Zagazig J.Agric. Res., Vol. 29 No.(4) 2002 1143-1167

EFFECT OF NUTRITION WITH NPK AND CALCIUM CHLORIDE AS PREHARVEST TREATMENTS ON FLOWERS QUALITY OF *HIPPEASTRUM VITTATUM* DURING POSTHARVEST HANDLING

Magda M. El-Saka[1] ; M. S. Auda[2] and T. Abou Dahab [3]
1. Postharvest Lab., Floriculture , Dept., Hort. Res. Inst.
2. Orman Botanical Garden, Floriculture Dept., Hort. Res. Inst.
3. Ornamental Hort. Dept., Fac. of Agric., Cairo Univ.

Received 17 / 6 / 2002 *Accepted 4 / 8 / 2002*

ABSTRACT : An investigation was carried out at Hort. Res. Inst. to study the effect of nutrition with NPK and calcium chloride as preharvest treatments and pulsing in 25 ppm GA_3 for one hour before different storage periods (0-time , 7 , 14 and 21 days) at 8-10°C and repulsing in preservative solution contain 30g / L sucrose + 200 mg/L 8-HQS for 24 hours then transferred to distilled water to complete the effect of the shelf life on the qualitative characters of cut tight bud stage of *Hippeastrum vittatum* Herb. cv "Apple Blossom". The results of this study are : application NPK 2:1:1 at the rates of 3g/pot for four times during the cultivation period improved the postharvest handling quality as compared to the untreated plants.

On the other hand , plants treated with NPK then sprayed with calcium chloride at 1000 ppm for three times from the begening of flower bud emergence enhanced flowers quality during handling; i.e. increased vase life and floret longevity as it was more doubled , which had the highest fresh and dry weights and stalk contents of lignin as compared to the control and other treatments. Also, it was more effective in reducing the postharvest problems related to stalk bending and crushing easily up to zero. Adding K with Ca during flowering period had lower effect on flower characters during handling as compared to adding Ca alone. There were positive correlation between floret longevity and fresh and dry weights and negative correlation between stalk bending and other characters, under the effect of pre- and postharvest treatments.

INTRODUCTION

Hippeastrum vittatum Herb, common name amaryllis cv "Apple Blossome" Fam. *Amaryllidaceae.* Large flowered bulbs, plant native to South America. It is grown in Egypt both indoor and outdoor, flowering in mid- April., and lasts for a limited short period (2-4weeks).The average of spike longevity is 7-8 days .

El-Ashry *et al.* (1995) pointed out that 2:1:1 NPK fertilization at 3g/ plant improved flower characters of amaryllis. On gladiolus flowers, Roychowdhury *et al.* (1995) found that application of K_2SO_4 at $8g/m^2$ produced the more number of florets / spike and increased flowers longevity after harvest . *Tagetes erecta* L.; *Zinnia elegans* J. and *Celosia argentea* L. plants treated with $CaCl_2$ gave the highest growth parameters; i.e. hight , fresh and dry weights of both shoots and roots (Menesi *et al.,* 1994) . On the the other hand, Torre *et al.* (1999) show that, in whole cut flowers and in detached petals of roses cvs " Mercedes and Baroness",$CaCl_2$ treatment promoted bud opening and delayed senescence . The treated flowers stayed turgid and continued their initial postharvest growth for longer period .

The previous parts of this study was to detect the best harvest stage, opening solution, vase solution and storage temperature and period (El-Saka and Auda, 1997 a ,b) but, some trade defects appeared during these studies. Through postharvest handling, amaryllis flowers suffer from two major problems; the first is stalk bending and crushing easily. This phenomenon is most common at early harvest stage of maturity (tight bud stage) than at late stage of maturity, exhibiting structurally stronger stems. The second is cleavage stem bases and roll out after flowers holding in water or solution.

The phenomenon of stem

bending at an acute angle under the heavy of flower bud in gerbera is termed "stem break" (Van Meeteren , 1978 b) . Stem stiffness depends on the turgidity of the cells in the neck area and is influenced by the transpiration rate, the rate of water uptake and the ability of different organs to compete for water . As long as there is full turger in the peduncle tissue ,bent neck did not occur in rose flower (Zieslin *et al.,* 1978). Abdel-Kader (1987) found that, placing gerbera flowers in preservative solution (3% sucrose + 200 ppm 8-HQS and citrate phosphate buffer at 3.5 pH) minimized or prevented stem break, enhanced longevity and improved quality of gerbera flowers cut at an early stage of maturity .

The resistance to stem bending in cut roses is related to stem lignin content . Late harvest or application of chemicals that induced lignification increased lignin content and reduced the incidence of bent neck (Parups and Voisey , 1976). Late harvest was also reported to prevent stem bending in cyclamen cut flowers (Halevy *et al.*,1984) . Similarly , the incidence of stem break in cut gerbera inflorescences varied with the season and the stage of development (Van- Meeteren, 1978 a), but this was attributed to their effects on the percentage of the hollowness within the stem (Van-Meeteren , 1978 b) .

The relationship between preharvest ,nutrition and calcium chloride and postharvest handling has never been studied in amaryllis flowers. Therefore, the study was conducted to evaluate the influence of preharvest nutrition with NPK and calcium chloride on postharvest handling quality. In addition, to reduce the stalk bending and crushing easily phenomenon during handling .

MATERIALS AND METHODS

This study was conducted at Horticultural Research Institute , Giza , Egypt , for two successive seasons of 1999 /2000 and 2000 /2001.

1.Preharvest Treatments:

1.1 Planting : Amaryllis bulbs cv "Apple Blossome" of 18 - 20 cm circumference, were planted at Orman Botanical Garden on 1st October, one bulb/ clay pot 30 cm diameter, in the clay soil; its analysis is presented in Table A.

1.2Fertilization: Ammonium sulphate (20.5% N), calcium superphosphate (15.5% P_2O_5) and potassium sulphate (48.5% K_2O). Fertilizers were used to obtain the ratio of 2:1:1 NPK. During the cultivation period, the mixture of NPK was applied (3gm/pot) one time menthly , starting from the 1st of November until 1st of February.

At the begening of flower bud emergence, calcium chloride and potassium sulphate were applied every 15 day starting from 1st March until 1st April as follows :

a.Calcium chloride at 1000 ppm as foliar spray (100 cm/plant)

b.Potassium sulphate at 0.5 gm/pot as soil dressing .

c.The combination of the previous treatments.

