Scientific J. Flowers & Ornamental Plants
www.ssfop.com/journal
ISSN: 2356-7864 **doi: 10.21608/sjfop.2020.114574**

EFFECT OF POTASSIUM NITRATE AND ADENOSINE TRIPHOSPHATE ON PRE- AND POST-HARVEST GERBERA (*GERBERA JAMESONII* L.) PLANTS

W.M.F. Abd-El-Hady
Ornamental Plants and Landscape Gardening Res. Dept., Hort. Res. Inst., ARC, Giza, Egypt

ABSTRACT: The pot experiment was conducted during the two consecutive seasons of 2016 and 2017 in plastic house at Horticulture Research Station, Mansoura, Dakahlia Governorate, Egypt as pre-harvest treatments. The main objective of the first experiment was to study the effect of two rates of adenosine triphosphate (0.0 and 7.0 g/l) alone or combined with potassium nitrate at the dose of 2.5, 5.0, 7.5 and 10.0 g/pot, on vegetative growth, flowering and chemical constituents of gerbera (*Gerbera jamesonii*). The highest values of plant height, number of leaves per plant, leaf area, number of flowers per plant, flower diameter, stalk length as well as the contents of total chlorophyll, carbohydrates, N, P, and K in plants were achieved with adenosine triphosphate (ATP) at 7 g/l as weekly foliar spray with significant difference compared to control. Also, increasing potassium nitrate from 2.5 up to 10.0 g/pot gradually increased the above mentioned parameters during both seasons. Furthermore, using the highest doses of potassium (7.5 and 10.0 g/pot) in interaction with ATP at 7 g/l significantly increased gerbera growth, flowering and chemical constituents compared to untreated plants and the other interaction treatments. From the first experiment the best interaction treatments were 7.5 and 10.0 g potassium nitrate/pot plus1 7 g ATP/l, these treatments were in the second experiment to study the effect of different pulsing solutions on flower vase life, solution uptake and flower fresh weight of gerbera. The obtained results revealed that, the longest vase life of gerbera and the highest quality cut flowers were obtained by using the combination treatments between (7.5 g potassium nitrate/pot + 7 g ATP/l) combined with 3% sucrose + 8-HQS at 200 ppm as holding solution. By studying simple correlation coefficients, gerbera cut flowers vase life exhibited strong positive relationship with each of water uptake and flower fresh weight which, indicated that the increase in these parameters was accompanied by increasing vase life of gerbera cut flowers under the effect of interaction treatments of pre and postharvest.

Scientific J. Flowers & Ornamental Plants, 7(3):337-348 (2020).

Received:
18/7/2020
Accepted:
20/8/2020

Key words: Gerbera, ATP, potassium nitrate, growth, cut flowers, chemical constituents, vase life, solution uptake.

INTRODUCTION

For the time being, cut flowers take up a remarkable position in the regional and foreign markets in order to their value as a source of national income of Egypt. Gerbera (*Gerbera jamesonii* L.) Fam. Asteraceae is an important decorative flower and is ordinarily utilized as a flowering pot plant and is one of 10 widespread cut flowers in the world which takes the 4th place according to the global orientation in floriculture (Choudhary and Prasad, 2000).

Adenosine triphosphate (ATP) is an all-over energy source, but acts as a neurotransmitter extracellular. ATP and else nucleoside triphosphates not only push energy-subordinate reactions into cells, but can also work outside the plasma membrane in the extracellular model, where they job as agonists that can encourage varied physiological replies without being hydrolyzed. This exterior function of ATP is well determined in animal cells but only lately has turn onto visible that extracellular ATP (eATP) can also job as a signaling factor in plants (Roux and Steinebrunner, 2007).

The application of potassium nitrates fertilizer may increase growth and flowering quality of cut flower plants. However, the application of KNO_3 significantly increased leaf area and its fresh and dry weight per plant irrespective to the growth of sunflower and safflower plants (Jabeen and Ahmad, 2011). Also, various concentrations potassium nitrate had significant effects on water uptake of chrysanthemum flower shelf life compared to control (Souri *et al*., 2018). Furthermore, nitrogen rates have positive correlations with total chlorophyll content and photosynthesis efficiency of plant leaves, which reflected in enhancing plant growth and flowering (Marschner, 2011). This can raise production of carbohydrate and sugar in plant tissues. On the other hand, nitrogenous compounds can influence ethylene production, chlorophyll declination and ion leakage in plant tissues (Druge, 2000). In fact, any internal or external factors that inhibit ethylene production can also increase cut flower vase life.

In addition, Halevy and Mayak (1979) found that sucrose irritates the influence of ABA, which encourages senescence. Usage of 8-hydroxy quinolone sulfate (8-HQS) reduced vascular blockages in rose cut flowers (Marousky, 1971). As well, sucrose lonely has not been ordinarily applied, because sugar treatment without disinfectant elevates bacterial reproduction, leading to shortening vase life. The use of 8-HQS increased vase life, wet weight, dry weight, flower diameter and mean absorbed preservative solution, it reduced the stem drooping in gerbera cut flowers (Banaee *et al.*, 2013).

