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Influence of Zinc Nano-Particles and Bulb Size on the Growth and Flower Production of Tuberose

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Abstract

A Research was conducted on "Influence of Zinc nano-particles and bulb size on the growth and flower production of tuberose" at the Ornamental Horticulture Nursery, Department of Horticulture, The University of Agriculture Peshawar, during the year 2023. The Experiment was conducted in Randomized Complete Block Design (RCBD). The treatments were repeated three times in field. Factor A included the bulb sizes, which was 20 mm, 30 mm and 40 mm in diameter and Factor B had different concentrations of zinc nano-particles Zn (NPs), which were 0, 150 mgl^{-1} zinc sulphate, 50 mgl^{-1} Zn (NPs), 100 mgl^{-1} Zn (NPs), and 150 mgl^{-1} Zn (NPs). As per experimental findings, bulb sizes and Zn (NPs) concentration had significantly affected most of the attributes. Interaction between bulb size and Zn (NPs) was found significant for two parameters such as fresh florets weight and dry florets weight. The results of bulb sizes revealed that highest number of leaves $plant^{-1}$ (24.02), plant height (107.73 cm), leaf area (577 cm^2), chlorophyll content (64 SPAD), number of florets (35.1), highest florets fresh and dry weight (8.3 and 4.1g), vase life (8.8 days), bulb weight (39 g) and bulb size (36 mm) in tuberose plants having bulb size 40 mm. While maximum days to spike emergence (83.7), days to first florets opening (98.03) and days to last floret opening (101.47) with minimum number of leaves (18.8), plant height (97.20 cm), leaf area (467 cm^2), chlorophyll content (54 SPAD), number of florets (23.5), lowest florets fresh and dry weight (4.9 and 2.4 g), vase life (8.1 days), bulb weight (34 g) and bulb size (30 mm) were noted in tuberose plants having bulb size 20 mm. In case of Zn (NPs) concentration, the maximum number of leaves (26.4), plant height (114.89 cm), leaf area (554 cm^2), chlorophyll content (66.3 SPAD), number of florets (37.0), highest florets fresh and dry weight (8.6 and 4.4 g), vase life (11.5 days), bulb weight (51 g) and bulb size (42 mm) was recorded in tuberose plants treated with 150 mgl^{-1} of Zn NPs. On the other hand, minimum leaves (13.7), plant height (83.33 cm), leaf area (488 cm^2), chlorophyll content (57.6 SPAD), least number of florets (23.3), lowest florets fresh and dry weight (4.7 and 2.4 g), vase life (6.4 days), bulb weight (25 g) and bulb size (24 mm) were observed in plants treated with distilled water (control) plants. It is concluded that foliar application of Zn (NPs) at 150 mgl^{-1} proved optimum concentration for better growth and flower production with higher quality florets in tuberose. Among various bulb sizes, the plants of tuberose raised from 40 mm bulbs were superior for all the studied attributes as comparted

to plants grown from 20 and 30 mm bulbs.

Key words: Zinc nano-particals, Tuberose flowers, Flowers quality, Flower production, Bulb size.

Introduction

Polianthus tuberosa is the botanical name of tuberose. It is one of the ornamental herbaceous perennial flowering plant in the family Amaryllidaceae (Singh et al., 2004). Its origin is Mexico. Tuberose, a Mexican native, is commonly planted in India's plains and blooms profusely during the summer, filling the air with its aroma both in outdoor and indoor environment. The florets are utilized for making beautiful garlands, buttonholes and their spikes are good for bouquets. The long spike of blooms makes it a beautiful table centerpiece. The flowers stay fresh for several days and fill the air with their lovely, pleasant scent (Dugan, 2011).

Plantation time of tuberose is in plains is from Feb-March to April. It requires well drained soil, as its performance is not satisfactory in water logged condition. It can adapt to conditions with a moderate level of salt and alkalinity. Cultivated extensively in tropical and subtropical climates, tuberose is highly valued for its use in cut flower arrangements and the extraction of essential oils. The ideal growing medium for tuberose is sandy loam soil having a pH of 6.5 to 7.5 with proper drainage and sufficient aeration (Amarjeet et al., 1996).

Tuberose flowers of high quality are almost impossible to grow without proper care. Chemical fertilizers and composts are utilized to improve soil fertility. Tuberose bulbs can be planted at various times to get flowers at different times for market. Bulb size is also critical, as it has a direct impact on vegetative development and flowering performance (Humaid, et al., 2005). It is essential to know about the optimum bulb size for commercial production of flowers and bulbs in tuberose (Manimaran et al., 2017).