2.Postharvest treatments :

The spikes of amaryllis were used in this experiment to study the effect of previous preharvest treatments in addition to the postharvest treatments on postharvest handling quality. The spikes of similar length (50 cm) were harvested on 15th April , at tight bud stage (flower bud showing color but spathe still tight). Then, spikes were transferred to postharvest lab during one hour . Every preharvest treatment had 36 uniformly spikes; they were cut and hold in pulsing solution at 25 ppm GA_3 for one hour. After that, every treatment was divided to four groups. All groups were prepared (packaged with tissue

paper and packed in carton box) to be stored at 8 -10°C for different periods, i.e., 0- time , 7, 14 and 21 days). At the end of the storage period, every group was re-pulsed in 30 gm /L sucrose + 200 mg/L 8HQS (pH 4.6) for 24 hours, then held in distilled water to complete its shelf life, under lab condition : 24 hrs. fluorescent light at 1000 lux , 22 ± 2°C and 50 - 55 RH.

3.The experimental design was split plot. The experimental consisted of 20 treatments which were the combination of five preharvest treatments which were randomly arranged in the main plots [control (without any fertilization), NPK, NPK + K, NPK + Ca and NPK + K +Ca] x four postharvest treatments [storage periods; i.e., 0-time , 7, 14 and 21 days] randomly

Table A. Chemical analysis of used soil in the two seasons (1999 / 2000 and 2000/2001) .

Property	1st season	2nd season
SP %	43.00	42.38
EC (mmhos/cm)	1.38	1.46
pH	7.98	8.07
HCO_3 (Meq/L)	3.80	4.65
Cl^- (Meq/L)	11.00	10.21
$SO_4^{=}$ (Meq/L)	33.91	34.33
Ca^{++} (Meq/L)	17.56	18.00
Mg^{++} (Meq/L)	9.42	9.04
Na^+ (Meq/L)	20.00	20.28
K^+ (Meq/L)	1.73	1.87
N %	0.070	0.07
P %	0.069	0.063

distributed in the sub plots . Each treatment had three replicates and three spikes per replicate .

4.Measurements :

1.Weight loss as percentage of initial weight of spikes during storage periods .

2.Vase life of spikes. The opened flowers were considered at the end of vase life when the edges of floret curled upwards and begin to wilt.

3.Floret longevity as percentage to related untreated flowers .

4.The rate of the increase in fresh weight percentrage after nine days from holding in distilled water (during shelf life) .

5. Spike dry weight percentage at the end of vase life .

6.Stalk bending and crushing percentage .

7.Stalk contents of lignin percentage in four harvest stages from tight bud stage until full open flower were determined according to Soutor and Bryden (1955).

5.Statistics : The data were subjected to statistical analysis according to Thomas and Hill (1978). Correlation coefficients between some studied characters were calculated according to Svab (1973) .

RESULTS AND DISCUSSION

I.Effect of nutrition with NPK and calcium chloride as preharvest treatments on flowers quality during handling

Data present in Fig. 1, clerarly indicate that although, NPK ; NPK + K and NPK + K + Ca treatments showed significant reduction in weight loss percentage during storage periods and showed significantly increase vase life and floret longevity as compared to control, the treatment of NPK + Ca surpassed with significantly in this regard. This indicated that, nutrition with NPK especially NPK plus calcium chloride play an important role for enhancing postharvest handling quality.

From Fig. 2 treatments

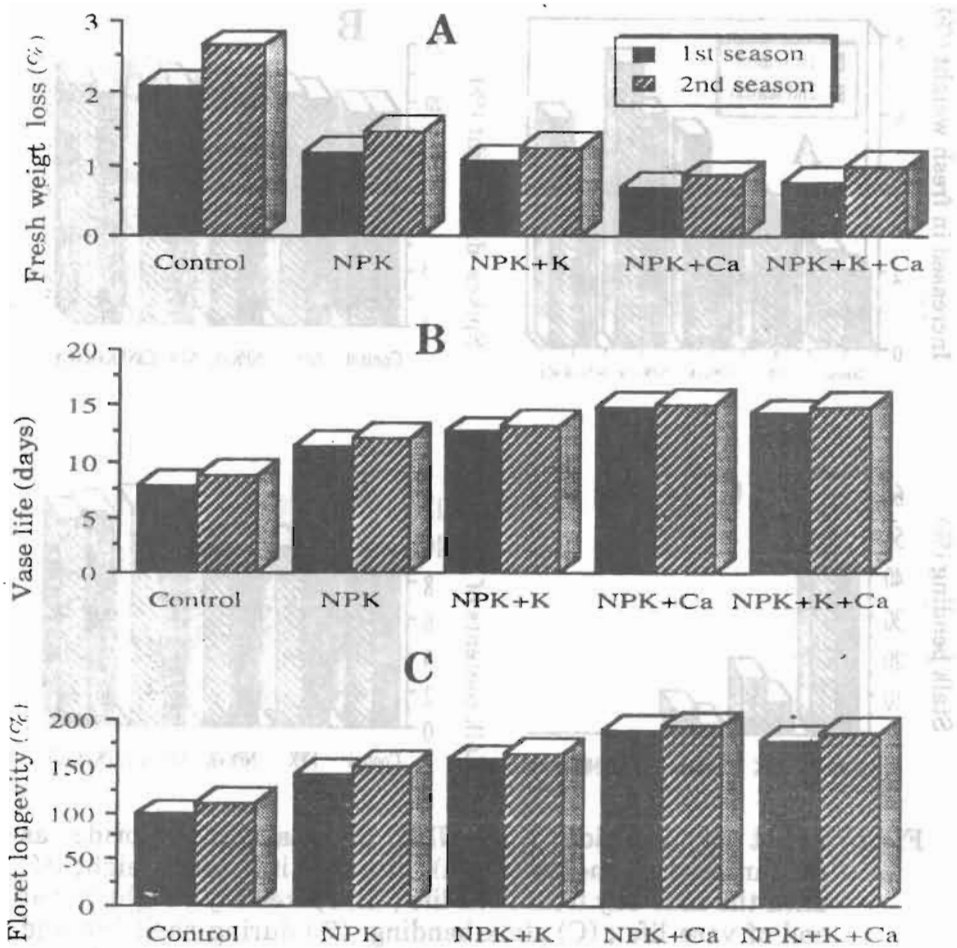

Fig.1.Effect of nutrition with NPK and calcium chloride as preharvest tratments on (A) weight loss as (%) to initial weight of spikes during storage period; (B) vase life (days and (C) floret longevity as (%) to untreated spikes of amaryllis in 1999/2000 and 2000 / 2001 seasons.