Therefore, the main purpose of the current study was to evaluate the effectiveness of pre-harvest treatments (potassium nitrate and adenosine triphosphate) on growth, flowering and chemical constituents as well as the effect of postharvest treatments (sucrose and 8-HQS as holding solutions) in combination with KNO_3 and ATP on prolonging vase life and keeping quality of *Gerbera jamesonii* L. cut flowers.

MATERIALS AND METHODS

This work was conducted in Horticulture Research Station at Mansoura, Dakahlia Governorate, Egypt, during the two consecutive seasons of 2016 and 2017 in plastic house. The first aim of the study was to investigate the effect of different pre-harvest treatments of adenosine triphosphate (0.0 and 7.0 g/l) and potassium nitrate concentrations (2.5, 5.0, 7.5 and 10.0 g/pot at 25 cm diameter) on growth, flowering and chemical constituents of *Gerbera jamesonii* (yellow color). A split plot design based on completely randomized design was utilized in this experiment. The ATP treatments was designated as the main plot wherase potassium nitrate at different concentrations were designed as sub plots.

Gerbera transplants obtained from private nursery (Abo-Shaish's sons) at Mansoura, Dakahlia Governorate, Egypt, during the first of February. All seedlings were similar in growth and 10 cm in length. Transplants were planted in pots 25 cm diameter filled with 6 kg of sand:peat moss (1:1 v/v) with adding individual calcium super phosphate (15.5% P_2O_5) at 5 g/pot during the mixing on 10th February in the two seasons. After a month from planting, the plants were weekly sprayed with ATP from the beginning of 10th March until the end of each season (10 times). Adenosine-5-

triphosphoric acid disodium salt 95% (ATP) as almost white crystalline powder with 2.5-3.5 pH (1% in water) were obtained from Oxford Lab Fine Chem Company, India. Commercial potassium nitrate (46.2% K_2O + 13.7 %N) product is produced by Kemapco Arab Fertilizers and Chemical Industry, Jordan.

Data recorded:

- Growth parameters: after 100 days from planting date, plant height (cm), number of leaves/plant and leaf area (cm^2) were recorded.
- Flowering parameters: number of days to flowering, number of flowers/plant, flower diameter (cm) and inflorescence spike length (cm) were listed recorded.
- Chemical constituents: total chlorophyll content mg/g f.w. as fresh weight of leaves were analyses according to A.O.A.C. (1990). Also, total carbohydrates percentage was determined in the dried leaves samples, colorimetrically according to the method described by Jackson (1973). Moreover, total nitrogen, total phosphorus and potassium percentages in dried leaves of gerbera plant were determined according to Chapman and Pratt (1978).

The second part of the study aimed to investigate the response of postharvest parameters of gerbera flowers and correlation between them to the best pre-harvest treatments of 7.0 g ATP/l + 7.5 KNO_3 g/pot as well as 7.0 g ATP/l +10.0 g KNO_3/pot combined with holding solutions using sucrose (S) at 1, 3 and 5% and 8-hydroxy quinolene sulphate (8-HQS) at 100 and 200 ppm as follows;

1. Distilled water (D.W.) as control;
2. 1% S+ 100 ppm 8-HQS;
3. 3% S+ 100 ppm 8-HQS;
4. 5% S+ 100 ppm 8-HQS;
5. 1% S+ 200 ppm 8-HQS;
6. 3% S+ 200 ppm 8-HQS and
7. 5% S+ 200 ppm 8-HQS.

The desired flowers of uniform size 8 cm diameter, 25 cm flower stalk length with yellow colure, free from diseases and pests were chosen and harvested using sideward push near the base of the flower stem, by holding the clump. The flowers were harvested when the ray florets are perfectly outspread. Promptly after harvest the gerbera flowers were brought to the laboratory (light fluorescent about 450 lux, temperature 23-25 °C and 60-70% relative humidity) for imposing the treatments. Gerbera cut flowers were held in glass containers with seven different vase solutions.

A split plot design based on completely randomized design was utilized in this experiment. The main plot was the pre-harvest treatments. Each plot was divided into seven flower groups, using holding solution treatments were applied in each group.

Data recorded:

- Post-harvest parameters: vase life (days), flower diameter (cm), solution uptake (ml) and flower fresh weight (g) were recorded.
- Correlation coefficient: simple correlation coefficients between post-harvest parameters of gerbera cut flowers under the effects of combinations between pre-harvest treatments (7.0 g ATP/l + 7.5 KNO_3 g/pot as well as 7.0 g ATP/l +10.0 g KNO_3/pot) and holding solutions were prepared according to Guler *et al*. (2001).

Experimental design and statistical analysis:

The complete randomized block design (CRBD) in a split-plot design was used in the two experiments with three replicates. The obtained data were statistically analyzed and the means were compared using least significant difference (L.S.D) at 5% level as reported by Gomez and Gomez (1984). The means were compared using computer program of Statistix version 9 (Analytical software, 2008).

