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THE EFFECT OF POSTHARVEST TREATMENTS ON FLOWER QUALITY AND VASE LIFE OF CUT ALSTROEMERIA 'DANCING QUEEN'

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A B S T R A C T

Alstroemeria is one of the most popular cut flowers in Europe, due to its postharvest longevity and a wide colour palette. However, premature leaf yellowing reduces the ornamental value of the flowering stems even before opening of the secondary florets in cymes. The aim of this study was to evaluate the use of sucrose, gibberellin and 8-hydroxychinoline citrate as postharvest treatments of cut *Alstroemeria* 'Dancing Queen'.

Several "flower models" were used to distinguish the effects of the chemicals on senescence of flowers and leaves in the above cultivar. Flowering stems were harvested in November 2011 and March 2012 and the response to treatments for both dates differed: while the longevity of primary and secondary florets was prolonged by the standard preservative (8-HQC+S) in the autumn, there was no difference for the spring collection date. For the March harvest, the secondary flower buds opened faster than for the November harvest, where bud opening was generally hastened by 8-HQC+S. Also, the flower model affected floret longevity and changed the response to the treatments: florets on defoliated flowering stems responded better to the preservative than those on stems with leaves. Florets from different flower models differed in diameter: those from complete stems were usually larger than those from isolated cymes. The secondary florets were much smaller than the primary florets, especially in isolated cymes. Both, GA_3 and the standard preservative significantly increased the second floret diameter in all models; however, there were no additive effects of the treatments. GA_3 significantly postponed leaf yellowing in all floral models while the sugar-containing preservative had little effect. Generally, the flower model had significant effect on leaf longevity.

Key words: standard preservative, GA_3, floral model, flower and leaf senescence

INTRODUCTION

Alstroemeria, commonly known as Peruvian Lily, belongs to the family *Alstroemeriaceae.* It is an important cut flower in Northern Europe (Breeze et al., 2004) and is popularly used in bouquets and flower arrangements. Due to its good postharvest longevity and a wide colour palette, alstroemeria became one of the most popular cut flowers, advancing in 2007 to the sixth position in the rank of 10 most important cut flowers sold by Dutch flower auctions .

The flowering shoots of alstroemeria bear numerous leaves and end with cymose inflorescences with three or four florets per cyme (Hicklenton, 1991). The vase life can be long, up to 14 days, and it is usually terminated by petal abscission of the flower (Chanasut et al., 2003; Wagstaff et al., 2005). However, the major postharvest problem associated with cut alstroemeria is premature leaf yellowing occurring well before senescence of the secondary florets (Mutui et al., 2001). To avoid the problem, leaves are commonly removed from shoots used in mixed bouquets (Hicklenton, 1991). However, this practice is unsatisfactory when cut stems are sold individually. Therefore, maintenance of green colour in the leaves is an important quality attribute in alstroemeria (Mutui et al., 2006).

Postharvest chemical treatments are used to reduce leaf yellowing and extend the alstroemeria's vase life. Presence of a sugar in the vase solution effectively delays petal wilting and abscission, and prolongs the longevity of many cut flowers. The exogenous sugars provide substrates for respiration, structural support and improve water balance in cut flowers (Pun and Ichimura, 2003). However, exogenous sucrose accelerates leaf yellowing on cut stems and in cut foliage (Skutnik and Łukaszewska, 2001). The initiation and progression of leaf senescence can be affected by both internal and external factors such as extremes of temperatures, moisture, pathogens, radiation intensity and duration. The internal senescence-inducing factors appear to be hormonally regulated (Weaver et al., 1998). Pre-treatments of cut stems with gibberellins have been reported to delay leaf yellowing in alstroemeria (Dai and Paull, 1991; Ferrante et al., 2002; Łukaszewska et al., 2008) and Easter lily leaves (Han, 1995). As presence of bacteria in vase water and xylem vessels obstructs water uptake and reduces cut flowers' longevity, 8-hydroxychinoline citrate (8HQC) is commonly used as antimicrobial agent in vase solutions, and it is effective for alstroemeria (Healy and Lang, 1989; Łukaszewska et al., 2008)

