International Journal of Horticultural Science and Technology
Vol. 2, No. 2; December 2015, pp 199-204

Efficacy of Spraying a Mixture of Amino Acids on the Physiological and Morphological Characteristics of Tuberose (*Polianthes tuberosa* L.)

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(Received: 4 January 2015, Accepted: 28 December 2015)

Abstract
Tuberose (*Polianthes tuberosa* L.) is one of the most important cut flowers in Iran. This research was conducted to investigate the effects of spraying a mixture of amino acids on the physiological and morphological characteristics of tuberose. The experiment was carried out in two successive years (2009 and 2010) using two tuberose cultivars 'Dezfuli' and 'Mahallati'. The experiment was arranged as a factorial on a completely randomized design with 4 replications. Treatments were 0, 0.25, 0.5, and 0.75 mg L^{-1} of amino acids. The results showed that applying amino acids improved all growth and flowering characteristics of tuberose cultivars. Concentration of 0.75 mg L^{-1} amino acids enhanced the floral stem, inflorescence, and stem diameters. The fresh weight of floral stem increased about 22% as a result of spraying with 0.25 mg L^{-1} amino acid mixture. Total protein and nitrogen contents of the 'Dezfuli' cultivar showed about 60% enhancement when using a 0.5 mg L^{-1} mixture of amino acid. In general, the effects of amino acids on 'Dezfuli' were greater than the 'Mahallati' cultivar.

Key words: Cultivar, cut flowers, foliar application, flowering characteristics, inflorescence.

Introduction

One of the most important cut flowers in tropical and subtropical areas is tuberose (*Polianthes tuberose* L.). Tuberose is an ornamental bulbous plant native to Mexico with a long spike of fragrant flowers (Benschop, 1993).

Nitrogen is an essential element for plant growth, and one of the available nitrogen forms for plant uptake is nitrate. Tuberose plants respond to supplementary nutrition well to have better growth and flowering (Kado *et al.*, 2009). According to Chaudhary (2007), applying 200 mg L^{-1} of nitrogen to tuberose plants increased inflorescence length, floret number, fresh weight of floret, and floret length. In another report, higher concentrations of nitrogen were needed for better flower yield, and higher doses of phosphorus were required for bulb production (Kado *et al.*, 2009; Eid *et al.*, 2010). However, the flower yield, flower quality, and time taken in flowering can be directly influenced by nutrients applied in the organic and inorganic forms. In addition, continuous use of inorganic fertilizers would adversely affect the soil productivity which eventually decreases yield, quality, and vase life of flowers (Chaudhary, 2007). On the other hand, nitrate contamination has become an important human concern, particularly when the soil is used for

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planting edible plants; on such occasions, excessive nitrate uptakes by plants will accumulate in plant tissues which is harmful to human diet.

Recent studies have indicated that plants may have an ability to absorb organic nitrogen directly from organic sources, and they do not need soil microorganisms to convert it into inorganic nitrogen (Kubik and Buczek, 1999; Aslam *et al.*, 2001; Tida *et al*., 2009). Amino acids and amino sugars are the most recognizable organic nitrogen compounds in soil hydrolysates (Arshad and Frankenberger, 1990). Amino acids as organic nitrogen compounds are the building blocks in protein synthesis which is directly used by plants (Abd El-Aziz *et al*., 2009). Plants could absorb amino acids more rapidly than inorganic nitrogen compounds. Tida *et al*. (2009) conducted an experiment on tomato to evaluate the absorption of ammonia, nitrate, and L-glycine which had labeled carbon and nitrogen. The higher amount of labeled carbon and nitrogen in plant tissues showed that plants absorb amino acids as an organic nitrogen source more rapidly than other inorganic nitrogen sources such as nitrate and ammonia.

Amino acids play different roles such as stimulating cell growth and maintaining plant cell pH values due to having both acid and basic groups. Amino acids can serve as a source of carbon and energy, so they protect plants against pathogens (Abd El-Aziz *et al*., 2009). Investigators carried out a number of researches on the advantages as well as the disadvantages of amino acids on plants. For instance, using tryptophan significantly improved growth due to its role in auxin synthesis (Abd El-Aziz *et al*., 2009). Koksal *et al*. (1999) observed that using Fe amino acid chelating significantly increased yield, fruit size, shoot length, and the amount of some microelements such as Fe, Cu, and Zn of leaves in 'Williams' peach. They showed that the foliar application of amino acid chelating keeps leaves away from browning, yellowing, and abscission. In another report, a mixture of amino acids with humic acids and compost improved crop characters in snap bean, and it was suggested that humic acid and compost ease amino acid absorption and hence cause growth improvement (Shehata and El-Helaly, 2010). Applying amino acids to tomato seedling significantly increased plant height, fruit quality, and mean fruit fresh weight (Tantawy, 2009).