L. S. D. at 5% First season (A : 0.12 , B : 1.2 and C : 8.2)
Second season (A : 0.22 , B : 0.80 and C : 5.8)

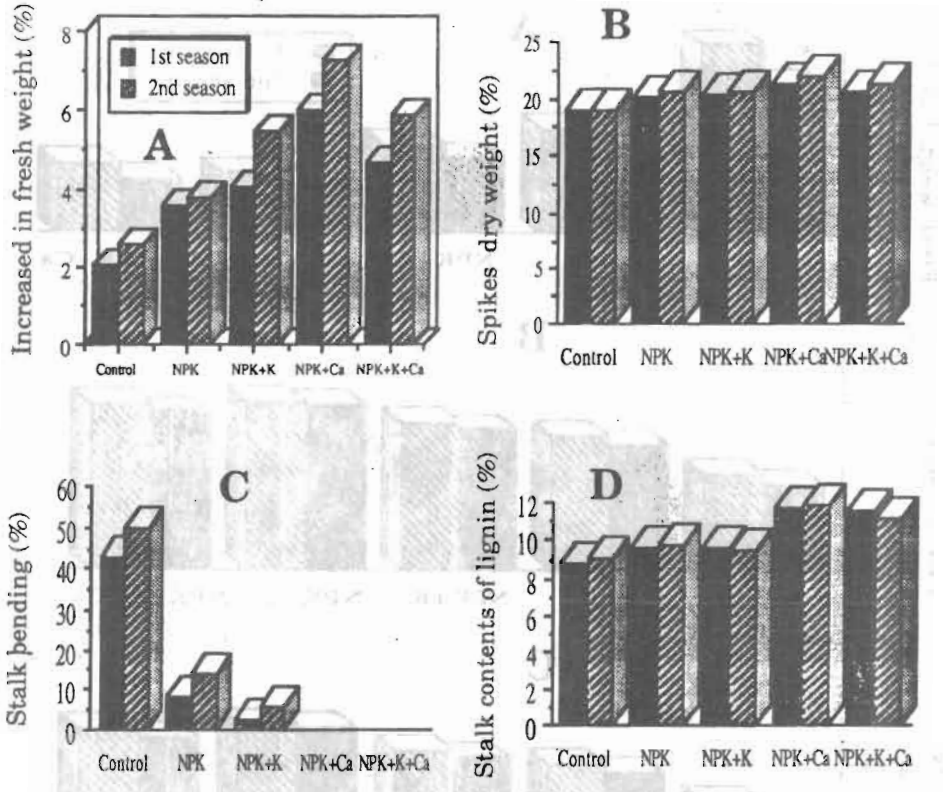

Fig.2. Effect of nutrition with NPK and calcium chloride as preharvest treatments on (A) increased in fresh weight (%) until the nine day from shelf life ; (B) spikes dry weight (%) at end of vase life ; (C) stalk bending (%) during shelf life and (D) stalk contents of lignin (%) , in spikes of amaryllis in 1999/2000 and 2000 / 2001 seasons.

L. S. D. at 5% First season (A : 1.23 , B: 0.33 and D : 0.11)
Second season (A : 1.70 , B: 0.95 and D : 0.35)

of NPK , NPK + K , NPK + Ca and NPK + K+ Ca recorded significant increase in fresh weight until the nine day during shelf life and dry weight of spikes at the end of shelf life as compared to control treatment. NPK + Ca treatment surpassed on the other treatments. The increase in fresh weight than its initial weight of spike may be associated with an enhancing in water uptake, improved water balance and metabolic activities. Thereby, maintaining the freshness of flowers for a longer period due to enhancing floret longevity and also vase life of spikes

Concerning stalk bending and stalk contents of lignin, Fig. 2 shows that, reduced stalk bending to zero was associated with significant increase in stalk contents of lignin under the effect of NPK +Ca and NPK + K + Ca treatments in the two seasons.

It is obvious from results that adding calcium chloride improved postharvest handling quality. These results are in agreement with Gerasopoulos and Chebli (1999) on gerbera flowers. This is due to calcium content in the tissue affects many processes during flowering period and after harvest during handling of flowers. This is in agreement with Ferguson and Drobak (1988) , who mentioned that, calcium content affects on the plant growth at all stages of development. The role of intra- and extracellular calcium in altering cell metabolism is often attributed to its influence on cell wall and membrane structure and function (Ferguson , 1984 ; Konno *et al.,* 1984 and Poovaiah , 1988). Calcium is also involved in the regulation of an array of intra . cellular events as a second messenger . Its signaling role is important for normal cellular function and for the regulation of ongoing metabolic processing in the cytoplasm and organelles (Buch, 1995).

On the other side, NPK + K + Ca treatment recorded

less effect on all characters under study as compared to NPK + Ca treatment . This is due to antagonism between Ca^{++} and K^{+} during the absorption , K^{+} induced the water absorpation. This increased water content in tissue of amaryllis stalk .This is may be increase the abality to stalk bending and crushing easily .

The data in Table 1 show , the correlation coefficient between studied characters as affected by NPK and calcium chloride as preharvest treatments. The increment in floret longevity accompanied by most positive highly significant response to the increase in fresh weight, spike dry weight and stalk contents of lignin, but significantly negative with stalk bending. Moreover, spike dry weight was correlated with negative significant response to stalk bending, but positive significantly response to stalk content of lignin. However, stalk bending had negative response to stalk content of lignin.

II. Effect of storage period and preservative solution as postharvest treatments on flowers quality during handling

As shown in Fig. 3, weight loss of cut spikes of amaryllis were gradually increased with the extended of dry cold storage periods (7, 14 and 21 days) at 8-10°C , in the two seasons. This was in agreement with El-Saka (1996) on iris cut flowers .