Alstroemeria 'Dancing Queen' is a cultivar with bright orange petals. It was recognized as the best new cultivar, receiving the Alstroemeria Award in Keukenhof, Netherlands (www.newplantsandflowers.com) and its popularity in the cut flower market is growing. However, no postharvest studies have been done on this cultivar. Therefore, the objective of this study was to evaluate the effectiveness of sucrose, gibberellin and 8-hydroxychinoline citrate as

postharvest treatments in the improvement of the postharvest quality of cut alstroemeria. Several "flower models" were used to compare the effects of the chemicals − commonly used on cut alstroemerias − on senescence of flowers and leaves in the above cultivar.

MATERIAL AND METHODS

Plant material

Cut flowers of *Alstroemeria* 'Dancing Queen' were harvested in November 2011 and March 2012 from a commercial nursery. The flower stems were cut at the stage where all buds were closed but primary florets were already coloured. Cut inflorescences were graded and separated into five "flower models": defoliated cut stems with inflorescences, leafy cut stems without flowers, complete inflorescences, isolated cymes and leaves. Cut stems were trimmed to 60 cm as measured from the top of the inflorescence; the lower 10 cm of the stems were defoliated and 2 cm were cut off under water to avoid air embolism before the stems were placed in glass jars containing different vase solutions. Ten inflorescence stems or floral parts were used for each treatment in the study, individually tagged and treated as single replications.

Treatments

Cut alstroemerias were continuously held in four different vase solutions: 0.1 mM GA_3, 200 ppm 8-hydroxychinoline citrate + 2% sucrose (8HQC+S), 200 ppm 8-hydroxychinoline citrate + 2% sucrose + 0.1 mM GA_3 (8HQC+S+GA_3) and distilled water (dH_2O) used as control. Experiments were carried out in a phytotron at 20 $\pm$1 °C; 60% RH, irradiance intensity of 35 µmol m^{-2} s^{-1} and under a 12 h photoperiod.

Vase life

Vase life of three flower types: isolated cymes, inflorescences on defoliated cut stems, and leafy flowering stems were determined from the time of harvest to petal drop (abscission), separately for the primary and secondary florets. Days to the second floret opening were also recorded.

Floret diameter

The diameter of the first floret was measured on day 3 of vase life while the diameter of the second floret was measured on the day after opening. Diameters were measured in two perpendicular directions. The averages of these two measurements are given as results of floret diameter.

Pedicel length

On the day of the diameter measurements three pedicels were measured from each inflorescence, on all 10 stems/isolated inflorescences. The length was measured from the base of the umbel till the base of the last (tertiary) bud.

Leaf yellowing

Leaf yellowing of four floral models: isolated cymes (the uppermost whorl of leaves evaluated), cut stems without flowers, cut leafy

stems with inflorescences and detached leaves was determined by daily observations. Leaf longevity is given as a number of days from harvest until the leaves showed yellowing on *ca* 30% of their surface.

Statistical analyses

The experiment was designed as a factorial arrangement in a completely randomised design with different flower types (isolated cymes, defoliated cut stems, complete inflorescences, cut stems without flowers and leaves only) and four chemical treatments. The differences among treatments were analysed by Least Significant Difference (LSD) test at $p \leq 0.05$ (SAS Version 9.1, 2003).

RESULTS

Vase life

In general, the vase life of the primary floret in flowers harvested in November 2011 was significantly longer when treated with the standard preservative (SP) 8HQC+S and 8HQC+S+GA_3 as compared to the aqueous solution of GA_3 and distilled water (Tab. 1). Flower models used modified the effects of holding solutions. The effect of SP was more pronounced on defoliated stems than on the leafy ones: flower longevity was increased by nearly 3 days. In flowers harvested in March' 12 leaf removal did not change the longevity of the primary and secondary florets. In complete flowering stems from the November harvest the positive effect of GA_3 on the first floret longevity was seen, statistically significant for stems held in the standard preservative. In flowers harvested in March 2012, there was no significant difference in the vase life of the primary floret when different flower models and vase solutions were used, except in defoliated cut stem treated with 8HQC+S+GA_3 which decreased vase life relative to water (Tab. 1).

