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EFFECT OF TRYPTOPHAN AND PHENYLALANINE ON SOME BIOCHEMICAL COMPONENTS AND FLORAL TRAITS OF GERBERA (*GERBERA JAMESONII* L.) cv. 'GREAT SMOKY MOUNTAINS'

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Abstract

The experiment was conducted during the 2017-2018 season underplastic houseat the Research station, Department of Horticulture and Landscape Gardening, College of Agriculture, University of Diyala, to study the effect of foliar spray with tryptophan and phenylalanine on some biochemical components and floral traits of *Gerbera jamesonii* L. cv. 'Great Smoky Mountains' (Orange flowers). The study consist of five treatments, T1 = spray with distilled water (control), T2 = 100 $mg.l^{-1}$ tryptophan, T3 = 150 $mg.l^{-1}$ tryptophan, T4 = 100 $mg.l^{-1}$ phenylalanine, T5 = 150 $mg.l^{-1}$ phenylalanine. The results indicated that foliar spray with tryptophan and phenylalanine improved all biochemical and flowertraits. Foliar sprayof phenylalanine at 150 $mg.l^{-1}$ was superiorin relative chlorophyll content, percentage of nitrogen, phosphorus and potassium in leaves, percentage of total carbohydrates in leaves, number of inflorescences, inflorescencediameter,inflorescences stalk length, total carotenoids content in inflorescence,and vase life, with values of48.41 SPAD unit, 2.24%, 0.31%, 3.53%, 19.77%, 6.17 $inf.plant^{-1}$, 9.08cm, 40.28cm, 75.17 $mg.100g^{-1}$ dry weight and 18 days, respectively. While foliar spray with tryptophan at concentration of 150 $mg.l^{-1}$ led to early flowering(73.42 days), which on par with treatment of 150 $mg.l^{-1}$ of phenylalanine (74.33 days) compared to the control treatment (85.67 days).

Key words : Tryptophan, phenylalanine, biochemical compounds, floral traits.

Introduction

The cultivation of decorative ornamental plants that their flowers are suitable for picking has become a large and extensive trade in the world after the development of its production and marketing. They are grown to benefit from their cut flowers for arrangement, or bouquets (Bhattacharjee, 2006). Gerbera (*Gerbera jamesonii* L.) also commonly known as Transvaal Daisy belongs to the Asteraceae family, which is an important cut flowers that are grown all over the world (Pattanashetti *et al.*, 2012). It ranks fourth in the international cut flower market and a popular cutflower in Holland, Germany and USA (Choudhary and Prasad, 2000). Modern gerbera arose from *Gerbera jamesonii* hybridized with *Gerbera viridifolia* and possibly other species (Leffring, 1973). Variety incolor has made this flowering plant attractive for use in garden decorations, such as herbaceousborders, bedding and pots and for cut flowers as it has a long vase life (Bose *et al.*, 2003; Chung *et al.*, 2005; Chauhan, 2005).

Several studies have reported that foliar applications with amino acids caused in increase growth and development of plants. Amino acids are the main building blocks for the construction of protein, many amino acids also act as primers for other compounds containing nitrogen for example nucleic acids. Amino acids can play wide roles in plants including working as regulatory molecules and as molecular transmitters. Amino acids also affect the synthesis and activity of certain enzymes, gene expression and oxidation suppression (Rai, 2002). Amino acids are involved in the construction of many organic compounds, including proteins, amines, alkaloids, vitamins and terpenes (Ibrahim *et al.*, 2010). They are essential in stimulating cell growth and act as buffers to provide a source of carbon and energy and protect cells

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from ammonia toxicity (Abd El-Aziz *et al*., 2010).