Concerning vase life and floret longevity (Fig. 3) and increase in fresh weight until the nine day from shelf life and dry weight of cut spikes at the end of shelf life of amaryllis flowers (Fig. 4) were gradually decrease significantly in most cases with the extended cold dry storage period. This was in agreement with El-Saka 1996 on iris flowers, El-Saka and Auda , (1997, b) on amaryllis flowers and others. This was probably attributed to flower respiration and transpiration. Moreover, stalk bending and crushing easily were associated

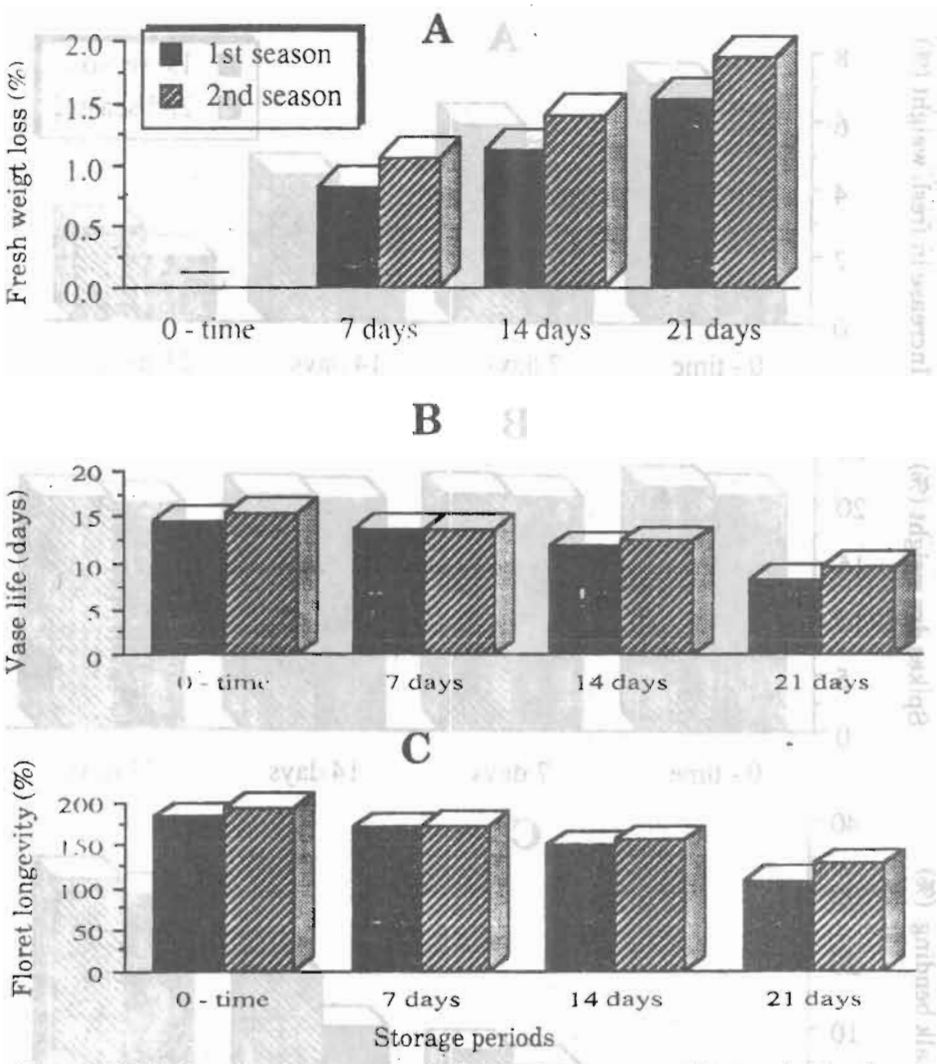

Fig. 3.Effect of storage periods and preservative solution* as preharvest treatments on (A) weight loss as (%) to initial weight of spikes during storage period; (B) vase life (days and (C) floret longevity as (%) to untreated spikes of amaryllis in 1999/2000 and 2000 / 2001 seasons.

L. S. D. at 5% First season (A : 0.30 , B: 1.1 and C : 4.8)
Second season (A : 0.28 , B: 0.15 and C : 6.2)

* preservaltive solution : (1) GA_3 at 25 ppm for 1 hr before storage period
(2) Sucrose at 30g/l + 8-HQS at 200 mg/l at the end of storage period for 24hrs. then holding in distilled water