RESULTS AND DISCUSSION

1. Effect of pre-harvest treatments:

Growth parameters:

Data tabulated in Table (1) show that, gerbera plants treated with adenosine triphosphate (ATP) showed significant different performances compared to control. Plants treated with the ATP at a concentration of 7 g/l showed the tallest plants (20.16 and 21.98 cm), the highest number of leaves per plant (27.79 and 29.81) and largest leaves (49.15 and 50.79 cm^2) in the first and second seasons, respectively. Moreover, gerbera plant growth parameters gradually increased with increasing potassium nitrate rate from 2.5 to 10 g/pot, in both seasons. The best significant treatments in increasing plant height, number of leaves per plant and leaf area were that 7.5 and 10 g/pot with no significant difference between them in the first and second seasons. Generally, increasing potassium nitrate rates under each ATP application increased gerbera growth parameters. These results hold true during the first and second seasons. The best interaction treatment in increasing plant height, leaf number per plant and leaf area was that application of ATP at 7 g/l + 7.5 g KNO_3 compared to the other interaction treatments under study.

Furthermore, adenosine triphosphate (ATP) is a life's form of energy. The ATP molecule has 3 phosphates jointed with an adenosine molecule. The latest phosphate bond withholds a lot of energy. As energy is wanted for cell division, the ATP is utilized to carry out cell division. If the plant cells hold a great supply of ATP, cell division is able to occur rapidly and more often (Merrett and Handoll, 1967). This means that with greater amount of ATP, gerbera plant is capable to grow to a greater height as well as more leaves number and its area. The

Table 1. Effect of adenosine triphosphate (ATP), potassium nitrate and their interactions on plant height, leaf number per plant and leaf area of gerbera during the two seasons of 2016 and 2017.

Treatments		Plant height (cm)		Number of leaves/plant		Leaf area (cm^2)	
		2016	2017	2016	2017	2016	2017
Adenosine triphosphate application (7 g/l)							
Without		19.17	20.47	24.89	26.48	43.44	44.59
With		20.16	21.98	27.79	29.81	49.15	50.79
LSD at 5%		0.36	0.97	1.22	1.11	1.07	0.62
Potassium nitrate rate (g/pot)							
2.5		18.23	19.69	21.93	23.68	39.04	40.99
5.0		18.63	19.91	25.39	26.26	43.46	43.97
7.5		20.94	22.71	28.77	30.89	50.89	52.31
10.0		20.87	22.60	29.25	31.74	51.77	53.48
LSD at 5%		0.80	1.17	1.31	1.50	1.85	1.29
Interaction effect between adenosine triphosphate and potassium nitrate							
Without ATP	**2.5**	17.95	19.25	20.01	21.92	37.05	38.86
	5.0	18.57	19.52	24.87	25.52	40.50	40.96
	7.5	19.63	21.03	26.75	27.98	45.42	46.48
	10.0	20.54	22.08	27.91	30.49	50.76	52.04
With ATP	**2.5**	18.51	20.13	23.86	25.45	41.03	43.12
	5.0	18.68	20.29	25.92	26.99	46.42	46.98
	7.5	22.25	24.39	30.79	33.80	56.36	58.14
	10.0	21.19	23.11	30.58	33.00	52.79	54.91
LSD at 5%		0.95	1.80	2.16	2.17	2.39	1.56

application of KNO_3 significantly increased leaf area, its fresh and dry weight per plant for the growth of sunflower and safflower plants (Jabeen and Ahmad, 2011). Also, the tested parameters (plant height, number of leaves/plant as well as fresh and dry weight) of coriander plants were generally positively influenced by potassium nitrate application (Elhindi *et al*., 2016). In addition, as mentioned just before, both ATP application and potassium nitrate fertilization rates (each alone) increased growth parameters of gerbera plant, in turn; they together might maximize their effects leading to taller, more leaves and larger leaves area.

Flowering parameters:

As shown in Table (2), the longest period required to flowering (122.92 and 122.42 days) was recorded without ATP application, while the shortest one (118.92 and 117.25 days) was observed with ATP application in the first and second seasons, respectively. No significant difference was noticed between the two treatments of ATP for the number of flowers per gerbera plant in both seasons. However, flower diameter and stalk length of gerbera plant were significantly increased by using ATP at 7 g/l compared to control in the two seasons (Tables 2 and 3). All treatments of potassium nitrate resulted a remarkable increase over control for the early flowering (days), number of flowers per plant, flower diameter (cm) and stalk length (cm). The best treatment in this connection was that 7.5 and 10 g/pot of potassium nitrate compared to the other ones under study during 2016 and 2017 seasons. In general, increasing KNO_3 rates under each ATP application increased gerbera flowering parameters (number of days to flowering, number of flowers/plant, flower diameter and inflorescences pike length). The best interaction treatment in this

Table 2. Effect of adenosine triphosphate (ATP), potassium nitrate rate and their interactions on number of days to flowering, number of flowers per plant and flower diameter of gerbera during the two seasons of 2016 and 2017.