In flowers harvested in November 2011, the vase life of the second floret was significantly affected both by the chemical treatments and the flower model, the latter effect clearly seen in water controls where flowers on isolated cymes and complete stems lasted 5.8 days and 6.6 days, respectively, while those on defoliated stems – 8.3 days (Tab. 2). Similarly as in the first floret, the longevity was prolonged by the standard preservative. However, in isolated cymes the effect of the water solution of GA_3 was significantly better than that of SP and the florets had the longest vase life, 10.2 days. When added to the standard preservative, GA_3 was ineffective. In flowers harvested in March 2012, there were no differences in the vase life of the second floret when different flower models and vase solutions were used, except again in isolated cymes, where the shortest vase life of 5.5 days was recorded in florets treated with 8HQC+S (Tab. 2). Generally, the longevity of alstroemerias harvested in March was shorter than that cut in November,

In November 2011 11.5-13.1 days were needed for the second floret to open in different flower models held in water (Tab. 3). This period was

Table 1. Effect of GA_3, 8HQC+S and 8HQC+S+GA_3 on vase life of the first florets of cut alstroemerias with three flower models used on two harvest dates

Treatment	Vase life (days)					
	November'11			March'12		
	isolated cymes (without stem)	cut inflores-cences (defo-liated)	cut inflores-cences (com-plete)	isolated cymes (without stem)	cut inflores-cences (defo-liated)	cut inflores-cences (com-plete)
dH_2O	11.5 de*	12.3 bcd	10.3 e	10.5 ab	11.0 a	10.3 abc
GA_3	11.2 de	11.7 de	11.4 de	9.4 bc	10.3 abc	9.9 abc
8HQC+S (SP)	13.5 abc	15.0 a	12.0 cd	9.8 abc	10.0 abc	10.8 a
8HQC+S+GA_3	13.8 ab	15.0 a	13.6 ab	10.4 abc	9.2 c	10.2 abc

*Values are the means of 10 flowers. Means within the harvesting time followed by the same letter are not significantly different by LSD at $p \leq 0.05$

Table 2. Effect of GA_3, 8HQC+S and 8HQC+S+GA_3 on vase life of the second florets of cut alstroemerias with three flower models used on two harvest dates

Treatment	Vase life (days)					
	November'11			March'12		
	isolated cymes (without stem)	cut inflores-cences (defo-liated)	cut inflores-cences (com-plete)	isolated cymes (without stem)	cut inflores-cences (defo-liated)	cut inflores-cences (com-plete)
dH_2O	5.8 e*	8.3 d	6.6 e	7.0 a	7.1 a	6.7 a
GA_3	10.2 a	9.8 ab	8.0 d	7.2 a	6.8 a	7.4 a
8HQC+S (SP)	8.7 bcd	9.4 abc	8.7 bcd	5.5 b	7.0 a	6.8 a
8HQC+S+GA_3	9.4 abc	9.7 ab	9.2 abcd	6.5 ab	6.5 ab	6.4 ab

*Explanations: see Table 1

Table 3. Effect of GA_3, 8HQC+S and 8HQC+S+GA_3 on number of days till the second floret opening in cut alstroemerias with three flower models used on two harvest dates

Treatment	Bud opening (days)					
	November'11			March'12		
	isolated cymes (without stem)	cut inflores-cences (defo-liated)	cut inflores-cences (com-plete)	isolated cymes (without stem)	cut inflores-cences (defo-liated)	cut inflores-cences (com-plete)
dH_2O	13.1 a*	11.6 b	11.5 bc	9.3 bcd	9.3 bcd	8.8 de
GA_3	10.6 ef	11.3 bcd	10.9 cde	9.8 ab	9.0 cde	8.6 e
8HQC+S (SP)	10.4 efg	10.8 de	10.1 fg	10.0 a	9.0 cde	9.1 cde
8HQC+S+GA_3	9.9 g	10.3 efg	9.9 g	10.0 a	9.5 abc	9.4 abcd

*Explanations: see Table 1

significantly shortened by GA_3 in isolated cymes. In all other cases gibberellic acid was ineffective (Tab. 3). Bud opening was generally hastened by 8-HQC+S. In alstroemerias harvested in March 2012, secondary flower buds opened faster that on stems harvested in November. In the November- harvested alstroemerias the number of days to full opening of the second bud was decreased in isolated cymes by GA_3 and SP as compared to water but increased in the March'12 cut flowers placed into SP and SP+GA_3.