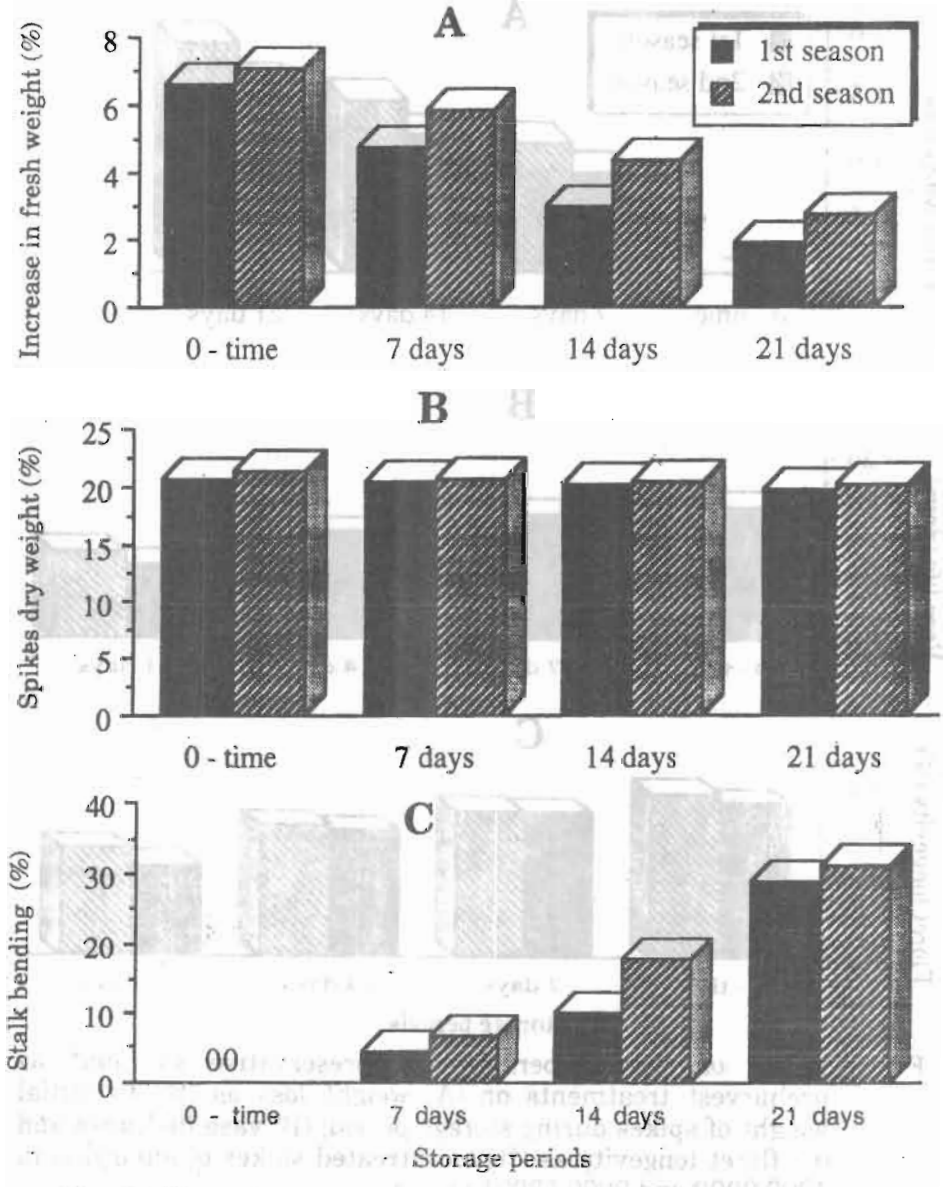

Fig. 4. Effect of storage periods and preservative solutions as postharvest treatments on (A) increase in fresh weight (%) until the nine day from shelf life ; (B) spikes dry weight (%) at the end of vase life and (C) stalk bending (%) during shelf life in the two seasons.

L. S. D. at 5% First season (A: 1.72 and B: 0.25)
Second season (A : 1.24 and B : 0.23)

with the increase of storage period. This was due to a long storage period which induced water stress of cut spikes of amaryllis .

It is obvious from results that, long storage periods are harmful to the flowers quality and it has negative effect on flowers handling. Han (2001) mentioned that cold dry storage periods induced bud blasting, inhibited flowers to fully opening and reduced the longevity and fresh weight of opened flowers of cut stems of asiatic lily.

On the other hand, the extended vase life with high quality of cut flowers depend on their water relations and retarding the rate of senescence which can be achieved by using chemicals . Results under discussion of all preharvest treatments were hold in pulsing solution (25 ppm GA_3) for one hour before cold dry storage. After end of storage period at 8-10°C for 0-time , 7, 14 and 21 days, flowers were re-pulsed in preservative solution (30 g/l sucrose + 200 mg /l 8HQS , pH 4.6) for 24 hours then transferred to distilled water to complete the shelf life period. Vase life was 14.7 and 15.4 days in the two seasons, respectively for 0-time storage period. This result was nearly doubled the vase life under storage for 21 days. However, fresh cut flowers of amaryllis (without any treatment) lasted for 7-8 days, when they were placed in water only. These result was showed similar trand. Flowers of amaryllis can be stored until 21 days at 8- 10°C with obviating any negative effect on flower quality under the above mentioned condition.

There was a positive relation between harvest stage from tight bud to fully open and stalk contents of lignin. With the progress of flowers maturity. Flowers the lignin contents increased in stalk of amaryllis (Fig. 5).

Concerning the correlation between study characters as affected by postharvest

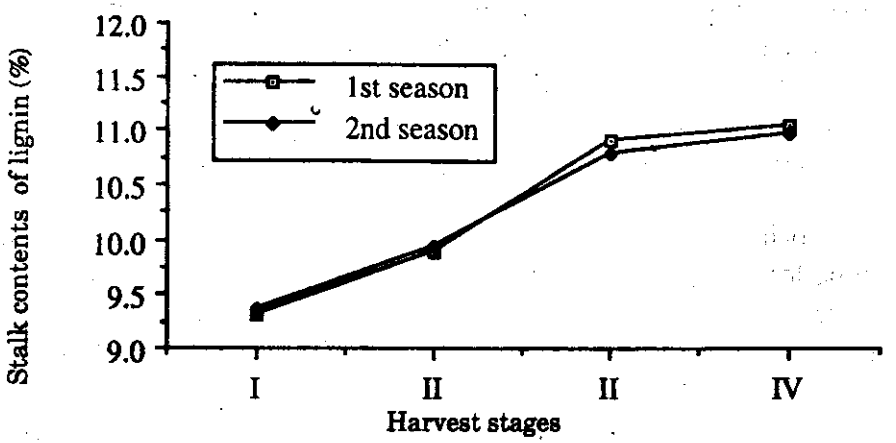

Fig. 5. Stalk content of lignin (%) in different harvest stages; I. Tight bud ; II. Appearance of two tight bud from the spathe; III. Appearance of three bud from the spathe and IV. fully open florets, in 1999 / 2000 and 2000/2001 seasons.

L. S. D. at 5% : First season (0.23) % Second season (0.52)

Table 1. Correlation coefficient between some characters as affected by preharvest treatments (average of the two seasons).

Characters	y	1	2	3	4
Y- Flower longevity	-	0.9592**	0.9774**	-0.9534*	0.9133*
1.Increased in fresh weight			0.9748**	-0.8700	0.9255*
2.Spike dry weight				-0.9315*	0.9185*
3. Stalk bending					-0.7624
4.Stalk contents of lignin					-

* Significantly at P≥ 0.05 **Significantly at P≥ 0.01

treatment in Table 2 indicated that vase life had positive and significant response to floret longevity and the increase in fresh weight and dry weight of spikes. However, it showed significantly negative response to stalk bending. Moreover, there are positive relation between floret longevity and the increase in fresh weight and dry weight of spikes but negative effect on stalk bending.

III.Effect of the interaction between nutrition with NPK and calcium chloride as preharvest treatments and storage periods and preservative solution as postharvest treatments on flower quality during handling.

Data in Table 3 illustrated that weight loss of amaryllus cut spikes as a percentage of initial spike weight during dry cold storage periods up to 21 days. This loss was originally attributed to flowers respiration and transpiration. The results under discussion pointed out that, the reduction of fresh weight loss during dry cold storage periods was affected by preharvest and postharvest treatment.

The interaction between NPK and calcium chloride as preharvest treatments and different storage periods as postharvest treatments recorded significantly decreased in weight loss of spikes as compared to NPK + K+Ca, NPK + K, NPK and the control under the same psotharvest treatments, respectively (Table 3).