Treatments		Number of days to flowering		Number of flowers/plant		Flower diameter (cm)	
		2016	2017	2016	2017	2016	2017
Adenosine triphosphate application (7g/l)							
Without		122.92	122.42	3.83	4.08	5.93	6.74
With		118.92	117.25	4.00	4.42	6.99	7.55
LSD at 5%		1.36	1.12	N.S.	N.S.	0.46	0.61
Potassium nitrate rate (g/pot)							
2.5		129.83	128.67	3.33	3.50	5.13	5.59
5.0		123.17	122.17	3.33	3.83	5.43	6.19
7.5		116.17	114.50	4.50	5.00	7.39	8.23
10.0		114.50	114.00	4.50	4.67	7.89	8.55
LSD at 5%		0.90	1.20	0.93	0.99	0.81	0.99
Interaction effect between adenosine triphosphate and potassium nitrate							
Without ATP	**2.5**	131.33	130.00	3.33	3.33	5.16	5.19
	5.0	125.67	125.00	3.33	4.00	5.27	6.06
	7.5	120.00	120.33	4.00	4.33	5.79	7.34
	10.0	114.67	114.33	4.67	4.67	7.51	8.36
With ATP	**2.5**	128.33	127.33	3.33	3.67	5.10	5.99
	5.0	120.67	119.33	3.33	3.67	5.58	6.32
	7.5	112.33	108.67	5.00	5.67	9.00	9.13
	10.0	114.33	113.67	4.33	4.67	8.28	8.74
LSD at 5%		2.12	1.99	1.17	1.28	1.04	1.31

regard was that application of ATP + 7.5 and 10 g/pot compared to the other interaction treatments under study.

ATP and other nucleotides can stimulate a raise in the cytosolic Ca^{2+} concentration and varied downstream changes that effect plant growth and blossom (Demidchik *et al*., 2003). Also, flowering time decreased with an increase in benzyl adenine (BA) and potassium nitrate rates, while there were no significant influence of BA and potassium nitrate interaction on floret numbers of narcissus plants (Matin *et al*., 2015). Furthermore, Thaneshwari (2014) indicated that the highest dose of potassium and nitrogen achieving good flowering attributes of hydrangea for commercialization purposes. Applying potassium to soil as dressing gave the highest significant values of number of florets per spike, floret diameter and spike length of gladiolus plant (El-Naggar and El-Nasharty, 2016). In addition, the lowest flower appearing rate of saffron plant was recorded in control, compared with treatments, and the application of 1000 ppm KNO_3 treatment was useful. The results indicated an increasing trend of this variable as KNO_3 levels increased (Khayyat *et al*., 2018).

Chemical constituents:

The obtained data in Tables (3 and 4) showed that, spraying gerbera plants with adenosine triphosphate at 7 g/l recorded the highest values of total chlorophyll content and total carbohydrates percentage as well as total nitrogen, total phosphorus and potassium percentages in leaves compared to untreated plants during the two consecutive seasons. Furthermore, the high levels of

Table 3. Effect of adenosine triphosphate (ATP), potassium nitrate rate and their interactions on stalk length, total chlorophyll content and total carbohydrates percentage of gerbera during the two seasons of 2016 and 2017.

Treatments		Stalk length (cm)		Total chlorophyll content (mg/g f.w.)		Total carbohydrates (% d.w.)	
		2016	2017	2016	2017	2016	2017
Adenosine triphosphate application (7g/l)							
Without		20.10	21.76	1.15	1.20	30.98	32.11
With		22.43	24.03	1.31	1.44	34.91	36.66
LSD at 5%		0.63	0.90	0.04	0.04	0.74	0.74
Potassium nitrate rate (g/pot)							
2.5		15.58	17.11	1.10	1.13	27.34	28.88
5.0		20.57	21.98	1.14	1.22	31.13	32.20
7.5		23.80	25.92	1.37	1.57	36.54	37.78
10.0		25.10	26.57	1.29	1.36	36.76	38.67
LSD at 5%		0.57	1.00	0.07	0.04	0.85	1.29
Interaction effect between adenosine triphosphate and potassium nitrate							
Without ATP	**2.5**	15.53	17.45	1.08	1.10	24.71	26.42
	5.0	19.09	20.54	1.12	1.15	28.40	29.57
	7.5	20.71	22.99	1.13	1.23	33.90	34.57
	10.0	25.06	26.05	1.26	1.31	36.90	37.87
With ATP	**2.5**	15.62	16.77	1.12	1.15	29.96	31.34
	5.0	22.06	23.42	1.17	1.28	33.87	34.83
	7.5	26.88	28.85	1.61	1.91	39.19	41.00
	10.0	25.14	27.09	1.32	1.42	36.61	39.47
LSD at 5%		1.06	1.62	0.09	0.07	1.35	1.67

Table 4. Effect of adenosine triphosphate (ATP), potassium nitrate rate and their interactions on total nitrogen, total phosphorus and potassium percentages in leaves of gerbera during the two seasons of 2016 and 2017.

Treatments		Nitrogen (% d.w.)		Phosphorus (% d.w.)		Potassium (% d.w.)	
		2016	2017	2016	2017	2016	2017
Adenosine triphosphate application (7g/l)							
Without		2.562	2.718	0.298	0.310	3.514	3.635
With		2.847	3.001	0.323	0.340	3.874	3.993
LSD at 5%		0.081	0.188	0.005	0.015	0.091	0.061
Potassium nitrate rate (g/pot)							
2.5		2.428	2.707	0.285	0.296	3.185	3.277
5.0		2.593	2.712	0.303	0.313	3.633	3.685
7.5		2.875	2.997	0.326	0.356	3.933	4.133
10.0		2.920	3.022	0.327	0.334	4.025	4.160
LSD at 5%		0.038	N.S.	0.008	0.026	0.063	0.133
Interaction effect between adenosine triphosphate and potassium nitrate							
Without ATP	**2.5**	2.277	2.680	0.263	0.282	2.957	3.090
	5.0	2.420	2.547	0.286	0.303	3.400	3.463
	7.5	2.667	2.710	0.316	0.323	3.753	3.883
	10.0	2.883	2.933	0.326	0.330	3.947	4.103
With ATP	**2.5**	2.580	2.733	0.308	0.310	3.413	3.463
	5.0	2.767	2.877	0.321	0.323	3.867	3.907
	7.5	3.083	3.283	0.335	0.390	4.113	4.383
	10.0	2.957	3.110	0.327	0.337	4.103	4.217
LSD at 5%		0.121	0.427	0.011	0.033	0.143	0.158