Amino acids as growth stimulators had been also used for better growth on ornamental plants (Attoa *et al*., 2002; Talaat and Youssef, 2002; Abou Dahab and Abd El-Aziz, 2006; Abd-El Aziz *et al*., 2009). *Philodendron erubescens* significantly responded to applying tryptophan and diphenylamine. Plant height, stem diameter, leaf number, and fresh and dry weights of the entire plant increased in response to tryptophan more than diphenylamine. They attributed this improvement to the role of tryptophan in auxin synthesis (Abou Dahab and Abd El-Aziz, 2006). The present investigation was undertaken to elucidate the effects of spraying a mixture of amino acids on the physiological and morphological changes in *Polianthes tuberosa*. This is the first report for amino acid application on tuberose.

Materials and Methods

This experiment was carried out during two successive years (2009-2010) at the research greenhouse of the Department of Horticultural Science, College of Agriculture, Shiraz University, Shiraz, Iran, at Badjgah, 1810 m above the mean sea level, 52˚ 32' E and 29˚ 36' N. The mixture of amino acids was a commercial product named Folammina from an Italian company (Biolchim). Table 1 shows the name of amino acids in Folammina. The bulbs were purchased from the city of Dezful (a main center for winter tuberose cut flower production in the south of Iran) and Mahallat (located in the central part of Iran) and planted in pots containing a 1:1:1: (v/v) mixture of soil: peat: perlite at the depth of 5-7 cm in 20 cm diameter pots. The experiment was conducted as a completely randomized factorial design with four treatments (control, 0.25, 0.5 and 0.75 mg L^{-1} of Folammina) and 4 replications. In the first year, spraying was performed three times. In the second year, spraying continued up to the appearance of the flower stem (three times). The morphological characteristics of tuberose plants such as height of the flowering stem, height of inflorescence, floret length, open floret diameter, close floret diameter, flowering stem diameter, leaf number per plant, fresh and dry weights of flowering stems, and physiological characteristics such as chlorophyll content, proline, total protein, and the nitrogen amount were measured. To measure the dry weights of the flowering stems, the materials were kept in an oven (Korl Kolb 112SL) for 48 h at 75˚C. The chlorophyll content was determined by the spectrophotometric method (Saini and Buvalda, 1998). The data were analyzed by the SAS software and means were compared using LSD test at 5% level of probability.

Table 1. List of amino acids in the Folamina (Biolchim) mixture.

gr per 100 gr of mixture	Amino Acids
9.16	Alanine
3.50	Leucine
6.40	Arginine
4.40	Lysine
5.60	Aspartic Acid
0.92	Methionine
10.50	Glutamic Acid
13.80	Proline
0.30	Cysteine
1.70	Serine
2.30	Phenylalanine
1.30	Tyrosine
25.20	Glycine
1	Threonine
8.30	Hydroxyproline
0.38	Tryptophan
1.50	Isoleucine
2.60	Valine
2.60	Histidine

Results and Discussion

Morphological characteristics

The foliar application of amino acids had a significant stimulatory effect on the growth parameters of tuberose plants (Table 2). However, the most effective treatment which had the highest floral stem length, the thickest floral stem diameter, and the highest florescence was the application of amino acids at the concentration of 0.75 mg L^{-1} with an increment of about 21, 15, and 12%, respectively. The foliar application of amino acids at 0.25 mg L^{-1} also increased leaf number (17%) and fresh (30%) and dry (37%) weights of the floral stem. However, the statistical differences between 0.25 and 0.75 mg L^{-1} for leaf number and fresh weight were not significant although numerical differences did exist. The foliar application of amino acids did not affect floret characteristics such as floret length and floret number. These results are in agreement with other reports that confirm the positive effects of amino acids on the plant growth of different species (Moursy *et al.*, 1988; El-Bahar *et al.*, 1990; Attoa *et al.*, 2002; Talaat and Youssef, 2002; Gamal El-Din and Abd el-Wahed, 2005; Talaat *et al.*, 2005; Abd El-Aziz and Balbaa, 2007; Dawood and Sadak, 2008; Abd El-Aziz *et al.*, 2009; Abou Dahab and Abd El-Aziz, 2009; Sarojnee *et al.*, 2009; Abd El-Aziz *et al.*, 2010; Mazher *et al.*, 2011). For instance, by applying tryptophan, the stem length of *Philodendron erubescens* K. Koch and Augustin increased about 50% compared to control (AbouDahab and Abd El-Aziz, 2006); also, the plant length and the number of branches of snapdragon (*Antirrhinum majus* L.) improved significantly by increasing concentrations of tryptophan and phenylalanine (Abd-El Aziz *et al*., 2009). These researchers found that the stimulatory effect of amino acids may be due to the vital effects of these organic nitrogen sources on the growth of plant cells. Amino acids provided carbon and energy for plant growth through breaking into ammonia and organic acids when carbohydrates become deficient. However, for providing energy, organic acid must enter the Kreb's cycle and release energy during respiration. Additionally, amino acid conversion into some plant growth regulators may be the result of growth promotion in plants. For instance, Talaat *et al*. (2005) found that an increase in the growth of the periwinkle (*Catharanthus roseus* L.) as a result of tryptophan application may be due to its conversion into Indoleacetic acid (IAA).

