Research Article

Influence of Various Concentrations of Gibberellic Acid and Micronutrients for Enhancing Growth and Flowering of Tuberose (*Polyanthas Tuberosa*)

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Abstract | Tuberose (*Polyanthas tuberosa)*, is an important ornamental and perfumery plant. The research was conducted at University of Swabi during summer 2018 to evaluate the performance of tuberose under various concentrations of gibberellic acid and micronutrients. Experiment was laid in Randomized Complete Block Design (RCBD) using two factors i.e. gibberellic acid and micronutrients with three replications. Both the factors gibberellic acid (GA_3) and micro nutrients had their significant effects. The best performance was found in the interaction of GA3 and micronutrients for plant height (53,21cm), number of leaves (16.34), length of spike (77.68cm), diameter of spike (7.51cm), floret number (25.27) and length of rachis (16.1cm) at 150 ppm gibberellic acid and 3000 ppm micro nutrients and hence recommended for increasing growth and flowers in tuberose.

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Introduction

Tuberose (*Polyanthas tuberosa*) belongs to the family Amaryllideceae and originated from Mexico. It is commonly grown in areas near equator /hot and humid subtropical part of the world. It is repeating its life cycle (every year) in nature and grown as cut flower (Feng et al., 2000).

Tuberose has a wide history in the world of perfumery and has been cultivated in the south of France for many years (Anonymous, 2007). Tuberose is very important commercial flower. It is successfully grown as potted plants, in borders or beds and mass plantation for floriculture market. Their white colored floret has very large demand in the markets (Dahiya et al., 2001). The flower is used for its sweet fragrance and its monumental oil plays a vital role in perfume industry.

It is one of the paramount fashionable and mass-market important swollen and bulb like flowers and got a key role in national and global market. Tuberose produces flowers which can be used for many purposes such as cut flower, loose flower and for its nice smelling value. It is red-hot among the farmers due to higher economic return, nice and sweet smell, longer shelf life and adoptability to wide range of climatic conditions and soil types (Tiwari et al., 2002).

The best climatic conditions for Tuberose include open sunny place in tropical and subtropical regions

having 20 to 30 C° temperature. It is vulnerable to cold conditions and frequent frost can damage the whole plant or its florets. Tuberose is grown on many types of soils such as light sandy loam to a clay loam and 6.5 to 7.5 pH. However, appropriate aeration and drainage are indispensable for higher production. It is highly susceptible to standing water so water logging conditions should be avoided during the growing stage (Sharga et al., 1994). In addition to the common propagation practice of bulbs, bulblets and seeds, it can be multiplied by bulb-segments and tissue culture. But Reproduction through bulbs is the main source of asexual means of propagation (Mahanta et al., 1999). Instead of fresh bulbs planting, bulb is treated to break its dormancy to get a good deal of flowers. Keeping proper depth during planting of bulbs is very important for saleable cut flowers (Hagiladi et al., 1992). The best planting distance of corm is 2.5-3.5cm while recommended depth is 6.0cm (Hussain, 1999). Ethylene and vascular tissues blockage are the major constraints in maintaining higher vase life. Citric acid and cobalt chloride are used as germicides for enhancing postharvest life of tuberose (Damunpula et al., 2006).

Gibberellic acid is a hormone present in plants and is produced in the plastids of plants cells. When purified, it is a white to pale-yellow solid. By nature, they are acid which are known to be the growth promoter. They are non-soluble in water and soluble in ethanol. Gibberellins need in very minute (ppm) quantity. Since gibberellins increase cell division and elongation, therefore, it also plays important role in increasing plant height and leaves numbers and length (Tyagi et al., 2006). It controls various aspects of plant development and are known to be involved in all phases of the developmental cycle of angiosperms. These growth regulators were discovered because of the dramatic effect they exert on stem growth via effects on cell elongation (Russell et al., 2008). Gibberellins affect photosynthesis and sink formation, thus changing source and sink metabolism. Therefore, they are responsible for improving biological responses (Iqbal et al., 2011). Fertilization through spray techniques are getting more popularity in floriculture industry of the world particularly under the growing conditions where nutrients absorption from soil is limited (Verma et al., 2000).