Tryptophan (denoted Trp or W), an amino acid of α type, is used in the bio-synthesis of proteins, contains α-amino group, α-carboxylic acid group, and side chain, making it non-polar annularamino acid. It is essential for humans, in the sense that the body cannot synthesize it so it must be obtained from the diet. Tryptophan is also the primary precursor of neurotransmitter serotonin, melatonin hormones, niacin (vitamin B3) and auxins (Slominski *et al*., 2002). Tryptophan or its initial precursor, Indol-3-glycerol phosphate, is the first precursor of IAA (Indol Acetic Acid) biosynthesis (Mano and Nemoto, 2012). Phenylalanine is protein-building unit and precursorof many plant-derived metabolites, which plays critical roles in growth, evolution, reproduction and environmental responses of plants. In vascular plants, about 30% of photosynthetic carbon channeled through phenylalanine towards the dynamic processing of Lignin,an essential component of plant cell walls and the main barrier to production of cellulosic biofuels (Boerjan *et al*., 2003). Several studies have shown the positive effects of foliar spray of amino acids in some biochemical components and floral traits (Sewedan, 2009) on *Hippeastrum vittatum* HERB.; Yassen *et al*. (2010) on *Pimpinella anisum* L. and Wahba *et al*. (2015) on *Urtica pilulifera*.

The main objective of the present study is to investigate the effect of foliar spray of tryptophan and phenylalanine on some biochemicalcomponents and floral traitsof Gerbera plants.

Materials and Methods

The experiment was conducted during the 2017-2018 season under plastic houseat the Research station, Department of Horticulture and Landscape Gardening, College of Agriculture, University of Diyala. The experiment was conducted for the period from 1/10/2017 to 1/6/2018, to study the effect of foliar spray of tryptophan and phenylalanine at concentration of 100 and 150 $mg.l^{-1}$ for each, in addition to spraying with distilled water as a control treatment.

The study used gerbera seedlings cv. 'Great Smoky Mountains' produced by Florist Holland B.V. Dutch and reproduced by tissue culture at Green Life Laboratories Ltd, Baghdad, Iraq. Homogeneous seedlings were picked up (approximately 15 cm) and transferred to 25 cm diameter pots containing a sandy loam soil. Soil culture was analyzed in the laboratory of Soil and Water Resources Department, College of Agriculture, University of Diyala, Iraq (table 1), which shows some chemical and physical properties of soil cultivation media.

Table 1 : Some of the chemical and physical characters of cultivation media.

The character	The value	The unit
pH	7.88	-
EC	0.95	$dS.m^{-1}$
Available N	29.75	$mg.kg^{-1}$
Available P	13.32	$mg.kg^{-1}$
Available K	208.6	$mg.kg^{-1}$
Organic matter	0.961	%
$CaCO_3$	205.12	$g.kg^{-1}$
Soil Separation		
Clay	116.0	$g.kg^{-1}$
Silt	132.0	$g.kg^{-1}$
Sand	752.0	$g.kg^{-1}$
Soil structure	Sandy Loam	

Plants were sprayed twice, after 30 and 60 days of transplanting. Tween-20 was added atconcentration of 0.1% as surfactant compound, plants sprayed with concentrations used until complete wetting by a 2 liters capacity hand sprayer. The experiment consists of five treatments as follows:

T1 = Spraying with distilled water (AA0).

T2 = 100 $mg.l^{-1}$tryptophan (Trp100).

T3 = 150 $mg.l^{-1}$ tryptophan (Trp150)

T4 = 100 $mg.l^{-1}$ phenylalanine (Phe100)

T5 = 150 $mg.l^{-1}$phenylalanine (Phe150).

The experiment implemented according to the randomized complete block design (RCBD) with three replicates.The data were analyzed according to the statistical program SAS (2003). The data were analyzed according to the statistical program SAS (2003). Means were compared using Duncan's Multiple Range Test (DMRT)($P>0.05$).

Experimental measurements included some biochemical components such as chlorophyll relative content in leaves (SPAD), percentage of nitrogen, phosphorus and potassium in leaves (%), percentage oftotal carbohydrate in leaves (%) and some of floral traits such asflowering date, number of inflorescences, inflorescence diameter (cm), length of inflorescences stalk (cm), total carotenoids content in inflorescence ($mg.100gm^{-1}$dry weight) and vase life(day). The percentage of nitrogen, phosphorus and potassium in the leaves was estimated according to A.O.A.C (1970). Percentage oftotal carbohydrate in the leaves was estimated, according to Joslyn (1970). Percentage of total carotenoids in inflorescence was estimated, according to Ranganna (1999).