Shedeed *et al.* (1993) on amaryllis flowers, stated that, NPK fertilization effect might be essentially in increase the plant growth. The more available supply of nitrogen fertilizers might allow the meristematic system to be more active and would encourage the plant to carry more active leaves and number of flowers. Prestorage application of $CaCl_2$ has been demonstrated to reduce chilling - induce disorder in many horticultural crops (Battey, 1990). The

Table 2. Correlation coefficient between some characters as affected by postharvest treatments (average of the two seasons.

Characters	y	1	2	3	4
Y- Vase life	-	0.9998**	0.9731*	0.9685*	-0.9985**
1.Floret longevity			0.9767*	0.9728*	-0.9974**
2.Increased in fresh weight				0.9983**	-0.9628*
3. Spikes dry weight					-0.9557*
4. Stalk bending					-

* Significantly at P≥ 0.05 **Significantly at P≥ 0.01

Table 3.Effect of the interaction between nutrition with NPK and calcium chloride as preharvest treatments and storage periods and preservative solution* as postharvest treatments on weight loss as (%) of initial weight of amaryllis spikes in 1999/2000 and 2000/2001 seasons.

Preharvest treatments	Storage periods (days)					
	1st season			2nd season		
	7	14	21	7	14	21
Control	1.24	2.11	2.95	1.98	2.76	3.25
NPK	0.94	1.15	1.47	1.15	1.39	1.46
NPK + K	0.89	1.01	1.33	0.90	1.15	1.26
NPK + Ca	0.48	0.60	0.98	0.57	0.87	0.88
NPK+ K+Ca	0.55	0.75	1.01	0.75	0.90	1.00
L.S.D. at 5%		0.50			0.65	

*Preservative solution 1.GA_3 at 25 ppm for 1 hr before storage

2.Sucrose at 30 g/L + 8HQS at 200 mg/L for 24hr at the end of storage period , then holding in distilled water.

important role of Ca^{++} is due to its influence the cell wall and membrane structure and function.

Concerning vase life and floret longevity (Tables 4 and 5) of amaryllis spikes, data show that, termination of NPK application before harvest and pulsing in GA_3 before storage and re-pulsing in 30 g/L sucrose + 200 mg/L 8-HQS after the end of storage periods for 0-time, 7, 14, and 21 days at 8-10°C has been found to increase vase life and floret longevity as compared to control treatment. This is in agreement with Nell and Barrett (1995) on chrysanthemum amd poinsettia flowers . NPK + Ca treatment were applied before harvesting at tight bud stage then storage its at 8-10°C for 0-time 7 and 14 days, enhanced postharvest flowers quality, and more effective significant increment in vase life and floret longevity as a compared to this treatment when it stored for 21 days and other treatments. This is attributed to the effect of Ca^{++}. The beneficial effects of prestorage calcium treatments reduce ethylene production and delayed senescence (Klein *et al,* 1990).

Regarding, the rate of the increase in fresh weight until the nine day and spikes dry weight at the end of vase life, it showed the same trend. mention above (Tables 6 & 7).

The increase in vase life and floret longevity of amaryllis spikes were accompanied by increase in fresh weight, and accumulation of dry matter and enhancing water balance. Likewise , improved water balance due to increase water uptake by preservative solution and reducing water loss, these lead to delay senescence and maintain spikes quality during shelf life.

Data of both seasons in Table 8 reveal the interaction between nutrition with NPK and calcium chloride as preharvest treatments and preservatives and storage periods as postharvest treatments. Results that, all treatments

Table 4. Effect of the interaction between nutrition with NPK and calcium chloride as preharvest treatments and storage periods and preservative solution as postharvest treatments on vase life (day) of amaryllis spikes in 1999/2000 and 2000/2001 seasons.

Preharvest treatments	Storage periods (days)							
	1st season				2nd season			
	0-time	7	14	21	0-time	7	14	21
Control	10.3	8.30	7.30	5.50	11.5	9.8	8.00	6.00
NPK	13.0	12.2	11.0	8.7	14.8	11.9	11.3	10.2
NPK + K	14.7	14.5	12.8	8.3	15.0	14.2	13.5	10.2
NPK + Ca	18.7	16.8	14.7	9.7	18.2	16.9	15.0	12.2
NPK+ K+Ca	17.0	16.5	13.3	10.0	17.6	15.9	14.2	11.9
L.S.D. at 5%	3.2				2.7			

Table 5. Effect of the interaction between nutrition with NPK and calcium chloride as preharvest treatments and storage periods and preservative solution as postharvest treatments on floret longevity as (%) of amaryllis spikes in 1999/2000 and 2000/2001 seasons.

Preharvest treatments	Storage periods (days)							
	1st season				2nd season			
	0-time	7	14	21	0-time	7	14	21
Control	128.7	103.7	91.2	68.7	143.7	122.5	100.0	75.0
NPK	162.5	152.5	137.5	108.7	155.0	148.7	141.2	127.5
NPK + K	183.7	181.2	160.0	103.7	187.5	177.5	168.7	127.5
NPK + Ca	231.2	210.0	183.7	133.7	227.5	211.2	187.5	152.5
NPK+ K+Ca	212.5	206.2	166.2	125.0	220.0	198.7	177.5	148.7
L.S.D. at 5%	9.64				8.75			

Table 6. Effect of the interaction between nutrition with NPK and calcium chloride as preharvest treatments and storage periods and preservative solution as postharvest treatments on increased in fresh weight until the 9 dry as (%) of amaryllis spikes in 1999/2000 and 2000/2001 seasons.

Preharvest treatments	Storage periods (days)							
	1st season				2nd season			
	0-time	7	14	21	0-time	7	14	21
Control	3.66	2.63	1.08	0.75	4.20	3.60	2.12	0.50
NPK	6.33	3.86	2.55	1.58	5.90	4.20	2.90	2.12
NPK + K	6.50	4.95	2.80	2.24	7.15	6.60	4.87	3.25
NPK + Ca	9.00	7.35	4.80	2.90	9.76	8.50	6.80	4.25
NPK+ K+Ca	7.65	5.14	3.85	2.12	8.35	6.25	5.13	3.65
L.S.D. at 5%		2.32				1.68		

Table 7. Effect of the interaction between nutrition with NPK and calcium chloride as preharvest treatments and storage periods and preservative solution as postharvest treatments on spikes dry weight (%) at the end of vase life of amaryllis spikes in 1999/2000 and 2000/2001 seasons.

