



Research Article

Enhancing Growth and Productivity of Gloxinia Flower Through Nano-Particles

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Abstract | Gloxinias flowers having vibrant shades, colors and splendid inflorescence are most suitable for decorating the gardens. However, its growth has been prone to several environmental conditions. The current study was planned to evaluate the impact of silver nanoparticles (30 and 40 ppm) on growth and productivity of five different gloxinia cultivars i.e., Kaiser Wilhelm, Violacea, Blanche de Meru, Mont Blanc and Tigrina Red. The experiment was conducted following complete randomized design under controlled conditions. The results concluded that Blanche de Meru and Mont Blanc were best among cultivars and exhibited the ameliorated vegetative and reproductive parameters. The maximum no. of leaves, plant height and lateral branches were found in 40 ppm AgNO₃ application. Similarly, the best outcomes regarding reproductive parameters were observed from 40 ppm AgNO₃. Thus, the use of nanoparticles is suggested as a promising technique to create a healthier environment for optimizing growth and productivity of Gloxinia flower.

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Keywords | Gloxinia, Nanoparticles (NP's), Growth, AgNO₃, Productivity, Flower



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Introduction

Gloxinia (*Sinningia speciosa* L.) is the member of *Gesneriaceae* family can be found in the tropics, Europe and U.S. It is commonly used as an indoor decorative plant and grown commercially in pots (Sudthai and Sakhonwasee, 2022). Gloxinias flowers have vibrant shades, colors and splendid inflorescence and it's all species are known for establishing a prominent garden. However, it is still one of the most neglected flower crops. Gloxinias can be problematic

to grow and propagate. It can take weeks to show signs of growth and it often requires a period of dormancy during its natural life cycle (Kessler, 2004). Moreover, it requires high temperature (20-32°C) for optimum growth and high-quality flower production and is also highly susceptible to fungal diseases (Xiaoyan et al., 2013).

Nanotechnology offers innovative solutions to enhance the growth of slow-growing plants and improve the resilience of plants sensitive to environmental

conditions (Khalid *et al.*, 2019). Nanoparticles (NPs), which are small molecular aggregates with diameters ranging from 1 to 100 nanometers and surrounded by an interfacial layer, exhibit unique properties compared to bulk materials due to their small size (Khan *et al.*, 2019). The nano-particles is carried out by chemical, green, and physical processes (Akhtar *et al.*, 2022).

In agricultural, food, and medical, nanoparticles have led to significant outcomes (Alabdallah and Hasan, 2021). Moreover, these compounds are also environment friendly and pose no-risk to human health and agricultural biodiversity (Khalid *et al.*, 2022; Hashem *et al.*, 2021). These compounds possess positive effects on both growing media and growth and development of plants depending upon their origin, concentration, size and growth stage of crop (Rubilar *et al.*, 2013). In soil or growing media, these NPs are attracted toward negatively charged nutrients resulting in colloid formation, thus improving stability and availability of nutrients along with lowering sedimentation and aggregation (Khalid *et al.*, 2020). These NPs pose positive impact on seed germination (Anderson *et al.*, 2017), root growth (Zhou *et al.*, 2021), biomass development (Hidalgo *et al.*, 2023), cell morphology and nutrients transport in plants (Wang *et al.*, 2023). Their role in boosting plant growth and productivity by influencing various physiological, biochemical, and molecular processes also has been documented (Xiong *et al.*, 2021; Moazzami *et al.*, 2020; Sun *et al.*, 2021). Keeping in view, the potential of nano-particles, the current study was planned to investigate the impact of silver nitrate nano-particles (AgNPs) on growth and productivity of Gloxinia cultivars.

Materials and Methods

The research was conducted at Pir Mehr Ali Shah Arid Agriculture University (33° 40' N, 73° 10' E) Rawalpindi (PMAS UAAR). Healthy and disease-free bulbs of five different Gloxinia cultivars i.e., Kaiser Wilhelm, Violacea, Blanche de Meru, Mont Blanc and Tigrina Red were purchased from Green Impex (Islamabad, Pakistan). These bulbs were sown in a well-prepared growing media i.e., soil enriched with well-rotten farm yard (FYM) at depth of 1.5 inches in 14-inch earthen pots. Following sowing, pots were irrigated and kept under controlled conditions (25–30 °C, 14 hours photoperiod). In addition, all cultural practices like weeding, irrigation, and hoeing were

regularly applied to all the treatments.



Silver nano particles synthesis

Silver nanoparticles (AgNPs) were synthesized by chemical reduction of silver nitrate (AgNO_3) by tri-sodium citrate dehydrate ($\text{Na}_3\text{C}_6\text{H}_5\text{O}_7 \cdot 2\text{H}_2\text{O}$) in the Crop Physiology Lab Department of Agronomy, PMAS UAAR. The following equations illustrate the reduction of silver nitrate.