Results

I- Biochemical properties

I-1 Relative chlorophyll content in leaves (SPAD unit)

Tryptophan and phenylalanine foliar spray showed a significant difference in relative chlorophyll content in leaves compared to the control treatment, (Table 2). Treatment at concentration of 150 mg.l^{-1} of phenylalanine and concentration of 150 mg.l^{-1} of tryptophangave the highest relative chlorophyll contentin leaves (48.41 and 47.41 SPAD unit) respectively.

I-2 Percentage of nitrogen in leaves (%)

Data in table 2 showed a significant increase in percentage of nitrogen in leaves. Treatment at concentration of 150 mg.l^{-1} of phenylalanine gave the highest percentage of nitrogen in the leaves (2.24%) compared tothe lowest percentage of nitrogen in the leaves (1.71%)for control treatment.

I-3 Percentage of phosphorus in leaves (%)

Data in table 2 indicated that foliar spray with tryptophan and phenylalanine resulted in a significant increase in percentage of phosphorus in leaves. The highest percentage of phosphorus in leaves achieved with treatment of 150 mg.l^{-1} of phenylalanine (0.31%), compared to the lowest percentage of phosphorus in leaves (0.17%) for control treatment.

I-4 Percentage of potassium in leaves (%)

Data in table 2 indicated that all foliar spray treatments of tryptophan and phenylalanine resulted in a significant increase in percentage of potassium in leaves compared to control treatment. Highest potassium content was achieved with plants treated with 150 mg.l^{-1} of phenylalanine (3.53%), which on parwith treatment of150 mg.l^{-1} of tryptophan (3.50%). The lowest percentage of potassium detected in control treatment (2.64%).

I-5 Percentage of total carbohydrate in leaves (%)

Data in table 2 indicated that foliar spray with tryptophan and phenylalanine resulted in a significant increase in percentage of total carbohydrate in leaves compared to control treatment. Highest percentage of total carbohydrate content was achieved with plants treated with 150 mg.l^{-1} of phenylalanine (19.77%), which on par with treatment of 150 mg.l^{-1} of tryptophan (19.21%).

II. Floral traits

II-1 Flowering date

The results presented in table 3 indicated that all foliar spray treatments with phenylalanine and tryptophan had a significant effect on flowering date. Treatment of 150 mg.l^{-1} of tryptophan resulted early in the flowering date) 73.42 days), which on par with treatment of 150mg.l^{-1} of phenylalanine (74.33 days), compared tocontrol treatment (85.67 days).

II-2 Number of inflorescence

Data in table 3 revealed that foliar spray with tryptophan and phenylalanine resulted in a significant increase in number of inflorescence and treatment of 150 mg.l^{-1} of phenylalanine gave the highest number of inflorescence (6.17) compared to control treatment, which recorded the lowest number of inflorescence (3.55).

II-3 Inflorescencediameter (cm)

Data in table 3 indicated that foliar spray with tryptophan and phenylalanine resulted in a significant increase of inflorescence diameter and treatment of 150 mg.l^{-1} of phenylalanine gave the highest inflorescence diameter (9.08 cm) followed bytreatment of 150 mg.l^{-1} of tryptophan (9.05 cm) compared to control treatment, which recorded the lowest inflorescence diameter (6.96 cm).

II-4 Length of inflorescencestalk (cm)

Data in table 3 indicated that there was a significant increase in length of inflorescence stalk when spraying with tryptophan and phenylalanine. Treatment of 150 mg.l^{-1} of phenylalanine and 150 mg.$l^{-1}$of tryptophan recorded highest length of inflorescence stalk reached 40.28 and 39.34 cm respectively, compared with control treatment, which recorded lowest length of inflorescence stalk reached 29.92 cm.

II-5 Total carotenoids content in inflorescence (mg. 100 g^{-1} dry weight)

Results in table 3 showed that all foliar treatments of tryptophan and phenylalanine resulted in a significant increase in total carotenoids content in inflorescence compared to control treatment. Treatment of 150 mg.l^{-1} of phenylalanine significantly exceed other treatments with 75.17 mg.100 g^{-1} dry weight, followed by treatment of 150 mg.l^{-1} of tryptophan with 73.91 mg.100 g^{-1} dry weight.

