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The Effect of Different Concentrations of Gibberellic Acid on Quantitative and Qualitative Characteristics of Three Cultivars Lacourtine, Yokohama and Red Favourite Tulip (*Tulipa gesneriana* L.)

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Abstract

Tulip is one of the most important flowers to precocity. Treatment of tulip bulbs with gibberellic acid reduces the forcing period in the greenhouse resulting energy saving and reduces the tulip's physiological disorders. This study carried out about three tulip cultivars includes 'Lacourtine', 'Yokohama' and 'Red Favourite'. The results showed that gibberellic acid reduced significantly stem length, first internode length and duration of precocity period. Based on the results gibberellic acid at 250 and 500 ppm can be effective agent in tulip's precocity.

Keywords: Cold treatment, Forcing period, Gibberellic acid, Tulip (*Tulipa gesneriana* L.).

INTRODUCTION

Tulip (Liliaceae) belongs to permanent bulbous plants. The initial diversity center of tulip genus is in Pamir and Tien-Shan the hillside of Central Asia and the second diversity is in Caucasus (Dole and Wilkins, 1999; Coskuncelebi *et al*., 2008). Tulip is one of the most important flowers to precocity. Different countries use tulip in different ways. In Western Europe most of tulips are used as cut flower and in the United States as a potted plant (De Hertogh, 1974). Treatment of tulip bulbs with gibberellic acid reduces the forcing period in the greenhouse. That resulting energy saving and reduces the tulip's physiological disorders (Hanks, 1984). Regardless of cold treatments duration of tulip's bulbs, gibberellin accelerates flower maturity and survivability. Tulip's bulbs have dormancy periods which the most physiological changes occur during this period (Xu and Niimi, 2008). Increasing duration of cold treatment caused reduction of forcing duration in greenhouse and synchronicity tulip flower opening (Charles-Edwards and Rees, 1975). Terminal bud in addition to carbohydrate nutrient elements receives a range of hormones factors of plant. In major groups of plant hormones, gibberellins have an important role in plant flowering. Application of hormones for the manipulation flower growth is more common in comparison with other crops. Investment return are supplied the cost of employing this materials. One of the purposes of growth regulators substance application is control of flowering that is important economically. Growth regulators substances are used to balance internal hormones, depending on the time of application and concentration stimulate or inhibit flowering (Viemont and Crabbe, 2000). Several physiological mechanisms involved in the increased stem length of tulip flower. Studies indicate that cold treatment and gibberellin application accelerate the flowering, stimulate the tulip stem elongation and prevent the flower bud abortion (Hanks, 1984; Suh and Cho, 1997). The effect of gibberellin treatments may be due to increase nutrition stretching power by the flowers when the daughter bulbs compete to mother bulbs and photosynthesis materials. Many studies have been done on gibberellin applications to reduce the duration of cold treatment or potted tulips production. Flower stem length is a qualitative factor in tulip cut flower. Stem length is different after the gibberellin application based on cultivar, the development stage of flower bud before the cold treatment, duration of cold treatment, the differences gibberellin concentrations, and method and time of gibberellin application (Franssen and Voskens, 1997). Hormonal status of tulip bulbs has been studied during the dormancy. It has been reported that within cold treatment tulip's bulbs increases free gibberellins (Hanks, 1984; Saniewski *et al*., 1999). Rebers *et al.* (1994) stated that GA_4 is probably involved in the elongation of the stem tulip. Gibberellin application on tulip bulbs that were exposure cold treatment at 12 weeks resulted in increased stem length compared with the control treatment (12 weeks at 17 ◦C). However, gibberellin treatment reduces the length of last internode and stem in flower opening stage that may be due to the early development of flower. Overall, the effect of gibberellin treatment and cold treatment of bulb is related to the time and method of application (Suh and Cho, 1997). External application of gibberellin provides chilling requirement of tulip bulb partially and stimulates stem length and flowering. In Apeldoorn tulip gibberellin replaces just the part of chilling requirement. Tulips that have not received cold treatment or cold treatment were short time; gibberellin application does not influence in producing flowers with desirable quality. Tulips treated with gibberellin are shorter than those met chilling requirement completely. Plants provided their chilling requirement completely; gibberellin stimulates pistil development and production of auxin. These factors increase length of internodes (Jones and Hanks, 1984; Hanks, 1985; Rebers *et al.,* 1994; Franssen and Voskens, 1997). Janowska and Jerzy (2004) reported that gibberellic acid increases the vase life of calla flowers. Saniewski *et al.* (1997) studied the effects of gibberellic acid on growth and flowering of some variety of Hyacinthus. They stated that application of gibberellic acid on Hyacinthus bulb before the cold treatment stimulates growth of inflorescence and leaves greatly and reduce the forcing duration. Gibberellin application reduced the forcing duration and stems length and increased the flower vase life. Followed by thermal treatment at 2-20°C gibberellin caused the reduce forcing period 15-25% and increase the stem length, regardless of storage temperature compared with control. Also gibberellin treatment reduces the stem length, decreases the stem length is more at 5°C or less temperature (bulbs stored temperature). The results of gibberellin application during cold storage at 17°C before cold treatment, during cold treatment or after cold treatment at 5°C indicated that gibberellin application during cold treatment or at the end of the cold treatment was more effective on the traits measured (Hanks, 1984).