Preharvest treatments	Storage periods (days)							
	1st season				2nd season			
	0-time	7	14	21	0-time	7	14	21
Control	19.5	19.32	19.05	18.50	19.81	19.22	18.50	18.00
NPK	20.31	20.12	20.10	19.86	20.80	20.25	20.62	20.46
NPK + K	20.65	20.45	20.35	20.06	21.25	20.93	20.36	19.90
NPK + Ca	21.80	21.53	21.00	20.80	22.55	22.00	21.80	21.20
NPK+ K+Ca	21.24	20.72	20.21	19.90	21.90	21.45	20.90	21.20
L.S.D. at 5%		1.58				1.24		

reduced stalk bending crushing easily as compared to spikes stored for 21 day with NPK+K, NPK and control with most stored periods, respectively. This may be due to the effect of fertilization with NPK plus potassium sulphate or calcium chloride or two together. These chemicals improve cell turgidity which may have a role in spike bending process. Ali *et al.* (1995) found that, the optimum concentration of 0.8% $CaCl_2$ proved to be effective on delaying the rate of softening and preserving the postharvest quality of red raspberries stored at 0°C up to 12 days. Also, El-Saka and Auda (1997,b) found that gibberellin was more effective in preventing spike bending than other preservative solutions. This may be due to the important role of GA_3 in improving cell turgidity leading to reduce stalk bending. Also, GA_3 improved water balance and increased fresh weight .

From Table 9 it is clear that, with increase development of harvest maturity stage, the stalk contents of lignin increased under influence of treatments with NPK+ Ca, NPK+K+Ca, NPK+ K, NPK and control treatments descendingly with significant differences.

CONCLUSION

Termination of nutrition with NPK (3g / plant) monthly for four times during cultivation period then sprayed with $CaCl_2$ (at 1000 ppm) for three times every 15 days starting from the begening of flower bud emergence and harvesting at tight bud stage then pulsing in GA_3 at 25 ppm for one hour then stored at 8-01°C for 0-time, 7, 14 and 21 days and re- pulsing in 30g/L sucrose + 200 mg / L 8-HQS for 24 hr then holding in distilled water increased postharvest and handling quality of amaryllis spikes and reduced stalk bending and crushing easily.

REFERENCES

Abdel-Kader, H. H., 1987. Effect of flower preservative

Table 8. Effect of the interaction between nutrition with NPK and calcium chloride as prehrvest treatments and storage periods and preservative solution as postharvest treatments on stalk bending as (%) during shelf life of amaryllis spikes in 1999/2000 and 2000/2001 seasons.

Preharvest treatments	Storage periods (days)							
	1st season				2nd season			
	0-time	7	14	21	0-time	7	14	21
Control	0.0	22.2	50.0	100.0	0.0	33.3	66.6	100.0
NPK	0.0	0.0	0.0	33.3	0.0	0.0	22.2	33.3
NPK + K	0.0	0.0	0.0	11.1	0.0	0.0	0.0	22.2
NPK + Ca	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NPK+ K+Ca	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 9. Effect of the interaction between nutrition with NPK and calcium chloride as preharvest treatments and storage periods and preservative solution as postharvest treatments on stalk contents of lignin (%) at different harvest stages of amaryllis spikes in 1999/2000 and 2000/2001 seasons.

Preharvest treatments	Harvest stages							
	1st season				2 nd season			
	I	II	III	IV	I	II	III	IV
Control	8.45	8.82	9.00	9.00	8.60	9.10	9.20	9.35
NPK	8.96	9.52	9.95	10.18	9.05	9.71	9.95	10.28
NPK + K	8.55	9.36	10.20	10.40	8.65	9.11	9.90	10.11
NPK + Ca	10.33	10.85	12.92	12.96	10.50	11.00	12.98	13.20
NPK+ K+Ca	10.28	10.92	12.54	12.80	10.01	10.85	11.96	11.96
L.S.D. at 5%	0.58				0.65			

solutions on postharvest physiology, developmental ultrastructure and the stem break problem of cut gerbera. Ph. D. Thesis, Faculty of the Gracluate School, Univ. of Missouri. Columbia.

Ali, G. A; G. Stavroulakis and D. Gerasopoulos. 1995. The effect of preharvest $CaCl_2$ treatments on the quality of red raspberry during harvest and storage at O°C. Proceeding of the Inter Sym. on Postharvest Physiology, Pathology and Technologies for Hort. Comm. Agadir, Morocco 16-21 January 1994 p. 65-69.

Battey, N. H, 1990.Calcium deficiency disorders of fruits and vegetables. Postharvest News and Inf.1: 23-27.

Bush, D. S., 1995. Calcium regulation in palnt cell and its role in signaling. Ann. Rev. Plant, Physiol Plant Mol. Biol. 46: 95-122.

El-Ashry , Ameana I.; M. S. Auda and M. Y. Bakry , 1995. Response of amaryllis *(Hippeastrum vittatum*, Herb.) to different growing media and chemical fertilization levels. J. Agric. Res. Tanta Univ., 21(4):754-769.

El-Saka, Magda M. 1996. Postharvest handling of bud cut iris flowers . 4th Arabic Conf. for hort. Crops El-Minia, Egypt. 1293-1302.

El-Saka , Magda M. and M. S. Auda, 1997 a. Postharvest of *Hippeastrum vittatum*, Herb., cv "Apple Blossom" flowers. I. Effect of harvest stage and pulsing solution. Egypt J. Appl. Sci; 12 (2) : 244-258.

El-Saka , Magda, M. and M. S. Auda, 1997 b. Postharvest of *Hippeastrum vittatum*, Herb., cv "Apple Blossom" flowers 2. Effect of cold dry storage and pulsing solution Egypt . J. Appl.Sci.12 (3):128-145.

Ferguson, I. B. 1984. Calcium in plant senescence of fruit ripping. Cell Environ.,7: 477-487.

Ferguson, I. B. and B. K. Drobak , 1988. Calcium and the regulation of plant growth and senescence. Hort. Sci., 23 : 262 - 266.

Gerasopoulos , D. and B. Chebli , 1999. Effect of pre - and postharvest calcium application on the vase life of cut gerbera . J. Hort. Sci. and Biotechnology : 74 (1) : 78-81.

Halevy , A. H.; H. C. Kohl and A. M. Kofranek, 1984. Senescence and postharvest handling of cyclamen flowers. Hort Sci. 19 (6):848-850.