II-6 Vase life (day)

Table 3 indicated that there was a significant increase in vase life when plants treated with tryptophan and phenylalanine. Treatment of 150 mg.l^{-1} of phenylalanine and 150 mg.l^{-1} of tryptophan had a longest vase life reached 18.03 and 17.04 days respectively, compared with control treatment, which recorded vase life reached 13.30 days.

Table 2 : Effect of foliar spraywith tryptophan and phenylalanine in some biochemical properties of gerbera.

Treatments	Relative chlorophyll Content(SPAD)	Percentage of N in leaves(%)	Percentage of P in leaves(%)	Percentage of K in leaves(%)	Percentage of carbohydrate in leaves (%)
AA0	40.48c	1.72d	0.17 d	2.64 c	16.07 b
Trp 100	45.65 b	1.89c	0.22 c	3.13 b	17.07 b
Trp 150	47.41 a	2.12b	0.28 b	3.50 a	19.21a
Phen 100	45.12b	1.93 c	0.23 c	3.17 b	17.02 b
Phen 150	48.41 a	2.24 a	0.31 a	3.53 a	19.77a

Means in each column followed by similar letters are not significantly different (P>0.05) according to Duncan's Multiple Range Test (DMRT).

Table 3 : Effect of foliar spray with tryptophan and phenylalanine in floraltraitsof gerbera.

Treatment	Flowering date(Day)	No. of inflorescence	Inflorescence diameter (cm)	Length of inflorescence stalk (cm)	Total carotenoids content(mg. 100 g^{-1} dry weight)	Vase life (day)
AA0	81.67 a	3.55 d	6.96 c	29.92 c	68.77 d	13.30 c
Trp 100	79.33b	4.69 c	8.02 b	34.90 b	71.38 c	15.79b
Trp 150	73.42 c	5.64 b	9.05a	39.34 a	73.91 b	17.04 ab
Phen 100	79.58 b	4.90 c	8.02 b	35.93b	71.69 c	15.92b
Phen 150	74.33 c	6.17 a	9.08 a	40.28 a	75.17a	18.03 a

Means in each column followed by similar letters are not significantly different (P>0.05) according to Duncan's Multiple Range Test (DMRT).

Discussion

The results showed that foliar spray with tryptophan and phenylalanine positively affected all the biochemical components and floral traits of gerbera. Foliar spray of phenylalanine at 150 mg.l^{-1} was superior in relative chlorophyll content, percentage of nitrogen, phosphorus and potassium in leaves, percentage of total carbohydrates in leaves, number of inflorescences, inflorescence diameter, length of inflorescence stalk, total carotenoids content in inflorescence and vase life. The increase in the growth indices due to spraying phenylalanine may be related to its role in proteins building and will perform a number of additional functions in regulating metabolism, transport and storage of nitrogen (Davies, 1982). In addition, it can act as a source of carbon, energy and the manufacture of other organic compounds, such as protein, amines, purine, alkaloids, vitamins, enzymes, terpenes and others (Goss, 1973; Abd El-Aziz and Balbaa, 2007). The superiority of spraying treatment of phenylalanine in increase of biochemical components and most floral traits may be attributed to the role of amino acids in increasing growth of plant and its efficiency in absorption of nutrients. The amino acid ions are easily released for rapid use by the plant and easily enter the cytoplasmic cells, which increases the photosynthesis process because it constitute in composition of enzymes in the process, as a result of the rapid processing of nitrogen element and its activation of photosynthesis especially when sprayed on plant as a nutrient solution, which leads to an increase in production of carbohydrates, which in turn is exploited in vegetative growth (Koksal *et al*., 1999).

The results indicate that spraying of amino acids increased the percentage of nitrogen, phosphorus and potassium in leaves may be due to their role in accelerating growth and increase the leaf area and then increase rate of photosynthesis and consequent high absorption of plant and affect in content of nutrients in plant parts.

This is consistent with Abo-Sedera *et al*. (2010) that concentration of nutrients increases with increased concentration of amino acids because they help the plant to reach a good nutritional status, which increases the efficiency of the plant in absorption and accumulation of nutrients in the leaves.