Nutrients are necessary for the (usual/commonly and regular/ healthy) growth and development of plants and these nutrients have major role in metabolism, growth and involved in enzymatic processes, which in turn helps in increasing the biomass and yield. The elements required in small quantity are termed as micro-nutrients, however, we cannot ignore their role in plants growth, yield and quality but also essential just like major nutrients. In addition to above functions, they help in uptake of major elements as well (Saravaiya et al., 2014). Micronutrients had profound effect in plants height (Wahba et al., 2002). Foliar application of micronutrients on tomato also had significant effect on various agronomic parameters such as plant height, number of branches per plant, fresh and dry yield of plants, days taken to harvesting, fruits produced in a plant, fruit length and diameter, volume and quantity (Saravaiya et al., 2014).

Interaction of Boron with other micro elements and controlling some physiological actions in plants is unique as compared to Zn, Cu Fe, Mn and Mo (Mishra et al., 2002). B and Zn and their combination had extreme effect on flower characters and flower yield of Tuberose (Halder et al., 2007). Studies had revealed that there is beneficial effect of $FeSO_4$ and $ZnSO_4$ on marigold with maximum growth, flowering, yield and quality parameters such as height of plant, its spread, branches and flowers per plant and flowering timing and leaf chlorophyll content (Balakrishnan et al., 2007). It is detected that micronutrients play important role in the yield improvement (Rehm et al., 2006).

Micronutrients help in chlorophyll creation and construction of objects, nucleic acid, protein combination and play an active role in more than two enzymatic activities of food synthesis from light and respiration (Reddy et al., 2004).

Keeping in view the importance of GA_3 and micronutrients, the present experiment was designed to evaluate the role of GA_3 and micronutrients in enhancing flower quality of tuberose.

Materials and Methods

The pot experiment entitled "Influence of various concentrations of gibberellic acid and micronutrient for enhancing growth and flowering of tuberose" was conducted at University of Swabi, in the year 2018. The experiment was laid out in Randomized Complete Block Design (RCBD) with 13 treatment combinations, replicated thrice. Nine plants were

treated with each treatment and hence total of 128 plants were used.

Preparation of GA_3 solution

Gibberellic acid is insoluble in water but soluble in organic substances. So, to make it soluble in water first we dissolve it in ethanol. 50 ppm, 100 ppm, 150 ppm and 200 ppm of GA_3 solutions were prepared by dissolving 0.050gm, 0.10gm, 0.150gm and 0.20gm GA_3 and dissolved in few drops of ethyl alcohol separately and then labeled it. Each solution was diluted with distilled water to make volume up to 1000ml.

Then the stock solutions were prepared for micronutrients of 1000 ppm micronutrients, 2000 ppm micronutrients, 3000 ppm and 4000 ppm micronutrients. Then plant media were prepared with combination of silt, clay and farmyard manure with the ratio of 1:1:1. Then the pots were filled with proper procedure and exposed to sunlight for sterilization. After two days, plants were planted in pots at early morning and irrigated immediately after transplantation. Foliar application of each treatment was done separately. The spray had done twice throughout the entire period of experiment. Uniform management practices like weeding, cleaning, fertilizer application and irrigation were applied to all treatments during the entire period of experiment. Data on various parameters were taken from selected plants during different phases of growth. The data were collected by adopting standard procedure during the conduct of experiments.

The following treatment's combinations were used: T_1= Control; T_2= 50 ppm gibberellic acid; T_3= 100 ppm gibberellic acid; T_4= 150 ppm gibberellic acid; T_5=200 ppm gibberellic acid; T_6=1000 ppm micronutrients; T_7=2000 ppm micronutrients; T_8=3000 ppm micronutrients; T_8= 4000 ppm micronutrients; T_{10}= 50 ppm GA_3 and 1000 ppm micronutrients; T_{11}= 100 ppm GA_3 and 2000 ppm micronutrients; T_{12} = 150 ppm GA_3 and3000 ppm micronutrients; T_{13} = 200 ppm GA_3 and 4000 ppm micronutrients.

The data were recorded on the following guideline.

Plant height: Data on this parameter was taken by measuring tape. The length from bottom to the top of plant is considered plant height which was taken in all treatments and replications.

Number of leaves: The leaves produced in a plot were counted in each replication at the end of season and the average was calculated accordingly.

Spike diameter: Spike diameter was recorded of each tuberose plant at lower site, middle and at the upper site through digital vernier caliper and then average was calculated.

Number of florets: Florets number were counted and recorded in all plants of each treatment at the end of tuberose season and mean were tabulated.

Spike length: The length of the spike was measured in centimeter of each plant in replication through measuring tape and then average was taken.

Riches length: A riches length was measured in the treatments through measuring tape and average was taken at the end of experiment.