Zinc (Zn) influences the photosynthetic activity, nutrient metabolism and uptake, carbon hydroxylase activity, carbohydrate metabolism and tryptophan (Auxin precursor) synthesis, protein quality and enhanced resistance to oxidative stress. It also extends the vase life of flowers. Due to a Zn deficiency, leaf size is decreased and internodes are shortened (Broadley et al., 2012). Photosynthesis, enzyme activation, cell wall strengthening, hormone production, respiration and stomatal regulation all require the presence of Zn. Zn has a role in regulation of IAA, sugar translocation, cell division and membrane integrity. Zn deficiency negatively affects the photosynthetic rate, carbohydrate buildup and strength of cell membranes. Weak fertility status of the soil having poor availibity of Zn cause stunted growth (Subba et al., 2014).

Nanoparticles have physiochemical properties that are significant from other traditional fertilizer. This leads to increase sustainability and which is required for the optimization of agriculture production. The plant cell wall work as boarder that can avoid the entry of the peripheral supplies into the cells. However, NPs can easily enter plant cells through trichomes and stomata, since they are smaller than the pores of the cell wall. Zn nanoparticles are easily and efficiently prepared using the biosynthetic procedure (Shankar et al., 2010).

Materials and Methods

A field study on "Influence of zinc nano-particles and bulb size on the growth and production of tuberose" was performed during 2023. Experimental site was ornamental nursery, Department of Horticulture, The University of Agriculture, Peshawar. The study was performed in a Randomized complete block design. It was comprised of two factors i.e. Zn nanoparticles concentrations (0, 150mgl^{-1}ZnSo4, 50mgl^{-1}, 100mgl^{-1}) and bulb sizes. Bulbs diameter were also determined before sowing, large bulb 40g were having 40mm in diameter, medium 30g have 30mm in diameter while small bulb 20g were 20mm in size.

Soil analysis of research field ornamental horticulture field

Sand (%)	Silt (%)	Clay (%)	EC (dSm^{-1})	pH	Nitrogen	Phosphorus ($mg.kg^{-1}$)	Potassium ($mg.kg^{-1}$)
17.63	55.98	26.29	0.37	8.1	0.08%	4.30	119

The studied parameters included Number of leaves $plant^{-1}$, Chlorophyll content (SPAD), Leaf area (cm^2), Days to spike emergence, Days to first florets opening, Days to last florets opening, Number of Florets $spike^{-1}$, Plant height (cm), Florets fresh weight (g $spike^{-1}$), Florets dry weight (g $spike^{-1}$), Vase life (days) and Bulb weight (g).

Number of leaves $plant^{-1}$

Leaves data was collected from sample of five plants per treatment from each treatment and their means were calculated.

Chlorophyll content (SPAD)

Date were taken with SPAD meter (SPAD- 502) Minolta for all treatments and their average was noted.

Leaf area (cm^2)

Specific portions of leaves taken from plants, and their area recorded followed by its dry weight. At harvest, total leaves per plant were removed and dried (weight was noted).

Days to spike emergence

Data were collected from each treatment in every replication starting from bulb planting until spike emergence.

Days to first florets opening

Data were recorded from five plants in each treatment from date of plantation up to opening of 1^{st} floret for all treatments in each replication and means was determined.

Days to last florets opening

Data were taken on five plants from the date of sowing bulbs until the opening of last floret for all treatments and then average were calculated.

Number of Florets $spike^{-1}$

Five (5) plants were selected at random, and the number of florets per spike was noted from each treatment in each replication and then their means was noted.

Plant height (cm)

Plant height was recorded by measuring the tuberose from the base to the tip of spike with the help of a measuring tape in randomly selected five plants and their mean was calculated.

Vase life (days)

Tuberose spike were cut from five (5) plants, at early morning from field and were taken to the lab and were put in a vase holding water. Data were noted from date of placement of spike in vase up to it lost its market value.

Bulb weight (g)

Fresh bulbs were taken from five randomly chosen plants in each treatment, and they were cleaned and cleaned. Balance helped establish how much they weighed. then determined the new bulb's average weight.

Bulb size (mm)

The fresh bulbs harvested from the field randomly from five plants in each treatment and were washed, cleaned and size (diameter) of bulb was measure using Vernier caliper. Then their average bulb size was computed.

Statistical procedure

Statistical analyses were done for ANOVA through software (STATISTIX 8.1). Analysis of variance was applied to all the data. The separation of means for significant data was done on Least significant

difference (LSD) test 1 and 5% (Jan et al., 2009).

Results

Mean data regarding number of leaves plant^{-1}, plant height (cm), Leaf area (cm^2), and Chlorophyll content (SPAD) are shown in Table 1. Zn NPs has significant effect on number of leaves plant^{-1}, plant height (cm), Leaf area (cm^2), and Chlorophyll content (SPAD) as similarly bulb sizes also significantly affected all these parameters.