The most important point about amino acids is that these organic nitrogen sources provide plant cells with an immediately available nitrogen, which can generally be taken by the cells more rapidly than inorganic nitrogen (Goss, 1973; Thon *et al*., 1981; Abd-El Aziz *et al*., 2009). In other reports, researchers found that amino acids significantly increased the number of branches, fresh and dry weights, and the height of *Pelargonium graveolens* (Mona and Talaat, 2005), *Philodendron erubescens* K. Koch and Augustin (AbouDahab and Abd El-Aziz, 2006), and snapdragon (Abd El-Aziz *et al*., 2009).

Table 2. Effects of spraying a mixture of amino acids on the morphological characteristics of tuberose plants.

Concentrations of amino acids mixture	Stem length (cm)	Stem diameter (mm)	Inflorescence length (cm)	Leaf number	Fresh weight (gr)	Dry weight (gr)
Control	66.83 c	8.18 c	23 b	23.33 d	46.93 b	6.44 b
0.25 mgL^{-1}	73 b	9.1 b	23.8 b	27.33 a	61 a	8.89 a
0. 5 mg L^{-1}	62.16 d	7.73 d	20.58 c	24.83 c	45.23 c	5.81 b
0.75 mg L^{-1}	80.83 a	9.42 a	25.83 a	26.33 b	49.29 a	8.29 a

In each column, means with the same letters are not significantly different at 5% level using LSD.

Physiological characteristics

The data presented in Table 3 indicate that among the different concentrations of amino acid mixture, 0.25 mg L^{-1} caused 79% increase in proline content (Table 3). Similar findings were obtained in chamomile (*Chamomill arecutita* (L.) Rausch.), in which different amino acids (ornithine, proline, and phenyalalanine) enhanced the total amino acids (Gamal El-Din and Abd El-Wahed, 2005). The chlorophyll content of plants treated with 0.5 mg L^{-1} amino acids increased about 10%. The foliar application of a mixture of amino acids improved the total protein content of tuberose plants about 55%. The present results are similar to the reports of other investigators (Tarraf *et al*., 1999; Gamal El-Din and Abd El-Wahed, 2005; Abd El-Aziz and Balbaa, 2007; AbouDahab and Abd El-Aziz, 2009). According to these researchers, applying amino acids exogenously could improve the total endogenous amount of amino acids. Abd El-Aziz *et al*. (2009) reported that the leaves with chlorophyll contents in snapdragon increased by increasing amino acid concentration. They attributed these improvements to the role of some amino acids, such as glycine in the biosynthetic pathway leading to chlorophyll formation. In other words, amino acids such as glycine initiate chlorophyll formation pathway through succnyl CoA (Krebs cycle intermediate) (Abd El-Aziz *et al*., 2009). Mixture of amino acids also significantly increased total protein and nitrogen contents. According to the results of Wang *et al*. (2007), amino acids also affected total NPK contents. The NPK content of pak-choi shoots significantly increased by amino acid treatments. Asparagine and glutamine treatments significantly increased N and P concentrations in pak-choi tissues. Other researchers also confirmed that amino acids increased total protein contents (Tarraf *et al*., 1999; Youssef and Talaat, 2003; Gamal El-Din and Abd El-Wahed, 2005; Abd El-Aziz and Balbaa, 2007; Abd El-Aziz *et al*., 2010; Mazher *et al*., 2011). Increase in total protein contents may be due to conversion to protein by ribosomes and using them as protein block structures. Moreover, plant cells can absorb organic N more rapidly than inorganic N, so they use amino acids as organic N sources for polymerizing proteins instead of using ammonia or nitrate as inorganic N sources (Jones *et al*., 2005). Higher proline content in treated plants with 0.25 mg L^{-1} of a mixture of amino acids compared to control may suggest that this compound may be useful under stress conditions due to the role of proline as an osmotic adjustment.

Table 3. Effects of spraying a mixture of amino acids on the physiological characteristics of tuberose plants

Concentrations of amino acid mixtures	proline	chlorophyll	protein	nitrogen
Control	55.59 d	42.93 b	0.052 b	0.0083 b
0.25 mgL^{-1}	99.75 a	44.06 b	0.055 b	0.0098 b
0. 5 mgL^{-1}	76.19 c	43.96 b	0.081 a	0.013 a
0.75 mgL^{-1}	67.7 c	47.26 a	0.058 b	0.0092 b*

*In each column, means with the same letters are not significantly different at 5% level using LSD.

Conclusions

According to the present results, the foliar application of different concentrations of a mixture of amino acids improved the growth characteristics of tuberose plants. The results also showed that the mixture of amino acids used in this study may be suggested as a nitrogen source for other cut flowers.

Acknowledgments

The authors gratefully appreciate the scientific support of Dr. Saeid Eshghi and Dr. Hasan Salehi and thank the Horticultural Department of Shiraz University for providing research facilities.

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