potassium nitrate rates significantly increased most of chemical constituents of leaves compared to the lowest rate (2.5 g/l), in both seasons. Generally, the effects of KNO_3 at 7.5 and 10 g/pot were significant on total chlorophyll content as well as the treatments of carbohydrates, phosphorus and potassium percentages, whenever, total nitrogen percentage in gerbera leaves was not significant, as compared with the control in the second season only. The best interaction treatment for increasing total chlorophyll content as well as total carbohydrate, N, P and K percentages was that 7 g/l ATP + 7.5 g/pot KNO_3 compared to the other interaction treatments under study in both seasons.

In addition, as mentioned just before, both ATP application and potassium nitrate rate (each alone) increased growth and flowering parameters of gerbera plant, in turn, they together might maximize their effects leading to more chlorophyll content, total carbohydrates and NPK percentages. Moreover, plants which were foliar sprayed by ATP in low and high concentrations enhanced the chemical composition (nitrogen, phosphorus, potassium and total carbohydrates percentages) of fresh and/or dry plants and green pods of snap bean plant (Abdel-Hakim *et al*., 2012). Potassium elevates the development of meristematic tissue, reactive some enzymatic reactions, aids in nitrogen metabolism, and the synthesis of proteins, some mineral elements catalyzes activities and aid in metabolism and translocation of carbohydrates (Zörb *et al*., 2014). Also, increasing nitrogen fertilization rates in combination with different potassium fertilization rates increased chemical constituents of hydrangea (Chhune, 2015). However, Elbohy (2017) pointed out that the maximum values of total chlorophyll (SPAD unit) and total carbohydrates (%) in the sunflower leaves

were obtained by treating plants with N + K fertilization rates at 5 + 7.5 g/pot, respectively.

2. Effect of the best pre-harvest × holding solutions treatments:

Postharvest parameters:

Data presented in Table (5) show that, gerbera plants treated with potassium nitrate at 7.5 g/pot + adenosine triphosphate (ATP) at 7 g/l showed significant increases in gerbera flowers vase life, flower diameter, solution uptake and flower fresh weight compared to the highest rate (10 g KNO_3/pot + 7 g/l ATP) without significant differences between them in both seasons. Moreover, all holding solutions under study significantly increased abovementioned parameters of gerbera flowers compared to control (distilled water) during the two seasons, in most cases. Furthermore, the highest values in flower vase life, flower diameter, solution uptake and flower fresh weight of gerbera were obtained by the treatment of 3% sucrose (S) + 200 ppm of 8-hydroxy quinolenesulphate (8-HQS) compared to the other holding solutions under study in both seasons. In general, increasing holding solutions concentrations up to 3% (S) + 200 ppm (8-HQS) under the two rates of KNO_3 + ATP increased gerbera postharvest parameters. The best combination treatment in this concern was that (7.5 g KNO_3/pot + 7 g/l ATP) interacted with holding solution at 3% (S) + 200 ppm (8-HQS) compared to the other interaction treatments under study.

It was found through previous results that ATP + potassium nitrate led to improved vegetative growth, flowering parameters and chemical constituents of gerbera plants as pre-harvest treatments. This was reflected in the post-harvest parameters of gerbera cut flowers. In this regard, the size and shelf life of zinnia cut flowers significantly increased with the highest rates of pre-harvest P and K fertilizers application (Abbasi *et al*., 2004). In addition, pre-treatment of chrysanthemum with potassium nitrate could significantly enhance shelf life and postharvest flower qualities. There was constant increase in water solution uptake by increasing the levels of potassium nitrate (Souri *et al*., 2018).

Correlation coefficients:

Data presented in Table (6) reveal that, the results of simple correlation coefficients between some characters of vase life and solution uptake, flower fresh weight as well as flower diameter of gerbera cut flowers under the effects of the interaction treatments between the best pre-harvest treatments (7.5 or 10 g KNO_3/pot + 7 g ATP/l) and holding solution treatments. Gerbera cut flowers vase life exhibited strong positive relationship with each of solution uptake, flower fresh weight and flower diameter, which, indicated that the increase in solution uptake was accompanied by increasing vase life of gerbera cut flowers under the effect of interaction treatments of pre-harvest treatments and holding solution. These results are in accordance with those stated by Diab *et al*. (2015) on sweet pea and El-Ghazouly *et al*. (2016) on gerbera cut flowers.