Our objective in this study was to evaluation of the influence of gibberellic acid on forcing period in greenhouse and some qualitative and quantitative characteristics of three cultivars of tulip.

MATERIALS AND METHODS

This experiment was carried out in Jan 2009 at the Department of Horticulture, University College of Agriculture and Natural Resources of University of Tehran, Iran. Bulbs (three cultivars include 'Lacourtin', 'Yokohama' and 'Red favourite') were obtained from Mahde Laleha, Institute of Gachsar. To prevent fungal diseases the bulbs were disinfected with benomyl 2/1000 for 20 minutes and then were exposed to air an hour. In order to develop internal organs of flower, the bulb stored at 17-20°C for 35 days. During this period the bulbs were sampled weekly (each sample consisted of 5 bulbs), then the bulbs were analyzed. The pistil of bulbs are reached to G stage (at this stage, pistil has 3 lobes and anthers are specified). Moist cold treatment of bulbs was at 5°C for 12 weeks. After the cold treatment the bulbs were soaked at (0, 125, 250 and 500 ppm) concentrations of gibberellic acid for 24 hour then were cultured in perlite medium in greenhouse at 18-24°C. During the forcing period plants were fed with the Quick nutrient solution. The measured characteristics in this experiment included number of leaves, length and width of the lowest leaf, length of flower stem (Plant height), flower durability on the plant, flower number, flower diameter before the opening, length of upper internode, length of flower bud, stem diameter, mean of leaf area, shoot dry weight, duration of forcing period, percentage of flowering plants and percentage of shoot calcium. Two factor studied (Cultivar and hormone concentration) in different levels. However experiment was Factorial (Table 1). Each bulb was planted in a pot and each experimental unit was consisted five pots. The data obtained from pot measurements and laboratory observations were subjected to an analysis of variance using SPSS software and the Duncan mean separation test procedure was applied.

RESULTS

Results showed that plant height, length of upper internode and duration of forcing period

Table 1. The analysis of variance (Mean Squares) the effects of gibberelic acid on measured characteristics of three cultivars Lacourtine, Yokohama and Red favourite tulip.

sov	df	PH	LUI	MLA	DFP	PSC	SD	PPF
Block	2	1.77 ns	0.67 ns	601809.67 ns	1.86 ns	0.01 ns	0.24 ns	19.61 ns
A	3	102.63 **	23.71 **	10058987.21 ns	216.33 **	0.09 ns	0.59 ns	147.64 ns
B	2	1.59 ns	1.19 ns	1502996.1 ns	0.16 ns	0.03 ns	1.73 *	491.22 ns
A×B	6	7.38 ns	1.67 ns	1427135.28 ns	0.3 ns	0.01 ns	0.38 ns	374.54 ns
Error	22	4.03	1.59	3618680.8	1.67	0.04	0.36	181.91
cv		7.57	14.25	12.04	7.17	14.82	7.27	17.15

**,* and ns: Significant in 0.01, 0.05 and non-significant, respectively
A: gibberellic acid B: tulip cultivars
PH: Plant height LUI: Length of upper internode MLA: mean of leaf area
DFP: duration of forcing period PSC: percentage of shoot calcium SD: stem diameter PPF: percentage of plants flowering

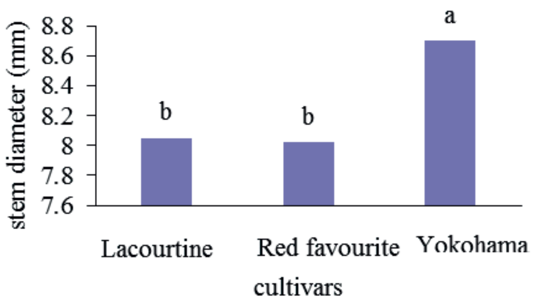

Fig. 1. The effect of cultivar on stem diameter.