Floret diameter

In flowers harvested in November 2011, application of 8HQC+S either with or without GA_3 significantly increased the diameter of the primary floret in each of the three flower models used as compared to water. On the other hand, GA_3 in water was ineffective except in the isolated cymes where it significantly enhanced bud opening (Tab. 4). In flowers harvested in March 2012, there were no significant differences in floret diameter between different flower types and vase solutions used (Tab. 4) and, generally, flowers were larger than in November, especially when held in water.

In flowers harvested in November 2011, the secondary florets were much smaller than the primary florets, especially those in isolated cymes (36.3 mm) (Tab. 5). Florets from different flower models differed in diameter; those from complete stems were always significantly larger than those from isolated cymes. Both GA_3 and the standard preservative significantly increased floret diameter in all models; however, there was no additive effects of both treatments. Florets from complete inflorescences treated with 8HQC+S+GA_3 and 8HQC+S, and from defoliated cut stems held in 8HQC+S+GA_3 were the largest: 70.6, 64.9 and 65.4 mm, respectively (Tab. 5). In the flowers harvested in March 2012, the smallest secondary florets were in flowers held in water. An addition of GA_3 to water increased floret diameters in every model. The preservative was even more effective, especially in complete stems, where it nearly doubled floret diameters as compared to water. The florets with the largest diameter were found on the complete stems held in 8HQC+S+GA_3 and 8HQC+S: 79.1 mm and 79.7 mm, respectively (Tab. 5).

Pedicel length

The pedicels of flowers harvested in March were longer by over 50% than those harvested in November (Tab. 6). The latter elongated by *ca* 20% when the complete leafy inflorescences were placed in the preservative. GA_3 was ineffective in all the flower models.

Leaf yellowing

For observations of leaf yellowing, single leaves detached from the flowering stems were included in the floral models. In flowers harvested in November, leaf longevity in water ranged between 11 and 13 days (Tab. 7). The removal of cymes significantly reduced foliage longevity.

Table 4. Effect of GA_3, 8HQC+S and 8HQC+S+GA_3 on diameter of first floret in cut alstroemerias with three flower models used on two harvest dates

Treatment	I Floret diameter [mm]					
	November'11			March'12		
	isolated cymes (without stem)	cut inflores-cences (defo-liated)	cut inflores-cences (com-plete)	isolated cymes (without stem)	cut inflores-cences (defo-liated)	cut inflores-cences (com-plete)
dH_2O	62.2 d*	65.0 c	65.8 c	69.3 ab	70.9 ab	73.5 a
GA_3	65.0 c	64.9 cd	63.8 cd	62.8 b	68.2 ab	68.5 ab
8HQC+S (SP)	70.7 ab	73.0 a	71.2 ab	70.9 ab	73.0 a	68.9 ab
8HQC+S+GA_3	70.4 ab	70.0 b	71.8 ab	72.7 a	66.4 ab	68.2 ab

*Explanations: see Table 1

Table 5. Effect of GA_3, 8HQC+S and 8HQC+S+GA_3 on diameter of second floret in cut alstroemerias with three flower models used on two harvest dates

Treatment	II Floret diameter [mm]					
	November'11			March'12		
	isolated cymes (without stem)	cut inflores-cences (defo-liated)	cut inflores-cences (com-plete)	isolated cymes (without stem)	cut inflores-cences (defo-liated)	cut inflores-cences (com-plete)
dH_2O	36.3 g*	45.9 f	51.9 ef	47.3 ef	55.7 de	40.7 f
GA_3	55.4 de	55.3 de	61.5 bcd	63.1 cd	69.1 abc	56.3 de
8HQC+S (SP)	57.9 cde	63.3 bc	64.9 ab	65 bcd	76.9 ab	79.7 a
8HQC+S+GA_3	59.8 bcd	65.4 ab	70.6 a	48.5 ef	61.0 cd	79.1 a