Results and Discussion

Plant height (cm)

According to Figure 1 where the data pertaining to plant height is given, GA_3 and micronutrients had significant effect on plant height of tuberose. Treatments having 150 ppm gibberellin and 3000 ppm micronutrients produced the tallest plants (53.21cm) followed by plants (52.07 cm) with 150 ppm GA_3 alone while the least plant height (39.1cm) was observed in control plants.

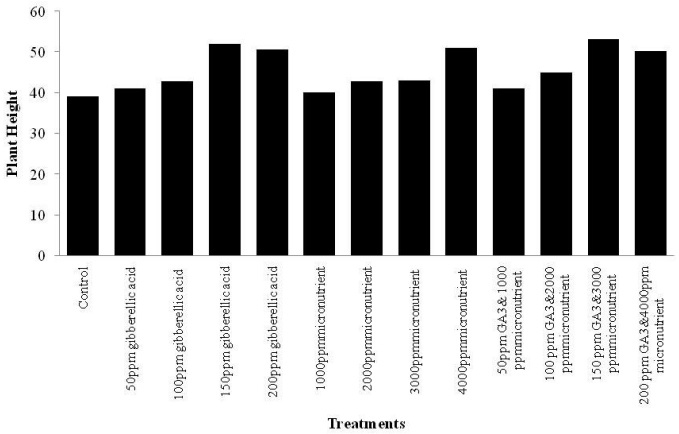

Figure 1: *Influence of GA3 and micronutrients on plant height (cm) of tuberose*

There is direct correlation of plant height with GA_3 and micronutrients. These results are matching with the data obtained by Abdallah *et al.* (2013), who also reported the tallest plants with higher dose of GA_3 and micronutrients. Plant height was increased at the

application of growth promoters and micro nutrients which might be due to enhancement of cell in terms of division and elongation occurring at shoot tips and this effect was due to increase in photosynthetic efficiency, improvement in mobilization of photosynthates, rapid increase in reducing sugars which leads to change in membrane permeability (Shukla et al., 1997).

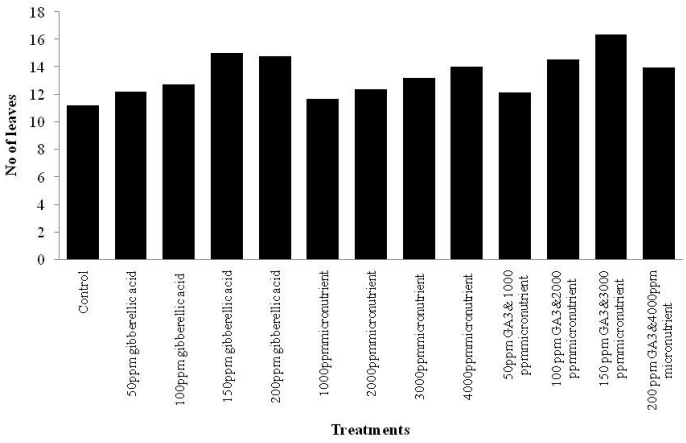

Figure 2: *Influence of GA3 and micronutrients on number of leaves of tuberose.*

Number of leaves

Table 1 indicates that maximum number of leaves (16.34) was observed in plants treated with 150 ppm gibberellic acid and 3000 ppm micronutrients, followed by plants (15.01) with 150 ppm GA_3 while the least plant height (11.22) was observed in control plants (Figure 2). GA_3 and phosphorus plays important role in plant leaves development and plants treated with GA_3 and phosphorus produce highest leaves. Gibberellic acid and micronutrients have a positive effect on vegetative growth as it has a great role in promoting cambial activity, cell elongation as well as activating RNA and protein synthesis (Naggar et al., 2009; Kashif et al. 2014).

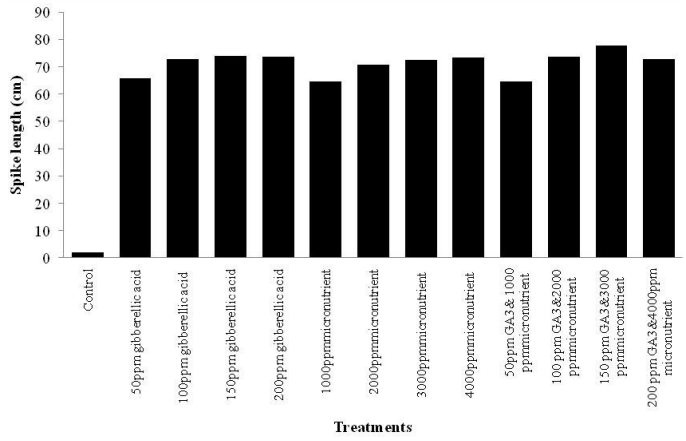

Figure 3: *Influence of GA3 and micronutrients on spike length (cm) of tuberose.*

