IMPACT OF GIBBERELLIC ACID PRETREATMENT ON GROWTH AND FLOWERING OF TUBEROSE (*Polianthes tuberosa* L.) CV. PRAJWAL

Rani P. and Singh N.
Department of Botany, Kurukshetra University,
Kurukshetra, Haryana, India-136119
Tel: +919416412622; Fax: +911744238277; E-mail:nsheorankukbot11@gmail.com

ABSTRACT

An attempt has been made to study the influence of GA_3-pretreated bulbs on growth, flowering and quality of *Polianthes tuberosa* L. cv. Prajwal, laid on randomized block design in an open field condition. For this purpose, bulbs were dipped in three different concentrations of gibberellic acid (GA_3) (0, 50, 100 and 150 ppm), each with 10 replicates. Results indicated that the pretreatment had significantly improved various growth and flowering parameters. Maximum vegetative growth in terms of plant height, number of leaves, leaf length and leaf width was observed in 150 ppm GA_3. In addition, the results also showed that the pretreated bulbs at a higher concentration of GA_3 had significantly increased spike length, rachis length, number of florets per spike and floret length. Early appearance of initial spike, maximum number of bulbs and maximum durability of spike were also recorded with GA_3 150 ppm. GA_3 pretreatment also increased chlorophyll content of leaves. Therefore, it was concluded that GA_3 at 150 ppm proved to be best concentration in enhancing all the vegetative (plant height, number of leaves and sprouting of bulbs), floral (spike length, number of florets/ spikes, floret length) and bulbous characteristics in tuberose.

KEY WORDS- *Polianthes* sp., leaf width, GA_3, chlorophyll, spike length.

INTRODUCTION

Tuberose (*Polianthes tuberosa* L.), a member of Agavaceae family, native of Mexico, is a perennial bulbous ornamental plant, grown in many tropical and subtropical parts of world for its elegant waxy white cut spikes and beautiful display in vase. In India, it is mainly grown in Karnataka, Andhra Pradesh, Gujarat, Uttar Pradesh and Haryana. Besides its popularity as ornamental garden plant, tuberose inflorescence have diverse uses as natural flower, its oil is one of the expensive raw materials in perfumery industry due to its delightful fragrance. Its spikes are used as cut flower, for decorating tables, floral ornaments, bouquet and garland (Singh and Srivastava 2009). Fragrance of tuberose also has some health remedies for insomnia, influenza and rheumatism.

Apart from its multifarious uses, due to increased demand of tuberose in domestic and international market as cut and loose flower and with shortage of supply at present, blooms of tuberose are becoming attractive for growers as well as sellers. Therefore, keeping this in view, production technologies should be improved at

commercial scale which may be acquired by in vitro establishment, addition of optimum dose of nutrients or by better agro-techniques for producing better quality and extended vase life of tuberose. With the expectation to all above, use of plant growth regulator for producing better quality crop is gaining much more importance which is highly beneficial not only for the producers and sellers but also for the consumers.

The application of gibberellins has brought a sort of revolution for the floriculture industry. Gibberellins are the plant growth regulators that are known to stimulate physiological responses in plants and alter the source-sink metabolism through their effect on photosynthesis and sink formation (Iqbal et al. 2011). Studies have indicated that GA signalling is involved in maintaining source-sink relation, phloem loading with sucrose, long distance transport of sucrose by phloem cells of plant's vascular system and metabolism in sink organs by unloading of sucrose from phloem to sink organs or tissues influencing overall performance or growth of plants. Gibberellic acid treatments are known to play important role in promoting diverse processes throughout the development of plant; induced early flowering, increased length or height of plant, number of leaves, chlorophyll content, yield and quality in different flowering crops (Kumar et al. 2003; Tyagi and Singh 2006; Janowska and Andrzejak 2010; Emami et al. 2011 and Sure et al. 2012). Therefore, the present investigation was conducted to ascertain the influence of GA_3 pretreated bulb on growth, flowering and longevity of tuberose under open field conditions.