Yu *et al*. (2002) noted that the percentage of nitrogen in plant parts increases due to the treatment of amino acids, which is the main source of nitrogen supply. This is consistent with the findings of Awad *et al*. (2007). Results showed that an increase in the percentage of carbohydrates in leaves due to spray with phenylalanine may be attributed to the fact that amino acids are not only used in the construction of proteins, but also as precursorof natural products, including carbohydrates, plant pigments, alkaloids and hormones (Maeda and Dudareva, 2012).

Increment in number and diameter of inflorescence and length ofinflorescence stalk when sprayed with phenylalanine may be due to the fact that it is used with a certain concentration to improve the vegetative growth characteristics of the plant and thus the possibility of increasing production and accumulation of photosynthetic materials, thus increasing number and diameter of inflorescence and length of inflorescence stalk. Incrementin length of inflorescence stalk may be due to the biological effect of these amino acids in stimulating cell division and elongation (Pareek *et al*., 2000). Increment in floral traits due to foliar spray with amino acids are in agreement with those obtained by Sewedan and Osman (2014) in *Dendranthema grandiflorum* and Khattab *et al*. (2016) in *Gladiolus grandiflorum*.

Conclusion

From the results of the present study, it can be concluded that foliar spray with tryptophan and phenylalanine positively affected all the biochemical components and floral traits of gerbera (*Gerbera jamesonii* L.) cv. 'Great Smoky Mountains'. Foliar spray with phenylalanine at concentration of 150 mg.l^{-1} was surpassed in giving the best results as compared to control treatment.

References

Abd El-Aziz, N. G. and L. K. Balbaa (2007). Influence of tyrosine and zinc on growth, flowering and chemical constituents of *salvia farinacea* plants. *J. of APP. Sci. Res*., **3(11)** : 1479-1489.

Abd El-Aziz, Nahed, G., Azza A. M. Mazher and M. M. Farahat (2010). Response of vegetative growth and chemical constituents of *Thuja orientalis* L. plant to foliar application of different amino acids at Nubaria. *J. American Sci*., **6(3)** : 295-303.

Abo Sedera, F. A., A. S. Abd El-LafifAmany, L. A. Bader and S. M. Rezk (2010). Effect of NPK mineral fertilizer levels and foliar application with humic and amino acids on yield and quality of strawberry. *Egypt. J. Appl. Sci*., **25** : 154-162.

Awad, M. M., A. M. Abd El-Hameed and Z. A. El-Aimin (2007). Effect of glycine, lysine and nitrogen fertilizer rates on growth, yield and chemical composition of potato. *J. Agric. Sci. Mansoura Univ*., **32(10)**: 8541-8551.

Bhattacharjee, S. K. (2006). Advances in Ornamental Horticulture. Flowering shrubs and seasonal ornamentals. Vol.1, Pointer Publishers. Jaipur. 302003 (Raj), India.

Boerjan, W., J. Ralph and M. Baucher (2003). *Annu. Rev. Plant Biol*., **54** : 519–546.

Bose, T. K., L. P. Yadav, P. Pal, V. P. Pathasarathy and P. Das (2003). *Commercial flowers* (2nd Ed.). NayaUdyog, Calcutta, India.

Chauhan, N. (2005). Performance of gerbera genotypes under protected cultivation. Dept. Hort. College of Agri, Dharwad University of Agricultural Science, Dharwad.

Choudhary, M. L. and K. V. Prasad (2000). Protected cultivation of ornamental crops-an in sight. *Indian Journal of Horticulture*, **45(1)** : 49-53.

Chung, Y. M., Y. B. Yi, Y. C. Cho, J. B. Kim and O. C. Kwon (2005). A new high-yielding red cut flower gerbera cultivar with strong peduncle, Misty Red. *Korean Journal of Breeding*, **37(4)**: 273-274.

Davies, D. D. (1982). Physiological aspects of protein turn over. Encycl., *Plant Physiology*. New Series, 14A (Nucleic acids and proteins: structure biochemistry and physiology of proteins). 190-288 – Ed., Boulter, D. and Par.