CONCLUSION

From the above mentioned results, it is preferable to fertilize *Gerbera jamesonii* L. plants with 7.5 g/pot in two doses of potassium nitrate with 7 g/l of ATP sprayed 10 times to improve the growth parameters, flowering characters and chemical constituents of the plant under Dakahlia Governorate conditions. Also, using pre-harvest treatments especially above rate (7.5 KNO_3/pot + 7 g ATP/l) and holding solution (3% sucrose + 200 ppm of 8-hydroxy quinolenesulphate) was the best treatment for enhancing vase life and gerbera cut flowers quality.

REFERENCES

Abbasi, N.A.; Zahoor, S. and Nazir, K. (2004). Effect of preharvest phosphorus and potassium fertilizers and postharvest $AgNO_3$ pulsing on the postharvest quality and shelf life of zinnia (*Zinnia elegans*

Table 5. Effect of potassium nitrate rate, adenosine triphosphate (ATP) and pulsing solution treatments as well as their interactions on vase life, flower diameter, solution uptake and flower fresh weight of gerbera during the two seasons of 2016 and 2017.

Treatments		Vase life (days)		Flower diameter (cm)		Solution uptake (ml)		Flower fresh weight (g)	
		2016	2017	2016	2017	2016	2017	2016	2017
Potassium nitrate (g/pot) + adenosine triphosphate (7 g/l)									
KNO_3 at 7.5 g + ATP		10.52	11.24	9.03	9.23	16.04	16.60	47.49	49.13
KNO_3 at 10 g + ATP		10.38	11.19	8.80	9.06	15.51	15.99	46.80	47.75
LSD at 5%		N.S.	N.S.	N.S.	0.13	N.S.	0.18	N.S.	0.95
Pulsing solution treatments									
Distilled water		7.17	7.83	8.19	8.34	11.71	12.20	34.73	35.60
1% S + 100 ppm 8-HQS		8.00	8.50	8.68	8.79	12.65	13.03	46.12	46.37
3% S + 100 ppm 8-HQS		10.00	11.00	8.90	9.07	13.78	13.77	49.62	50.75
5% S + 100 ppm 8-HQS		11.00	11.83	8.88	8.96	13.55	13.43	49.22	49.84
1% S + 200 ppm 8-HQS		12.50	13.17	8.96	9.18	17.56	18.34	47.49	48.44
3% S + 200 ppm 8-HQS		13.33	14.00	9.58	9.90	21.00	22.20	51.70	54.80
5% S + 200 ppm 8-HQS		11.17	12.17	9.22	9.78	20.20	21.12	51.15	53.28
LSD at 5%		1.04	1.24	0.36	0.24	0.52	0.55	0.74	0.82
Interaction effect between ATP and KNO3 and pulsing solutions									
KNO_3 at 7.5 g + ATP	**Distilled**	7.33	7.67	8.17	8.22	11.97	12.31	34.75	35.83
	1% S + 100 ppm 8-HQS	7.67	8.33	8.85	9.10	12.72	13.11	46.46	46.91
	3% S + 100 ppm 8-HQS	9.67	10.67	8.98	9.06	13.88	13.90	49.93	51.16
	5% S + 100 ppm 8-HQS	11.00	12.00	8.92	9.02	13.55	13.46	49.85	50.34
	1% S + 200 ppm 8-HQS	12.67	13.00	9.06	9.22	18.76	19.37	47.73	48.53
	3% S + 200 ppm 8-HQS	14.00	14.67	9.92	10.17	21.33	22.56	52.16	56.73
	5% S + 200 ppm 8-HQS	11.33	12.33	9.32	9.80	20.11	21.49	51.56	54.43
KNO_3 at 10 g + ATP	**Distilled water**	7.00	8.00	8.22	8.45	11.46	12.08	34.72	35.37
	1% S + 100 ppm 8-HQS	8.33	8.67	8.51	8.47	12.57	12.95	45.77	45.84
	3% S + 100 ppm 8-HQS	10.33	11.33	8.81	9.07	13.69	13.64	49.32	50.34
	5% S + 100 ppm 8-HQS	11.00	11.67	8.83	8.90	13.54	13.40	48.58	49.34
	1% S + 200 ppm 8-HQS	12.33	13.33	8.86	9.13	16.36	17.31	47.26	48.35
	3% S + 200 ppm 8-HQS	12.67	13.33	9.24	9.62	20.67	21.84	51.23	52.87
	5% S + 200 ppm 8-HQS	11.00	12.00	9.11	9.76	20.28	20.74	50.75	52.14
LSD at 5%		1.46	1.69	0.61	0.33	0.84	0.73	1.32	1.36

S = sucrose, 8-HQS = 8-hydroxy quinolenesulphate.

Table 6. Simple correlation coefficients between vase life and solution uptake, flower fresh weight and flower diameter during 2016 and 2017 seasons.

Characters	2016			2017		
	1	2	3	1	2	3
Y. Vase life (day)						
1. Solution uptake	0.716**	0.740**	0.707**	0.770**	0.703**	0.731**
2. Flower fresh weight		0.630**	0.726**		0.684**	0.828**
3. Flower diameter			0.709**			0.842**

The *P* values were highly significant (0.000).

cv. Blue point) cut flowers. Int. J. Agri. Biol., 6(1):29-31.