MATERIALS AND METHODS

Experiment was conducted at Botanical Garden, Kurukshetra University, Kurukshetra based on a randomized block design in open field conditions under prevailing conditions of about 35-42 ^{0}C temperature and 41% relative humidity. Healthy bulbs of tuberose cv. Prajwal having a diameter of about 3 cm were used for propagation. Bulbs were procured from the Indian Agricultural Research Institute, New Delhi. The propagation was done on raised bed in April, 2011. Gibberellin treatments were comprised of bulb dipping at three different GA_3 concentrations viz. 0, 50, 100 and 150 ppm was conducted for 24 hours before sowing. Standard package and practices were followed for raising the crop under field conditions. After treatment, solution was drained. All the bulbs were taken out and grown at a distance of 20-25 cm apart in the field. Plants were irrigated at regular intervals. Various growth attributes viz., plant height, number of leaves, leaf length, leaf diameter and floral attributes viz., the spike length, rachis length, number of days taken for spike emergence, number of florets per spike etc. were recorded. Chlorophyll content of leaves (chl a, chl b and total chlorophyll) was estimated by Arnon's method (1949).

STATISTICAL ANALYSIS

Each treatment consisted of 10 replicates. Data were analyzed using one-way analysis of variance (ANOVA) and a Duncan's multiple range test (DMRT) at $P \leq 0.05$. All statistical analysis was performed using the SPSS (version 20.0).

RESULTS AND DISCUSSION

Growth parameters

The results revealed that GA_3-treated bulb significantly influenced all the growth attributes. In general, pretreated bulbs showed significant increase in all the growth parameters as compared to control. Significant maximum plant height (71.27±1.33) was observed with GA_3-treated bulb at 150 ppm (Table 1). The plant height decreased with the reduction in concentration of GA_3. Similarly, treatment of GA_3 at 150 ppm gave the highest number of leaves (59.6±2.88) and control plants were observed to have the lowest number of leaves /plant (47.1±2.51). The leaf length also showed a significant increase with the application of GA_3 at increasing concentration as compared to control (59.96±1.55) plants.

An application of GA_3 enhanced plant height, number of leaves and leaf length due to increase in level of auxin causing increased cell division and cell elongation (Taiz and Zieger 1998). The mechanism involves the hydrolysis of starch resulting from the production of GA_3 induced α-amylase which might increase the concentration of sugars, thereby raising the osmotic pressure of the cell sap. As a result of which, water enters into the cell and tends to stretch cell wall (Macleod and Millar 1962), consequently contributes to cell elongation and promotes growth. Earlier studies have also reported maximum plant growth with respect to plant height, number of leaves and leaf length with GA_3 (Tyagi and Kumar 2006), Sharifuzzaman et al. (2011) in *Chrysanthemum* and in gladiolus (Chopde et al. 2012). Singh and Shanker (2011) also found the best result at the highest concentration of 300 ppm GA_3 in case of tuberose. The influence of GA_3-treated bulb was also found to be significant on width of leaves amongst all the concentrations. Table 1 clearly showed enhancement in width of leaves with application of GA_3 at 150 ppm whereas the lowest width of leaves was found in control plants. Girisha et al. (2012) also observed significant increase in width of leaf when sprayed with GA_3 at 150 ppm among all the growth regulators (GA_3, IBA and NAA) in *Aster amellus* L. cv. Dwarf pink. Favorable effect of GA_3 might be due to the fact that it improves the sink strength of actively growing plant parts like immature leaves which are the metabolic sinks to support growth and development of the plant throughout the life cycle. Data pertaining to sprouting of bulbs revealed that application of GA_3 at 150 ppm took minimum days among all the concentrations and control plant took maximum days for sprouting. Kumar and Singh (2005) also found lower number of days taken for germination of corm in gladiolus at 150 ppm GA_3. The highest concentration of GA_3 resulted in early sprouting of corms in case of *Gladilous* × *grandiflorus* L. also (Kumar et al. 2009).

This might be due to rapid rate of hydrolysis of stored starch by higher activity of α-amylase and decrease in level of abscisic acid formed during dormant state which makes the bulbs unable to germinate.

Table 1. Influence of GA_3-treated bulbs on growth parameters of tuberose cv. Prajwal

Pretreated GA_3 (ppm)	Plant height (cm)	No. of leaves /plant	Leaf length (cm)	Leaf Width (cm)	Sprouting of bulbs (days)
T_0	56.14±0.75^d	47.1±2.51^d	59.96±1.55^c	1.46±0.084^c	27.8±1.22^d
T_1	61.68±1.34^c	51.2±1.55^c	60.75±1.66^c	1.59±0.087^b	25.4±0.87^c
T_2	65.18±1.67^b	54.6±2.72^b	63.99±0.7^b	1.82±0.209^a	24.1±0.96^b
T_3	71.27±1.33^a	59.6±2.88^a	65.85±0.78^a	1.82±0.105^a	22.2±1.32^a
L.S.D(P≤0.05)	1.1911	2.2386	1.1411	0.12	1.0084
ANOVA($F_{8,3}$)	230.423	46.023	48.185	21.352	44.730