Han, Susan S. 2001. Benzyladenine and gibberellin improved postharvest quality of cut asiatic and oriented lilies . Hort. Sci. 36 (4): 741-745.

Konno, H.; T. Yamaya; Y. Yamasaki and H. Matsumoto, 1984. Pectic polysaccharide break-down of cell walls in cucumber roots grown with calcium starvation. Plant Physiol. 76: 633 - 637.

Klein, J. D.; S. lurie and R. Ben-Arie, 1990. Qulity and cell wall component of "Anna" and "Granny Smith" apples treated with heat, calcium and ethylene. J. Amer. Soc. Hort. Sci. 115 : 954-958.

Menesi, Fordose A.; M. M. Khalafalla and Y. Kandeel, 1994. Effect of some growth regulators and calcium chloride on *Tagetes erecta* L.; *Zinnia elegans* J. and *Celosia argentea* L. plants. The 1st Conf. of Ornamental Hort. Vol. (2) : 408-425.

Nell, T. A. and E. Barrett, 1995. Effect of production light level and fertilization on acclimatization and post-prod-uction longevity of chrysanthemum and poinsettia. HortScience 20 : 562.

Parups , E. V. and J. V. Voisey, 1976. Lignin content and resistance to bending of the pedicel in greenhouse grown roses. Hort. Sci. 51 : 253-259.

Poovaiah, B. D. 1988. Molecular and cellular aspects of calcium action in pants . Hort. Sci., 23 : 267-271.

Roychowdhury, N.; P. Roychowdhury,T. Fjeld and E. Stromme, 1995. The effect of field application of K^+ on postharvest behaviour of gladiolus. Acta Hort. 405 - 172.

Soutor, H. and M. Bryden, 1955. Differentiation of fruit and other vegetable fibers by acetyle content. J. Text. Inst. Trans. Vol. 46: 528 -529.

Shedeed, M. R.; Sh. A. El-Gindy; E. S. Nofal and M. S. Auda, 1993. Physiological studies on amaryllis bulbs. I. Effect of kinetin and fulifertil on growth, flowering and bulb productivity. Minia 1st Conf. Hort. Crops 14-21 Oct. 1033-1057.

Svab, J. 1973. Biometrial modszerek akutatsfan Mezogazd or sagikiada-Budapest.

Thomas , M. I. and F. D. Hill , 1978. Agricultural Expermentation. Jan Wiley and Aons New York.

Torre, S.; A. Borochav and A. Halevy , 1999. Calcium regulation of senescence in rose petals. Physiologia Plantarum 107 : 214-219.

Van-Meeteren, U.,1978 a. Water relation and keeping quality of cut gerbera flowers. I. the cause of stem break. Hort Sci. 8 : 65-75.

Van-Meeteren, U.,1978 b. Water relations and quality of cut gerbera flowers. II. water balance of aging flowers. Hort. Sci. 9 : 189-197.

Zieslin , N. ; H. C. Kohl, A. M. Kofranek and A.H. Halevy, 1978 . Changes in water status of cut roses and its relationship to bent neck phenomenon. J. Amer. Soc. Hort. Sci., 103 (2) : 126-179.

تأثير التسميد بالنيتروجين والفوسفور والبوتاسيوم والرش بكلوريد الكالسيوم على جودة ازهار الاميريللس بعد القطف وخلال فترة التداول

ماجدة مصطفى السقا[١] – مصطفى عودة[٢] – طارق أبو دهب[٣]

١– معمل تداول الزينة – قسم بحوث الزينة – معهد بحوث البساتين.
٢– حديقة الأورمـــان – قسم بحوث الزينة – معهد بحوث البساتين.
٣– قسم بساتين الزينة – كلية الزراعة – جامعة القاهرة.

أجرى هذا البحث خلال موسمين متتاليين ١٩٩٩/٢٠٠٠ – ٢٠٠٠/٢٠٠١ حيث تم زراعة الأبصال فى حديقة الأورمان بالجيزة وأجريت معاملات التسميد بـ NPK والـرش بكلوريد الكالسيوم وبعد قطف الأزهار فى مرحلة البرعم الناضج المغلق تم نقلها إلى معمل التداول بقسم بحوث الزينة بمعهد بحوث البساتين بالجيزة حيث أجريت معاملات ما بعد الحصاد.

وُضعت الأزهار بعد القطف فى محلول الجبريللين ٢٥ جزء/مليون لمدة ساعة ، بعد ذلك أُعدت الأزهار للتخزين على درجة ٨ ـ ١٠ °م لمدة صفر، ٧، ١٤، ٢١ يوم بعد إنتهاء فترة التخزين ، أُعيد وضع الأزهار فى محلول مكون من ٣٠٪ سكروز + ٢٠٠ ملليجم/لتر هيدروكسى كينولين سلفات لمدة ٢٤ ساعة ، بعد ذلك نقلت الأزهار إلى الماء المقطر.

أدى تسميد النباتات بـ NPK ١ : ١ : ٢ خلال موسم النمو إلى تحسين صفات الأزهار خلال التداول عند مقارنتها بأزهار النباتات الغير مسمدة.

أدى تسميد النباتات بـ NPK ثم رشها بكلوريد الكالسيوم (٣ مرات خلال فترة تكوين الأزهار) بمعدل ١٠٠٠ جزء/ مليون إلى زيادة عمر الأزهار فى الفازة ، وزيادة عمر الزهيرات على الساق الزهرية ، وزيادة معدل الوزن الطازج والوزن الجاف للأزهار، وكذلك محتوى الساق من اللجنين عند مقارنتها بأزهار النباتات الغير معاملة بعد نهاية فترة التخزين ، أدى استخدام المواد الحافظة إلى إختزال بعض مشاكل التداول وخاصة ظاهرة إنحناء الساق بعد التخزين ومن الملاحظ أيضا عند إضافة سلفات البوتاسيوم إلى معاملة NPK وكلوريد الكالسيوم كانت أقل تأثيراً عند مقارنتها بمعاملة بـ NPK مـع كلوريد الكالسيوم فقط .

هناك أرتباط ايجابى بين عمر الأزهار ووزنها الطازج والجاف وأيضاً ارتباط سلبى بين ضاهرة انحناء الساق وسهولة تهشمها وباقى الصفات الأخرى تحت تأثير المعاملات قبل وبعد الحصاد.