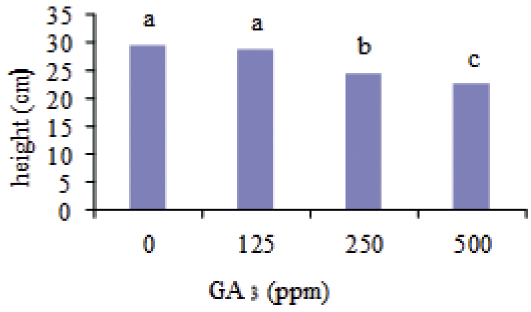

Fig. 2. The effect of GA_3 on height.

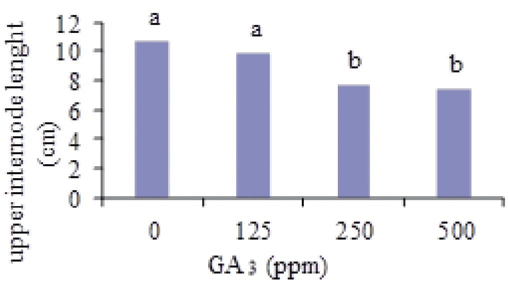

Fig 3. The effect of GA_3 on upper internode length.

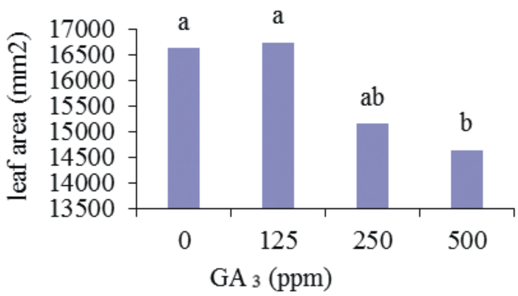

Fig 4. The effect of GA_3 on leaf area

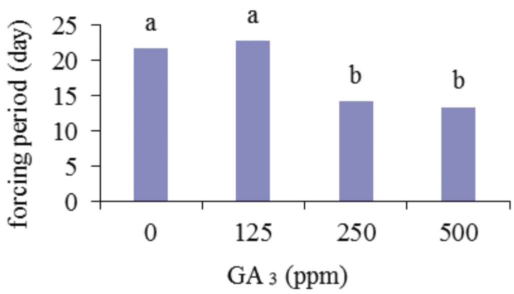

Fig. 5. The effect of GA_3 on forcing period.

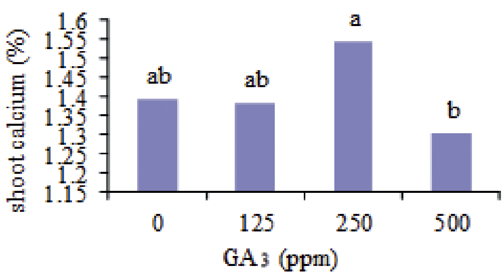

Fig. 6. The effect of GA_3 on shoot calcium.

were affected significantly by different concentrations of gibberellic acid (Table 1). Mean of leaf area and percentage of shoot calcium were not significant in the analysis of variance table, however, with Duncan's multiple range tests showed significant differences at 5%. According to the results the highest plant was the control (29.72 cm) and the lowest plants were those treated by gibberellic acid at 500 ppm (22.66 cm). There were no significant differences between 0 and 125 ppm concentration of gibberellic acid. The longest upper internode was belonging to control (10.61 cm) and the shortest upper internode was belonging to gibberellic acid at 500 ppm (7.33 cm) (Fig. 3). The highest and lowest average duration of the forcing period was related to control (21.77 days) and gibberellic acid at 500 ppm (13.44 days), respectively (Fig. 5). Results indicated that cold treatments and gibberellic acid accelerates flowering, stimulates stem elongation and prevent to flower bud abortion. The results of mean comparison showed that different concentrations of gibberellic acid had a significant effect on mean of leaf area and percentage of shoot calcium. Maximum mean of leaf area related to control (16636 mm^2) and minimum mean of leaf area related to gibberellic acid at 500 ppm (14643 mm^2). Also maximum and minimum mean of shoot calcium percentage belonging to gibberellic acid at 250 ppm (1.54%) and gibberellic acid at 500 ppm

(1.3%), respectively (Fig. 4 and 6). Analysis of Varience shows that the effect of cultivar was significant on tulip stem diameter. The highest mean of stem diameter and the lowest mean of stem diameter were observed in Yokohama (8.7 mm) and Red favourite (8.02 mm) respectively (Fig. 1). The highest mean of plant flowering was related to Lacourtin (83.3%) and the lowest mean of plant flowering belonged to Yokohama (71.3%) (Fig. 7).