EL-Naggar, A. H. and E. Sewedan (2009). Effect of light intensity and amino acid tryptophan on the growth and flowering of Amaryllis (*Hippeastrum vittatum*, HERB.) plants. *J. Agric. and Euv. Sci. Alex. Univ., Egypt.* **8(1)**.

Goss, J. A. (1973). Amino acids synthesis and metabolism physiology of plants and their cell. P. 202. Pergamon Press INC, New York, Toronto, Oxford, Sydney, Braunschweig.

Ibrahim, S. M. M., L. S. Taha and M. M. Farahat (2010). Influence of foliar application of pepton on growth, flowering and chemical composition of *Helichrysum bracteatum* plants under different irrigation intervals. *Ozean J Appl Sci*., **3(1)**: 143-155.

Joslyn, M. A. (1970). Method in food analysis: Physical, Chemical and instrumental method of analysis. 2nd Ed. Academic Press, New York and London.

Khattab, A. S., E. Abou El-Saadate and K. Al-Hasni (2016). Effect of Glycine, Methionine and Tryptophan on the vegetative growth, flowering and corms production of Gladiolus Plant. *Alexandria Science Exchange Journal*, **4(37)** : 647-659.

Koksal, A. I. H. Dumanoglu and N. T. Gunes (1999). The Effects of different amino acid chelate foliar fertilizers on yield, fruit quality, shoot growth and Fe, Zn, Cu, Mn content of leaves in williams pear Cultivar (*Pyrus communis* L.). *Tr. J. of Agriculture and Forestry*, **23** : 651-658..

Leffring, L. (1973). Flower production in gerbera: Correlation between shoot, leaf and flower formation in seedlings. *Scientia Horticulturae*, **1** : 221-229.

Maeda, H. and N. Dudareva (2012). The shikimate pathway and aromatic amino acid biosynthesis in plants. *Annu. Rev. Plant Biol*., **63**: 73-105.

Mano, Y. and K. Nemoto (2012). The pathway of auxin biosynthesis in plants. *Exp. Bot*., **63(8)** : 2853-2872.

Pareek, N. K., N. L. Jat and R. G. Pareek (2000). Response of coriander (*Coriandrum sativum* L.) to nitrogen and plant growth regulators. *Haryana J. Agron*., **16(1&2)**: 104- 109.

Pattanashetti, C. N., S. I. Athani, D. K. Harish and S. J. Imamsaheb (2012). Economics of gerbera (*Gerbera jamesonii*) cultivation under protected conditions. *Plant Archives*, **12(1)** : 91-94.

Rai, V. K. (2002). Role of amino acids in plant responses to stresses. *Biologia Plantarum*, **45(4)**: 481-487.

Ranganna, S. (1999). *Handbook of analysis and quality control for fruit and vegetable products* (II Ed.).Tata Mc-Graw Hill publishing company Ltd, New Delhi.

Sewedan, E. and A. R. Osman (2014). Influence of diphenylamine and ascorbic acid on the production of *Dendranthema grandiflorum*, RAM. *Life Sci.*, **11(9)**: 846-852.

Slominski, A., I. Semak, A. Pisarchik, T. Sweatman, A. Szczesniewski and J. Wortsman (2002). Conversion of L-tryptophan to serotonin and melatonin in human melanoma cells. *FEBS Letters*, **511 (1-3)**: 102–106.

Wahba, H. E., H. M. Motawe and A. Y. Ibrahim (2015). Growth and chemical compostion of *Urtica pilulifera* L. plant as influenced by foliar application of some amino acids. *J. Mate. Environ. Sci.*, **6(2)**: 499-506.

Yassin, A. A., A. A. A. Mazher and S. M. Zaghloul (2010). Response of anise plants (*Pimpinella anisuym*) to nitrogen fertilizer and foliar spray of tryptophan under Agricultural Drainage water. *New York Sci. J.,* **3(9)**: 120 -127.

Yu, Z. T., Q. V. Zhang and T. E. Kraus (2002). Contribution of amino compounds to dissolved organic nitrogen in forest soils. *J. Biogeochemistry*, **61** : 173-198.