Maximum number of leaves plant^{-1} (26.4), plant height (114.89 cm), Leaf area (554cm^2), and Chlorophyll content (66.3 SPAD) observed in plants which are sprayed with Zn NPs at a concentration of 150 mgl^{-1} while the minimum number of leaves plant^{-1} (13.7), plant height (83.33 cm), Leaf area (488 cm^2), and Chlorophyll content (57.6 SPAD) were recorded in plants sprayed with distal water. In case of bulb sizes maximum number of leaves plant^{-1} (26.4), plant height (114.89 cm), Leaf area (554cm^2), and Chlorophyll content (66.3 SPAD) was recorded in plants having large bulb size in contrast, the minimum number of leaves plant^{-1} (18), plant height (97 cm), Leaf area (467cm^2), and Chlorophyll content (54 SPAD) were noted in plants having small bulb size.

Regarding mean data of days to spike emergence, first floret opening, days to last floret opening and number of florets spike^{-1} are shown in Table 2. Zn NPs has significant effect on days to spike emergence, first floret opening, days to last floret opening and number of florets spike^{-1} as similarly bulb sizes also significantly affected all these parameters.

Mean data shows that significantly highest days to spike emergence (78.1 days), first floret opening (89), and number of florets spike^{-1} (37.0) were noted in plants treated with Zn NPs with 150 mgl^{-1} and days to last floret opening (95.77) was noted in plants treated at the rate 100mgl^{-1}of Zn NPs. while least days to spike emergence (72.8 days), first floret opening (87), days to last floret opening (91.66) and number of florets spike^{-1} (23.3) was noted in plants.

Regarding mean data of vase life of tuberose flower, bulb weight (g), and bulb size (mm) are shown in Table 03. Zn NPs has significant effect on vase life of tuberose flower, bulb weight (g), and bulb size (mm) as similarly bulb sizes also significantly affected all these parameters.

According to mean data, vase life was increased with the application of Zn NPs extended vase life of tuberose (11.5 days), bulb weight (51g), and bulb size (42mm) were noted in plants treated with Zn NPs with 150 mgl^{-1}. However, minimum vase life (6.4 days), bulb weight (51g), and bulb size (42mm) was noted in plants treated distilled water.

Discussion

Zinc influenced leaves per plant. Foliar spray of Zn increased leaves in tuberose. The number of leaves plant height, leaf area and chlorophyll content is considered as an important developmental characteristic because it promotes photosynthesis, which in turn affects bloom development and quality (Pal et al., 2016). Ali, et al., (2015) also found that leaves were increased due to foliar application of micro-nutrients.Mir, et al., (2020) reported that zinc has a significant role in promoting auxin uptake when sprayed on plants.The results illustrated that plant height increased with the increase in bulb size. Ahmad et al., (2009) also agree with our findings, who noticed that larger bulbs of tuberose produced taller plants.Foliar application is a great way to quickly upscale the nutritional deficiencies in plants as they are readily absorbed from the leaf surface, and work immediately (Niu et al., 2020).Foliar spraying significantly increased the chlorophyll content of rose cultivar leaves due to Zn and other micro nutrients (Ahmad et al., 2010). Fahad et al., (2014) found similar findings, concluding that the application of micro nutrients, particularly Zn, improved the chlorophyll content of gladiolus. It is clear from the results that days to spike emergence were increased with increase in zinc concentration. It means that Zn resulted in delayed spike emergence. The results are in line with Fahad et al., (2014) who also reported delayed inflorescence in response to foliar application of Zn (Khan et al., 2007).It is evident from mean data that smaller bulbs took more days to 1st floret opening as compared larger bulb sized bulbs. Larger sized bulb contained more reserved food, produced