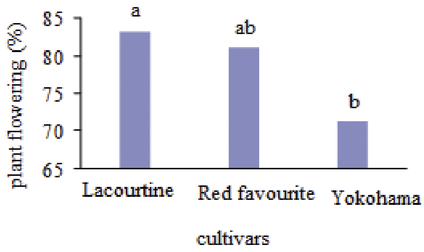

Fig. 7. The effect of cultivar on plant flowering

DISCUSSION

Means comparison showed that high concentration of gibberellic acid reduces the plant height. Miller and Kim (2008) found that application of GA_{4+7} and BA in color bud stage (to increase the flower vase life) had a low effect on plant height. The results of this study correspond to finding to Hanks (1985) and were inconsistent to finding to Miller and Kim (2008). Shoub and Hertogh (1974) reported that application of Ansymidol, GA_3 and GA_{4+7} at premature stage in greenhouse reduce the tulip height. Contradiction of results may be due to differences in concentration and time of application of plant growth regulators. Effects of gibberellic acid on flowering and reduction of flower bud damage during storage at 20 °C probably may be due to stimulate of intracellular biosynthesis of indole acetic acid (IAA) (Xu and Niimi, 2007). The effect of gibberellin treatments on flowering, stimulation of stem elongation and prevent to flower bud abortion may be due to increase nutrition stretching power by the flowers when the daughter bulbs compete to mother bulbs and photosynthesis materials (Hanks, 1984; Suh and Cho, 1997). Saniewski (1989) reported that gibberellin is produced during the bulbs cooling plays an important role in the development of flower buds. Also other gibberellins synthesized during the stem growth control tulip stem elongation with auxin. On the other side, ethylene stops growth elongation of aerial parts of most of plants. It seems that growth elongation by the ethylene could be due to inhibiting of polar auxin transport. Van Bragt and Van Ast (1976) found that the upper internode length of plants treated with gibberellic acid reduced compared to control at the beginning of flowering. Jones and Hanks (1985) treated bulb of Apeldoorn tulip for 2-48 hours with gibberellic acid at 250 to 500 ppm prior to planting to reduce the storage period in greenhouse (duration of forcing period) after cooling treatments at 5 ◦C which gibberellic acid had the greatest effect on reducing of duration of forcing period for 7-10 days rather than control. Gibberellic acid cannot increase the growth of tulip upper internode because of may be before increase the growth upper internode converted to the less active or inactive substance. One of the symptoms of calcium deficiency is bending of neck of tulip flower (Topple). Calcium deficiency occurs during the forcing period in hydroponic method and at high relative humidity. In most of plants there are large amounts of calcium in the leaves. Older leaves have the more calcium than the younger leaves, unlike the phosphorus and potassium. Calcium content of lower leaves is more than the upper leaves in tulip. This process there is also in 42% and 82% relative humidity. So that the calcium amount of dry weight in 42% is more than 82% relative humidity. Because of the low relative humidity the more transpiration is occurring which causes to calcium absorb from the roots to shoots. Calcium addition to cell division in meristematic regions is involved in activating of some enzyme such as amylase (Nelson *et al.,* 2003). Increasing of calcium dry weight may be due to the role of gibberellin in activation of some enzymes. Using histochemical method determined that gibberellin affected on activity of α-glucosidase enzyme in potato. This enzyme breaks down the starch (Alexopoulos *et al.*, 2008). Considering the different cold range of varieties of tulip (13 to 20 weeks) adequate cold treatment is effective in flowering stage. Increasing treatment duration at low temperature reduces duration forcing period in greenhouse and flowers are open simultaneously. Also storing the bulbs in low temperature causes the proper growth of stem, improves of flower quality and decreases physiological disorders during forcing period (Charles - Edward and Reese, 1975; Dole and Wilkins, 1999; Dole, 2003). Although Yokohama is an early crop but the present results it appears that reduction of flowering is due to genetical agents or thermal stress.

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