Abdel-Hakim, M.; Moustafa, Y.M.M. and Gheeth, R.H.M. (2012). Foliar application of some chemical treatments and planting date affecting snap bean (*Phaseolus vulgaris* L.) plants grown in Egypt. J. Hort. Sci. & Ornament. Plants, 4(3):307-317.

Analytical Software (2008). Statistix Version 9, Analytical Software, Tallahassee, Florida, USA.

A.O.A.C. (1990). Official Methods of Analysis.15th ed. Association of Official Analytical Chemists, Inc., Virginia, USA, 1298 p.

Banaee, S.; Hadavii, E. and Moradi, P. (2013). Interaction effect of sucrose, salicylic acid and 8-hydroxyquinoline sulfate on vase-life of cut gerbera flowers. Current Agric. Res. J., 1(1):39-43.

Chapman, D.H. and Pratt, R.F. (1978). Methods of Analysis for Soils, Plants and Waters. Div. Agric. Sci., Univ. of California, USA, pp. 16-38.

Chhune, T. (2015). Studies on Post Harvest Handling of Cut Hydrangea (*Hydrangea macrophylla* Thunb.) as Influenced by Pre-Harvest Fertilization. M.SC. Thesis, Dr Yashwant Singh Parmar University of Horticulture and Forestry, India, 67 p.

Choudhary, M.L. and Prasad, K.V. (2000). Protected cultivation of ornamental crops: an insight. Indian Hort., 45(1):49-53.

Demidchik, V., Nichols, C.; Oliynyk, M.; Dark, A.; Glover, B.J. and Davies, J.M. (2003). Is ATP a signaling agent in plants?. Plant Physiol., 133:456-461.

Diab, R.E.M.; Awad, A.E.; El-Saka, M.M. and Dawah, A.K. (2015). Improving the keeping quality of sweet pea cut flowers by nano silver and some other preservative solutions. Zagazig J. Agric. Res., 42(4):657-668.

Druge, U. (2000). Influence of pre-harvest nitrogen supply on post-harvest behavior of ornamentals: importance of carbohydrate status, photosynthesis and plant hormones. Gartenbauwissenschaft, 65(2):53-64.

Elbohy, N.F.S. (2017). Impact of pre-harvest nitrogen and potassium fertilizers rate on growth and longevity and some chemical constituents of sunflower (*Helianthus annuus* L.) cut flowers. Middle East J. Agric. Res., 6(4):536-1544.

El-Ghazouly, M.M.A.; Abdelkader, M.A.I.; Awad, A.E. and Bishr, G. A. (2016). Postharvest characteristics of gerbera cut flowers as influenced by pulsing, holding solutions and cold storage periods treatments. Zagazig J. Agric. Res., 43(5):1507-1520.

Elhindi, K.M.; El-Hendawy, S.; Abdel-Salam, E.; Schmidhalter, U.; Rehman, Sh. and Hassan, A. (2016). Foliar application of potassium nitrate affects the growth and photosynthesis in coriander (*Coriander sativum* L.) plants under salinity. Progress in Nutrition, 18(1):63-73.

El-Naggar, A.A.M. and El-Nasharty, A.B. (2016). Effect of potassium foliar application on growth, flowering, corms production and chemical contents of *Gladiolus hybrida*, L. cv. Rose Supreme. Alexandria Science Exchange Journal, 37(4):714-728.

Gomez, K.A. and Gomez, A.A. (1984). Statistical Procedures for Agricultural Research. John Wiley & Sons Inc., Singapore, 680 p.

Guler, M.; Adak, M.S. and Ulukan, H. (2001). Determining relationships among yield and some yield components using path coefficient analysis in chickpea. The European J. Agron., 14:161-166.

Halevy, A.H. and Mayak, S. (1979). Senescence and post-harvest physiology of cut flowers: Part 1. Hort. Rev., 1:204-236.

Jabeen, N. and Ahmad, R. (2011). Foliar application of potassium nitrate affects the growth and nitrate reductase activity in sunflower and safflower leaves under salinity. Notulae Botanicae Horti Agrobotanici, 39(2):172-178.

Jackson, M.L. (1973). Soil Chemical Analysis. Prentice-Hall of India Private Ltd. M-97, New Delhi, India, 498 p.

Khayyat, M.; Jabbari, M.; Fallahi, H. and Samadzadeh, A. (2018). Effects of corm dipping in salicylic acid or potassium nitrate on growth, flowering, and quality of saffron. J. Hort. Res., 26(1):13-21.

Marousky, F. J. (1971). Inhibition of vascular blockage and increased moisture retention in cut roses induced by pH, 8-hydroxyquinolinecitrate and sucrose. J. Amer. Soc. Hort. Sci., 96:38-41.

Marschner, H. (2011). Marschner's Mineral Nutrition of Higher Plants. Academic Press, London, 672 p.

Matin, S.R.M.; Mortazavi, S.N. and Heidari, M. (2015). Application of benzyl adenine and potassium nitrate on growth, nitrate content and nitrate reductase activity in narcissus (*Narcissus tazetta*). Intl. Res. J. Appl. Basic. Sci., 9(6):824-830.

Merrett, M.J. and Handoll, C. (1967). Some effects of adenine on growth, respiration, adenosine diphosphate and triphosphate concentrations in plant tissues. New Phytol., 66:569-575.