T_0- GA_3 0ppm; T_1- GA_3 50ppm; T_2- $GA_3$100ppm; T_3- GA_3 150 ppm

Values represent means ±Standard deviation, n=10
Means were compared by using the least significant difference (LSD) test at ($P \leq 0.05$) followed by Duncan's multiple range tests. Different letters mark significant difference at $P \leq 0.05$

Flowering characters

Table 2 clearly indicated that all concentrations of GA_3 under study succeeded in respect of first spike appearance, length of spike, length of rachis, number of florets/spike and floret diameter as compared to control. When comparing early appearance of initial spike, it was found that GA_3-treated bulb at 150 ppm caused early appearance of spike (69.5±1.43) whereas control plant took maximum days for spike emergence (83.1±2.02) which might be due to early flower primordial development, cell differentiation and early utilization of nutrients. GA_3 at higher concentration might have reduced the vegetative period, resulting in induction of early flower development. Likewise, GA_3 treatments at the highest concentration significantly shortened the time taken from planting to flowering in *Iris* sp. (Taha 2012) and *Polianthes tuberosa* L. (Panwar et al. 2005; Asil et al. 2011). Spike

length (114.18±1.44) increased with application of GA_3 and maximum was found in 150 ppm treated plants. Similar variations have also been found previously by Tyagi and Singh 2006 in tuberose; Mayoli et al. 2009 in *Ranunculus* sp. and Dogra et al. 2012 in gladiolus at the highest concentration of GA_3. Rachis length (36.23±0.975) was markedly influenced with the highest concentration of 150 ppm GA_3 over control (21.05±1.029). Chopde et al. (2012) also found the similar results in tuberose when soaked in the highest concentration of GA_3 at 150 ppm. The possible reason for increasing spike length and rachis length might be due to increase in the cell division and cell elongation of intercalary meristem resulting in rapid internode elongation (Shanker et al. 2011). Data presented in Table 2 with respect to floret length, floret diameter and no. of florets per spike also recorded significant results with GA_3-treated bulb. Variation in number of florets per spike among all the concentrations had also been observed as compared to control. GA_3 at 150 ppm gave the largest number of florets per spike (38.6±1.35). Wagh et al. (2012) also observed striking influence with the highest concentration of GA_3 at 100 ppm on number of florets per spike in tuberose over control. A dose of 150 ppm GA_3 was found effective for maximum floret diameter (5.56±0.18) as compared to control plant which showed a minimum floret diameter (4.25±0.23). These results are in consonance with findings of Kumar et al. (2012) in carnation and Rana et al. (2005) in gladiolus. Favorable effect of application of gibberellins on number of florets and floret diameter might be due to improved physiological efficiency, selective ion uptake, sufficient water uptake causing high rate of accumulate deposition. Maximum floret length (6.34±0.12) was recorded by gibberellins treatment of 150 ppm whilst the control exhibited the lowest floret length (5.13±0.45). This is in accordance with findings of Singh et al. (2003) in tuberose who also observed a rapid increase in the rate of cell elongation at the highest concentration of GA_3.

Chlorophyll content

Chlorophyll a, b and total chlorophyll content significantly increased with application of GA_3. The highest amount was recorded in 150 ppm GA_3 treated plants (Table 3). This may be due to non-degradation of chlorophyll, high rate of photosynthesis, more trapping of light and larger leaf surface under the influence of GA_3. These results are in close conformity with Janowska and Andrzejak (2010) who observed the highest chlorophyll content in leaves of GA_3 treated plants. Ferrante et al. (2009) also reported that gibberellins alone delayed leaf yellowing by preventing chlorophyll degradation in cut stock flowers.

Table 2. Influence of GA_3-treated bulbs on floral parameters of tuberose cv. Prajwal

Pretreated GA_3 (ppm)	Spike emergence (in days)	Spike length (cm)	Rachis length (cm)	Floret length (cm)	Floret diameter (cm)	No. of florets / spike
T_0	83.1±2.02^d	93.53±1.58^d	21.05±1.029^d	5.13±0.45^c	4.25±0.23^d	23.4±1.07^d
T_1	79.5±2.59^c	99.55±0.90^c	24.44±0.729^c	5.69±0.36^c	4.83±0.24^c	27.1±1.79^c
T_2	74.4±1.71^b	103.18±1.14^b	29.33±0.845^b	5.92±0.34^b	5.1±0.19^b	30.5±2.46^b
T_3	69.5±1.43^a	114.18±1.44^a	36.23±0.975^a	6.34±0.12^a	5.56±0.18^a	38.6±1.35^a
L.S.D($P \leq 0.05$)	1.8032	1.1773	0.8187	0.3271	0.1918	3.5898
ANOVA($F_{8,3}$)	86.190	447.096	532.893	28.683	66.939	137.935