The silver nanoparticles (AgNPs) standard solution was synthesized by reducing 317 mg/L of AgNO_3 by 147 mg of $\text{Na}_3\text{C}_6\text{H}_5\text{O}_7 \cdot 2\text{H}_2\text{O}$ retaining stirring (6000–7000 rpm) at 70 °C on a magnetic stirrer. From this technique 100 ppm AgNPs stock solution was prepared. The stock solution was used to prepare two different concentrations, 30 ppm and 40 ppm. The resultant solution of different concentrations was mixed in 20 ml of distilled water and foliar application to three weeks old plants was done. The foliar application was done with handheld garden sprayer with each concentration separately sprayed on the plant to ensure thorough coverage of plants.

Morphological parameters

The data of different morphological and qualitative parameters i.e., days of flower emergence, plant height, no. of lateral branches, no. of flowers, no. of leaves, flower length and diameter, leaf area, fresh and dry weight of flower was recorded.

Statistical analysis

The experiment was laid out following Complete randomized design (CRD) under controlled conditions of glass house. The experiment was laid out following Complete randomized design (CRD) under controlled conditions of glass house. Moreover, the collected data was statistically analyzed using Statistix 8.1 and the mean values were compared at a 5 % level of significance (Steel *et al.*, 1997).

Results and Discussion

The statistical analysis of the data regarding number of leaves showed significant differences where cv., Kaiser Wilhelm showed maximum (19) number of leaves under 40 ppm NP's application. However, cv., Violacea recorded the minimum (8) number of leaves under controlled condition. The results conclude that

w.r.t varietal comparison, Kaiser Wilhelm, Violocia and Tigrina red performed better as compared to other cultivars. Results indicate that an increase in the concentration of silver nano particles has significant effect on increasing number of leaves in plants. It directly influences the plant's vigor and causes the plant to do more photosynthesis by using large number of leaves. In particular, the nano-particles are known to enhance the nutrient uptake i.e., N, P and K which in turn enhances the development at early growth stages (Guzman-B'aez *et al.*, 2021). Patidar *et al.* (2024) conducted an experiment on onion using zinc nano particles and conclude that NP's posed significant impact on plant growth and resulted in higher number of leaves. The highest plant height (23 cm) was recorded in cv., Blenche de meru followed by cv. Mont blanc (20 cm) under 40 ppm NP's application (Figure 1B). The nano-particles are known to induce positive impact on growth and yield of plants through their role in bio-chemical and enzymatic modulation of plants (Jyothi and Hebsur, 2017; Sharma *et al.*, 2012).

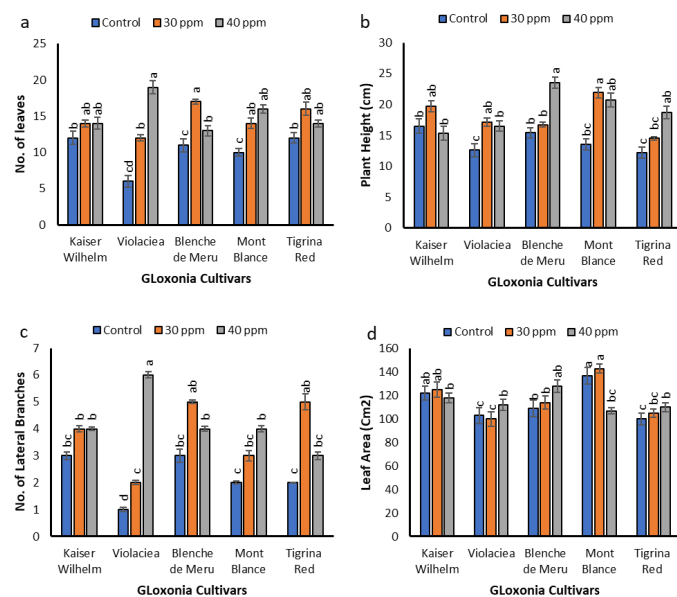


Figure 1: Effect of Nanoparticles application on different vegetative growth parameters of Gloxinia cultivars.

The outcomes regarding the number of lateral branches exhibited a profound impact on NP's application. Maximum 6 lateral branches were found in violocia under 40 ppm followed by Tigrina red having 5 lateral branches under 30 ppm NP's application (Figure 1C). However, minimum 2 lateral branches were recorded in control conditions. Our results are in agreement with findings of Laware and Raskar (2014) that silver nano particles in a range of 20 to 60 ppm led to enhanced development, growth and seed yield of