Roux, S.J. and Steinebrunner, I. (2007). Extracellular ATP: an unexpected role as a signaler in plants. Trends Plant Sci., 12:522-527.

Souri, M.K.; Goodarzizadeh, S.; Ahmadi, M. and Hatamian, M. (2018). Characteristics of postharvest quality of chrysanthemum cut flowers under pretreatment with nitrogenous compounds. Acta Sci. Pol. Hortorum Cultus, 17(3):83-90.

Thaneshwari, N. (2014). Effect of Nitrogen and Potassium on Growth and Flowering of Hydrangea (*Hydrangea macrophylla* Thunb.). M.Sc. Thesis, Dr. Yashwant Singh Parmar University of Horticulture and Forestry, India, 68 p.

Zörb, Ch.; Senbayram, M. and Peiter, E. (2014). Potassium in agriculture: Status and perspectives. J. of Plant Physiol., 171:656-669.

تأثير نترات البوتاسيوم وادينوسين ثلاثي الفوسفات على نباتات الجربيرا

وليد محمد فهمي عبد الهادي
قسم بحوث نباتات الزينة وتنسيق الحدائق، معهد بحوث البساتين، مركز البحوث الزراعية، الجيزة، مصر

أجريت تجربة أصص خلال الموسمين المتتاليين لعامي ٢٠١٦ و ٢٠١٧ في صوبة بلاستيكية بمحطة بحوث البساتين بالمنصورة محافظة الدقهلية، مصر بهدف دراسة تأثير معدلين من الأدينوسين ثلاثي فوسفات (صفر و ٧,٠ جم/لتر) مع تركيزات مختلفة من نترات البوتاسيوم (٢,٥، ٥,٠، ٧,٥ و ١٠,٠ جم/ أصيص) على النمو الخضري والإزهار و المكونات الكيميائية لنبات الجربيرا (صنف أصفر). تم الحصول على أعلى القيم لإرتفاع النبات، عدد الأوراق لكل نبات،

مساحة الورقة، عدد الأزهار لكل نبات، قطر الزهرة، طول الساق الزهرية، بالإضافة إلى المحتوى الكلي من الكلوروفيل والنسب المئوية للكربوهيدرات، النيتروجين، الفسفور والبوتاسيوم بأوراق الجربيرا بإستخدام الرش الأسبوعي من ثلاثي فوسفات الأدينوزين (ATP) بمعدل ٧ جم/لتر مع وجود فرق معنوي مع الكنترول كما أدت زيادة تركيزات نترات البوتاسيوم من ٢,٥ إلى ١٠,٠ جم/أصيص إلى زيادة تدريجية للصفات السابقة خلال الموسمين. علاوة على ذلك، فإن استخدام أعلى تركيزات من نترات البوتاسيوم (٧,٥ و ١٠,٠ جم/ أصيص) بالتداخل مع ATP بمعدل ٧ جم/لتر أدى إلى زيادة معنوية في النمو الخضري للجربيرا والصفات الزهرية والكيميائية مقارنة بالنباتات غير المعاملة ومعاملات التفاعل الأخرى. تم إختيار أفضل معاملات التداخل السابقة (٧,٥ و ١٠,٠ جم من نترات البوتاسيوم/أصيص + ٧ جمATP/ لتر) من التجربة الأولى لدراسة تأثير محاليل الحفظ الدائمة على طول عمر الأزهار في الفازة، ومقدار إمتصاص محلول الحفظ ووزن الأزهار الطازج في معمل ما بعد الحصاد. مع إستخدام محاليل الحفظ الدائم ككنترول في صورة ماء مقطر، السكروز بتركيز ١٪ + ٨-هيدروكسي الكينولين سلفيت بتركيز ١٠٠ جزء في المليون ، ٣٪ سكروز + ١٠٠ جزء في المليون ٨-هيدروكسي الكينولين سلفيت، ٥٪ سكروز + ١٠٠ جزء في المليون ٨-هيدروكسي الكينولين سلفيت، ١٪ سكروز + ٢٠٠ جزء في المليون ٨-هيدروكسي الكينولين سلفيت، ٣٪ سكروز + ٢٠٠ جزء في المليون ٨-هيدروكسي الكينولين سلفيت و٥٪ سكروز + ٢٠٠ جزء في المليون ٨-هيدروكسي الكينولين سلفيت . أوضحت النتائج ان أطول عمر للأزهار في الفازة وأعلى جودة للأزهار المقطوفة كان باستخدام معاملات التفاعل بين (٧,٥ جم نترات/أصيص + ٧ جمATP/ لتر) مع ٣٪ سكروز + ٢٠٠ جزء في المليون ٨-هيدروكسي الكينولين سلفيت كمحلول حفظ دائم. وأظهرت معاملات الارتباط البسيطة، أن طول عمر أزهار الجربيرا في الفازة كان له علاقة إيجابية قوية مع كل من امتصاص الماء والوزن الطازج للأزهار، مما يشير إلى أن الزيادة في هذه الصفات كان مصحوباً بزيادة عمر الأزهار المقطوفة في الفازة تحت تأثير معاملة التداخل بين معاملات ما قبل وبعد الحصاد.