Spike length

Data pertaining to spike length revealed that significant differences were found among GA_3 levels and micronutrients in combination or solely on spike length of tuberose. Maximum plant height (77.8 cm) was observed in plants, treated with 150 ppm gibberellins and 3000 ppm micronutrients followed by plants (52.07 cm) with 150 ppm GA_3 while the least plant height (39.1 cm) was observed in control plants (Table 1 and Figure 3). Ganesh et al. (2013) also observed the longest spike length in tuberose plants treated with GA_3 and micronutrients. The increase in spike length might be due to GA_3 which is responsible for cell division, cell enlargement and vegetative growth, in turn increased the photosynthetic and metabolic activities in plants which results into transport and utilization of photosynthetic products (Maurya and Nagda, 2002).

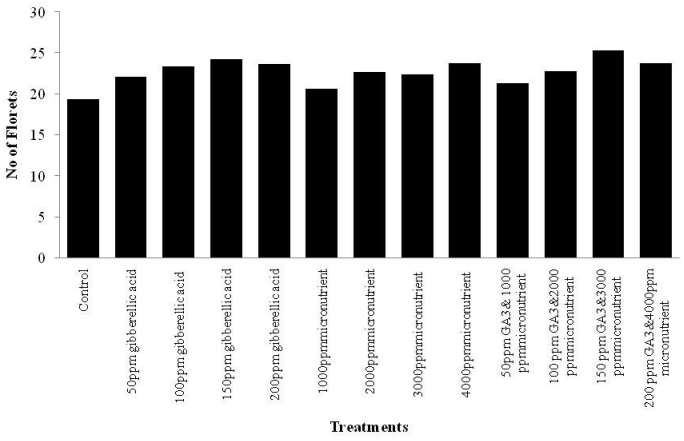

Figure 4: *Influence of gibberellic acid and micronutrients on number of florets of tuberose.*

Spike diameter

Analysis of variance regarding spike diameter of tuberose in Table 1 clearly indicated that the highest diameter was recorded in plants (7.51 cm) treated with 150 ppm GA_3 and 3000 ppm micronutrients followed by plants received 200 ppm GA_3 while the minimum spike diameter was recorded in control plot (Figure 4). These results are in conformity with Ganesh et al. (2013). Since GA_3 is increasing the efficiency of plants in terms of photosynthetic activity, enhancing nutrients uptake, nutrients translocation and improving its mobilization, thus GA_3 might be increased the spike.

Number of florets

Data pertaining to number of florets in a spike (Figure 5) show that there is significant difference among treatments. The highest number of florets (25.27) were rcorded in treatment T_{12} (gibbrelin+micronutrients

Table 1: *Influence of GA_3 and micronutrients concentrations on various parameters of tuberose (Polyanthas tuberosa).*

Treatment No.	Treatment	Plant Hieght (cm)	Number of leaves	Spike length (cm)	Spike Diameter (mm)	number of florets	Rachis length (cm)
T1	control	39.1h	11.22g	63.93f	4.8i	19.3h	12.82bc
T2	50 ppm GA_3	41.1f	12.17ef	65.72e	5.56g	22.13ef	13.4b
T3	100 ppm GA_3	42.8e	12.74de	72.7c	5.94f	23.32bd	13.12bc
T4	150 ppm GA_3	52.07b	15.01b	74.03b	7.23b	24.19b	15.97a
T5	200 ppm GA_3	50.62c	14.77b	73.57bc	6.8d	23.62bc	13.17bc
T6	1000ppm Micronutrients	40.05g	11.65fg	64.47f	4.87i	20.62g	13.09bc
T7	2000ppm Micronutrients	42.86e	12.35e	70.59d	5.65g	22.63de	12.67bc
T8	3000ppm Micronutrients	42.9e	13.22d	72.47c	6.18e	22.4de	15.45a
T9	4000ppm Micronutrients	50.93c	13.99c	73.47bc	6.9cd	23.74b	13.37b
T10	50/1000ppm GA and Micronutrints	41.12f	12.16ef	64.5bc	5.16h	21.28fg	12.33c
T11	100/2000ppm GA and Micronutrints	45.3d	14.52bc	75.53a	7.033c	22.75cde	13.24bc
T12	150/3000ppm GA and Micronutrints	53.21a	16.34a	77.68c	7.51a	25.273a	16.1bc
T13	200/4000ppm GA and Micronutrints	50.24c	13.96c	72.73a	6.2e	23.74b	13.11a