onion (*Allium cepa* L.). The foliarly applied NP's are absorbed through cuticle or stomata are transported to plants metabolism via the protoplast pathway (Chen *et al.*, 2010; Guha *et al.*, 2022). The nano-particles pass through plasmodesmata and are gathered in cytoplasm followed by transportation to root and other parts via plant vascular system-phloem pathways (Raliya *et al.*, 2018; Bussi eres, 2014). The leaf area is fundamental variable of plants that affects the structural canopy and have a crucial role in manipulating the plant growth and reproductivity. The leaf is the primary source for building the nutrients through several processes i.e., photosynthesis and Krebs cycles (Gilman *et al.*, 2024). The outcomes exhibited that Mont Blanc resulted in maximum leaf area (145.2 cm²) under 30ppm NP's application and Blenche de meru recorded the second highest leaf area (128 cm²) under 40 ppm NP's application. The improved leaf area is ascribed to the enhanced chlorophyll contents, hormones (IAA) and photosynthetic pigments i.e., chlorophyll a, chlorophyll b and carotenoids under NP's application (Sadak, 2019). The increment in leaf area could also be due to several morphological and physiological characters regulated by leaf water potential which is often enhanced by the use of silver nanoparticles (Rahman *et al.*, 2023).

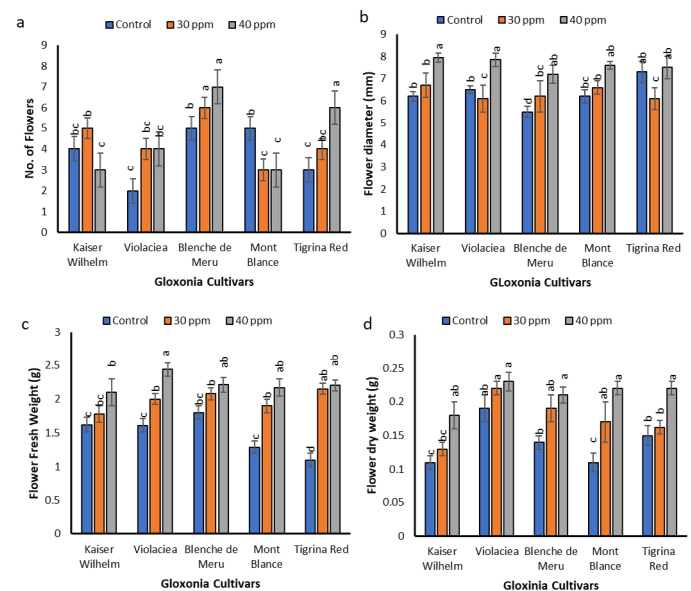


Figure 2: Effect of nanoparticles application on different reproductive growth parameters of Gloxinia cultivars.

The productivity of gloxinia cvs. has been substantially increased as a result of the NP's application. The outcomes exhibited that cultivar, Blenche de meru recorded the highest number of flowers. However, the outcomes were statistically at par among both NP's levels. The results of flower diameter also

exhibited the significant impact of NP's application (Figure 2A). However, cultivar Kaiser Wilhelm and Violocia were statistically at par with each other and recorded maximum flower diameter (7.9 cm) under 40ppm followed by Mont blanc exhibiting 7.6 cm, respectively. Kalayeh *et al.* (2011) reported that rose (*Rosa indica* L.) flower treated with hydroxyl quinolone sulphate and silver nano particles enhanced the flower diameter in rose along with induction of flower opening. Feizi *et al.* (2013) reported that applying silver nanoparticles significantly affected reproductive parameters of muskmelon (10). So, it is concluded that use of silver nano particles along with other preservative can cause positive effects on flowering, along with increment of flower vigor.

Similar results were recorded regarding flower fresh weight through NP's application (Figure 2C). The cultivar Violocia showed maximum fresh weight (2.41 g) under 40ppm followed by Blanche de meru yielding 2.15 g fresh weight under 40ppm respectively. However, cv. Tigrina red recorded minimum fresh weight (1.1 gm) under controlled conditions. The findings are in line with Feizi *et al.* (2013). The results regarding dry weight of flower also yielded the similar findings (Figure 2D). The cultivar Tigrina red showed maximum dry weight (0.24 g) followed by cv., Mont blanc (0.23 g) under 40 ppm NPs application. Nano particles prevent the plant from losing freshness so they can contribute to sustain the vase life of flowers. In the initial 10 days of treatment with nano particles on tuberose cut flowers, there was no significant difference, but flowers kept in controlled conditions dried early (Hutchinson *et al.*, 2003).

Conclusions and Recommendations

The current study concludes, that foliar application of Nano-particles i.e., AgNO₃ provides substantial improvement in growth and productivity of Gloxinia production. However, it is hereby recommended that using a commercial Nano-particles product should be dealt with care and low conc. Avoiding the symptoms of toxicity is the preferred choice.

Novelty Statement

This is the first research trial regarding the Nano-particles application on Gloxinia flowers.

Author's Contribution

Jalal Ahmed Khan and Ishfaq Ahmed Hafiz: Conceived and designed the experiment and collected the data.

Rashid Iqbal Khan and Ayesha Maryam: Analyzed data and wrote the paper.

Sher Muhammad: Critically reviewed and revised the article.

Conflict of interest

The authors have declared no conflict of interest.

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