T_0- GA_3 0ppm; T_1- GA_3 50ppm; T_2- $GA_3$100ppm; T_3- GA_3 150 ppm

Values represent means ±Standard deviation, n=10
Means were compared by using the least significant difference (LSD) test at ($P \leq 0.05$) followed by Duncan's multiple range tests. Different letters mark significant difference at $P \leq 0.05$.

Table 3. Influence of GA_3-treated bulbs on chlorophyll content, durability of flower and bulbous parameters of tuberose cv. Prajwal

Pretreated GA_3 (ppm)	**Chlorophyll a (mg g^{-1} fresh wt.)**	**Chlorophyll b (mg g^{-1} fresh wt.)**	**Total chlorophyll (a+b) (mg g^{-1} fresh wt.)**	**Durability of flower (days)**	**Number of bulbs after harvesting**
T_0	0.363 ± 0.007^{d}	0.095 ± 0.0009^{d}	0.459 ± 0.008^{d}	14.6 ± 0.96^{d}	20.9 ± 2.77^{c}
T_1	0.474 ± 0.007^{c}	0.109 ± 0.0062^{c}	0.583 ± 0.008^{c}	16.3 ± 1.03^{cc}	22.6 ± 1.35^{c}
T_2	0.581 ± 0.006^{b}	0.143 ± 0.0057^{b}	0.724 ± 0.011^{b}	16.9 ± 0.74^{b}	26.2 ± 1.62^{b}
T_3	0.735 ± 0.013^{a}	0.186 ± 0.0095^{a}	0.922 ± 0.021^{a}	20.7 ± 1.14^{a}	30.7 ± 1.95^{a}
L.S.D($P\leq0.05$)	0.0088	0.0069	0.012	0.8879	1.8083
ANOVA($F_{8,3}$)	2635.860	276.408	2269.981	36.130	47.771

T_0- GA_3 0ppm; T_1- GA_3 50ppm; T_2- $GA_3$100ppm; T_3- GA_3 150 ppm
Values represent means ±Standard deviation, n=10
Means were compared by using the least significant difference (LSD) test at ($P \leq 0.05$) followed by Duncan's multiple range tests.
Different letters mark significant difference at $P \leq 0.05$.

Bulb production

The highest number of bulbs per plant (30.7±1.95) was noticed when bulbs were treated with GA_3 at 150 ppm followed by GA_3 at 100 ppm (26.2±1.62). This number decreased with reduction in concentration of GA_3 (Table 3). Gibberellic acid is known to increase the plant height, number of leaves and leaf width that might have led to enhance the rate of photosynthesis. As a result of this, availability of metabolites to the developing bulbs and bulblets might be increased, thereby led to increase in the number of bulb count. The present results are in agreement with findings of Siraj and Al-Safar (2006) and Shankar et al. (2011) in tuberose who also observed the best result at the highest concentration of GA_3.

Durability of flower

Application of GA_3 pretreatment also increased the durability of flowers. Maximum durability was observed at the highest concentration of GA_3. Gibberellic acid application results in continuous supply of photosynthetic assimilate for longer duration due to high source strength at higher concentration. Dalal et al. (2009) also recorded the best flower quality in gerbera when sprayed with 150 ppm GA_3.

CONCLUSION

Gibberellins constitute a group of tetracyclic diterpenes influencing seed germination, leaf expansion, stem elongation, flower initiation and flower or fruit development. The present studies were conducted to ascertain the effect of GA_3 on growth, flowering and quality flower production of tuberose. From our experimental findings, it was concluded that GA_3 at 150 ppm proved to be best concentration in enhancing all the vegetative (plant height, number of leaves and sprouting of bulbs), floral (spike length, number of florets/ spikes, floret length) and bulbous characteristics in tuberose. GA_3 also resulted in early flowering and more durable flowers which are the major contributing traits for floriculture industries. Better performance of tuberose with application of GA_3 might be due to efficient nutrient uptake, enhancing source and sink potential by promoting photosynthetic enzymes, leaf area, more trapping of light for increasing photosynthetic rate, proper metabolism of antioxidant enzymes to normal level.

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