Mseer et al. (2020) in *Ficus carica* and Abdulkadhim and Mortada (2022) in pomegranate seedlings.

3.3. *Chlorophyll content*

Chlorophyll content acted as an indicator of photosynthetic efficiency, directly influencing plant vitality and quality. Treatment T_{11} demonstrated the maximum chlorophyll content (14.64), succeeded by T_8 (13.21), whereas the control (T_{12}) recorded the lowest value (2.20) (Table 1). The elevated chlorophyll concentration in nano fertilizer applications was likely owing to the improved penetration and nutrient absorption enabled by their size and extensive surface area, hence enhancing nutrient use efficiency (Kavitha et al., 2025). These results corresponded with those of Davarpanah et al. (2017) in *Punica granatum* and Merghany et al. (2019) in cucumber.

3.4. *Vase life*

The longevity of cut foliage was a crucial factor influencing its commercial value and consumer satisfaction. T_{11} had the longest vase life of 10.08 days, succeeded by T_8 at 9.13 days, whereas the control (T_{12}) demonstrated the shortest vase life of 3.68 days (Table 1). Comparable findings were reported by Deepa et al. (2022) in banana and by Ali (2021) in Chrysanthemum. The prolonged vase life noted in nano fertilizer applications might result from their capacity to augment the physiological activities of nitrogen, which aided in the creation of biomolecules such as porphyrins vital for respiration and photosynthesis. Furthermore, phosphorus facilitated enzyme activity, while potassium reinforced

Table 1. Effect of Nano fertilizers on quality of *Asparagus densiflorus* cv. Sprengeri at 210 Days after planting

Treatments	Visual score	Freshness index	Chlorophyll content	Vase life
T_1: Nano NPK 4:4:4 at 1500 ppm	6.85^{gh}	80.95^{cde}	4.65^{j}	4.58^{gh}
T_2: Nano NPK 4:4:4 at 3000 ppm	7.37^{efg}	82.95^{bcde}	6.60^{h}	5.51^{f}
T_3: Nano NPK 4:4:4 at 4500 ppm	7.60^{ef}	84.14^{abcde}	7.59^{g}	5.97^{f}
T_4: Nano urea at 0.05 %	6.58^{hi}	79.93^{de}	3.44^{k}	4.19^{h}
T_5: Nano urea at 0.1%	7.09^{fgh}	81.88^{bcde}	5.74^{i}	4.99^{g}
T_6: Nano NPK 4:4:4 at 1500 ppm+nano urea at 0.05 %	7.89^{de}	85.39^{abcd}	8.87^{f}	6.78^{e}
T_7: Nano NPK 4:4:4 at 3000 ppm+nano urea at 0.05 %	8.38^{bcd}	87.23^{abc}	10.95^{d}	7.98^{d}
T_8: Nano NPK 4:4:4 at 4500 ppm+nano urea at 0.05 %	8.90^{ab}	89.38^{a}	13.21^{b}	9.13^{b}
T_9: Nano NPK 4:4:4 at 1500 ppm+nano urea at 0.1%	8.15^{cd}	86.35^{abc}	9.98^{e}	7.55^{d}
T_{10}: Nano NPK 4:4:4 at 3000 ppm+nano urea at 0.1%	8.63^{bc}	88.24^{ab}	11.96^{c}	8.49^{c}
T_{11}: Nano NPK 4:4:4 at 4500 ppm+nano urea at 0.1%	9.21^{a}	90.24^{a}	14.64^{a}	10.08^{a}
T_{12}: control (water spray)	6.29^{i}	78.60^{e}	2.20^{l}	3.68^{i}
SEd±	0.08	0.37	0.35	0.12
CD (p=0.05)	0.18	0.79	0.75	0.29

enzymes and proteins, together enhanced longevity and quality (Srisha and Prasad, 2022).

4. Conclusion

Combining Nano NPK 4:4:4 soil drenches at 4500 ppm with Nano urea foliar spray at 0.1% increased visual scoring, freshness index, chlorophyll content, and vase life, demonstrating Nano fertilizers' improved nutrient delivery and physiological advantages. The findings had benefits through less nutrient leaching, economic viability by improving marketability and returns, and scalability for large-scale production in other horticultural crops. Future research must examine cost-benefit evaluations, and methods to help small-scale farmers adopt this practice to ensure its wider application.

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