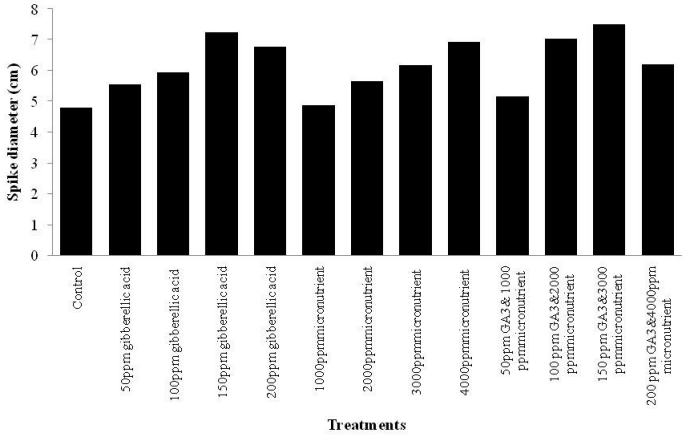

Figure 5: *Influence of gibberellic acid and micronutrients on spike diameter (cm) of tuberose.*

levels of 150 ppm+3000 ppm respectively) while the minimum number of florets (19.3) were observed in treatment T_1. The floret number is an important parameter regarding production of tuberose plant. The better flowers production in terms of large number of florets might be due to the proper combination of gibberellic acid and micronutrients. Thus, the accelerated growth leading to increased plant height, higher leaves, better spike diameter and length was found in Treatment T_{12} which led to increased florets produced in a spike as compared to all other treatments. Naggar et al. (2009) also collected matching data in Carnation and Sindhu and Verma (1997) in gladiolus.

Rachis length

Analysis of variance regarding rachis length of Tuberose depicted significant differences among treatments as given in Figure 6 and analysis of variation is shown in Table 1. The maximum rachis length (16.1 cm) were observed in treatment T_{12} while the minimun rachis length (12.8 cm) were observed in treatment T_1. The rachis length was signifacantly affected by gebberellic acid and micronutrients alone or in combination. The same results were revealed by Sultana et al. (2016) who found significant effect of GA_3 on rachis length. GA_3 has a key role in vegetative growth and in improving photosynthetic and metabolic activities of plants. Thus, taller plants were produced that lead to taller spike and rachis as well due to GA_3 and micronutrients which stimulated the conversion of storage polymers into sucrose or mobile amino acids to facilitate their translocation via vascular bundles to various parts such as root and shoot system and dry matter accumulation thus influencing higher Rachis length.

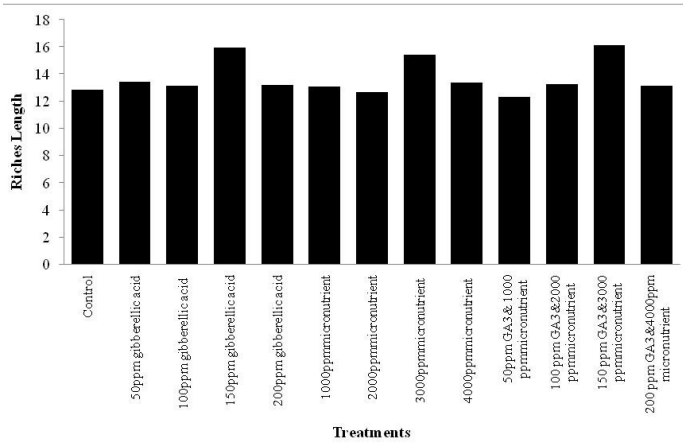

Figure 6: *Influence of GA3 and micronutrients on Rachis length of tuberose*

Conclusions and Recommendations

From the present experiment, it can be concluded that tuberose showed best response in terms of growth attributes and flowering quality to gibberellic acid and micronutrients. Gibberellic acid @ 150 ppm (GA3) in combination of 3000 ppm of micronutrients had better result regarding number of leaves, spike length and diameter, floret numbers and rachis length of tuberose (*Polyanthas tuberosa)*.

Author's Contribution

Hamid Ali conducted the research and data taken, Muhammad Arshad contributed in data recording, Ibad Ullah Jan was supervisor, Muhammad Zamin did data analysis and paper preparation and Junaid Khan, Ikram Ullah and Mushtaq Ali contributed in data recording.

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