healthy plants with early 1st floret opening (Ahmad et al., 2009). Zn NPs, however had non-significant effect on days to 1st floret opening in tuberose. It might be genetic character of the variety and hence was not affected by Zn. Our results are in contrast to Kumar et al., (2022) noted that Zn statistically significant variation in flowering due to Zn.Plants planted from larger bulb size produced healthy plants and produced fewer days for florets to open than bulbs of a smaller size. The increase in flower results may be related to increased micronutrient levels in leaves, which helped plants in producing greater numbers of florets by helping in photosynthesis, Auxin breakdown, and protein synthesis. Number of florets spike^{-1} was significantly influenced by spray of Zinc (Chopde et al., 2015). Application of Zn resulted in an increase in leaf area and leaf chlorophyll content with enhance photosynthesis (Torabian et al., 2016) and hence resulted in an increase in fresh floret weight (Qasim et al., 2014). Similarly, larger bulb produced plants with more florets fresh weight that might be due to more stored food material in bulb having larger size.Vase life was increased by applying Zn nanoparticle treatment. The vase life of spike was more in plants which treated with Zn (NPs) as compared to control. Zn (NPs) is involved in the activation of plant hormones, some minerals, and anti-oxidants is reportedly responsible for of the cut flowers' longer vase life. Plant hormone prolonged the time to fading, prolonging the shelf life of cut flowers (Kumar et al., 2022). These findings suggest that Zn NPs had a positive effect on bulb weight, with higher concentrations and larger bulb sizes leading to increased bulb weights, while distilled water treatment and smaller bulb sizes resulted in lighter bulbs (Byczynska et al., 2023). Zinc had a notable effect on the yield of tuberose. This suggests that the use of zinc in the experiment resulted in increased production of tuberose bulbs, which is a positive outcome for bulb yield.The findings of our research are in line with the research conducted by Al-Dur et al., (2021).

Conclusion

On the basis of results, the following conclusions are made:

Interaction between zinc (NPs) and bulb size showed that application of Zinc (NPs) at @ 150mgl^{-1} on plants of 40 mm bulb size, significantly increased number of florets spike^{-1}. Tuberose plants sprayed with zinc nano-particles @150mgl^{-1} significantly enhanced number of leaves, plant height (cm), leaf area (cm^2), chlorophyll content (SPAD), days to spike emergence, number of florets per spike, vase life (days), bulb weight (g) and bulb size (mm). Bulb size 40 mm showed highest plant height, number of leaves, chlorophyll content (SPAD) and vase life.

Recommendation

- Foliar application of zinc nanoparticles @150 mgl^{-1} is recommended for the better flower production and extended vase life of tuberose.
- Bulb size of 40 mm is recommended for better flower production and vase life of tuberose.
- Foliar of Zinc nano-particles at concentrations higher than 150 mg l^{-1} could be evaluated for better flower production in tuberose.

Table No.01 Number of leafs, Plant height, Leaf area and Chlorophyll content of tuberose as affected by Zinc NPs concentrations and Bulb sizes

Bulb Sizes	No. of leafs	Plant Height (cm)	Leaf area (cm^2)	Chlorophyll Content (SPAD)
Small	18.8 B	97.20 B	467 C	54 B
Medium	19.2 B	97.47 B	525 B	63 A
Large	24.2 A	107.73 A	577 A	64 A
LSD	2.79	9.637	19.5	3.07
Zinc NPs (mgl^-)				
Control	13.7 D	83.33 D	488 C	57.6 B
$ZnSo_4$ (150)	19.2 C	96.78 C	532 B	58.9 B
50	21.0 BC	100.22 BC	501 C	58.9 B
100	23.3 B	108.78 AB	539 A	60.4 B
150	26.4 A	114.89 A	554 A	66.3 A
LSD	6.75	7.465	20.19	5.076
Interaction B×Z	NS	NS	NS	NS

Table no. 02 spike emergence, first floret opening, last floret opening and number of florets per spike is affected by Zinc NPs and Bulb sizes.

Bulb Sizes	Spike Emergence(days)	1st floret Opening(days)	last floret Opening(days)	Number of florets spike^{-1}
Small	83.7 A	98.03 A	101.47 A	23.5 C
Medium	77.2 B	90.40 B	94.20 B	32.2 B
Large	66.4 C	80.53 C	84.80 C	35.1 A
LSD	3.29	5.07	5.0	2.29
Zinc NPs(mgl^{-1})				
Control	72.8 C	87	91.66	23.3 E
$ZnSo_4$ (150)	74.7 BC	89	92.33	26.8 D
50	74.8 BC	91	95.00	30.2 C
100	77.4 AB	92	95.77	33.5 B
150	78.1 A	89	92.66	37.0 A
LSD	4.24	NS	NS	2.90
Interaction B×Z	NS	NS	NS	NS

Table no. 03 Vase life, Bulb weight and Bulb size is affected by Zinc NPs concentration and Bulb sizes.

Bulb Sizes	Vase life (days)	Bulb weight(g)	Bulb size(mm)
Small	8.1	34 C	30 B
Medium	8.5	36 B	33 B
Large	8.8	39 A	36 A
LSD	NS	1.41	3.29
Zinc NPs(mgl^{-1})			
Control	6.4 C	25 E	24 D
$ZnSo_4$ (150)	7.1 BC	28 D	30 C
50	8.3 BC	36 C	32 C
100	9.16 B	43 B	38 B
150	11.5 A	51 A	42 A
LSD	2.01	1.82	2.93
Interaction B×Z	NS	NS	NS

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