*Explanations: see Table 1

Table 6. Effect of GA_3, 8HQC+S and 8HQC+S+GA_3 on pedicel length in cut alstroemerias with three flower models used on two harvest dates

Treatment	Length [mm]					
	November'11			March'12		
	isolated cymes (without stem)	cut inflores-cences (de-foliated)	cut inflores-cences (complete)	isolated cymes (without stem)	cut inflores-cences (de-foliated)	cut inflores-cences (complete)
dH_2O	157.8 bc*	159.7 bc	150.3 c	251.0 abc	237.0 abc	229.0 abc
GA_3	159.8 bc	163.6 abc	161.6 bc	207.0 c	262.0 abc	254.0 abc
8HQC+S (SP)	164.2 abc	178.7 ab	186.6 a	264.0 abc	275.0 abc	310.8 a
8HQC+S+GA_3	180.3 ab	162.0 bc	177.9 ab	285.0 ab	253.0 abc	290.0 a

*Explanations: see Table 1

Table 7. Effect of GA_3, 8HQC+S and 8HQC+S+GA_3 on number of days till leaf yellowing in cut alstroemerias with four models used on two harvest dates

Treatment	Days till leaf yellowing							
	November'11				March'12			
	single leaves	cut inflores-cences (defoliated)[1]	cut leafy stems (without flower)	cut inflorescences (complete)	single leaves	cut inflores-cences (defoliated)*	cut leafy stems (without flower)	cut inflorescences (complete)
dH_2O	13.3 h*	11.5 jk	10.9 k	12.5 i	10.0 g	19.4 d	10.0 g	9.8 g
GA_3	35.0 d	36.0 c	38.5 b	39.4 a	22.0 c	25.8 b	27.0 ab	28.3 a
8HQC+S (SP)	12.0 ij	12.6 i	11.1 k	15.4 f	9.9 g	9.7 g	10.8 g	9.0 g
8HQC+S+GA_3	14.6 g	14.7 g	21.2 e	21.4 e	14.0 f	16.8 e	19.4 d	18.0 de

[1]leaves of the uppermost whorl under the cyme were evaluated
*Explanations: see Table 1

In general, water solution of GA_3 significantly postponed leaf yellowing in all floral models, tripling leaf longevity as compared to water. The standard solution showed little effect on leaf senescence and the addition of GA_3 was again positive, prolonging longevity of leaves attached to stems up to 20 days, but significantly less than GA_3 in water. GA_3 was also effective in postponing leaf yellowing in stems harvested in March 2012, especially when used as a water solution (Tab. 7). The type of a floral model had a significant effect on leaf longevity in the second experiment.

DISCUSSION

Similarly to lilies, a common early symptom of aging in cut alstroemerias is leaf yellowing which limits the vase life of the entire flowering stem (Han 1995; van Doorn, 2011). This yellowing is due to chlorophyll breakdown and it occurs both in leaves attached to stems and detached from stems (van Doorn et al., 1992), as well as in detached leaf tips (Jordi et al., 1995). The onset of chlorophyll breakdown occurs at the same time in detached leaves as in leaves attached to cut flower stems, suggesting that the signal for the onset of senescence resides in the leaves themselves (Jordi et al., 1995). However, in our experiments, in several cases detached leaves showed yellowing earlier than those attached to stems.

In alstroemerias harvested in November, leaf longevity in different flower models held in water ranged between 11 and 13 days while in those cut in March it was between 10 and 19 days. Such differences in life span are not unusual and were reported earlier: large varietal differences in leaf longevity were observed among Polish cultivars with leaf yellowing starting between 6 and 20 days after harvest (Łukaszewska et al., 2008). The same phenomenon was observed by Ferrante et al. (2002) on 20 Dutch cultivars whose leaves started to senesce 5-18 days after cutting. Various plant growth regulators delay leaf senescence in cut alstroemeria flowering stems, and gibberellins proved to be most effective (Hickleton, 1991; van Doorn et al., 1992). For this reason, a pulse treatment with preparations containing GA has been mandated for alstroemerias sold at flower auctions in The Netherlands. All Polish cultivars tested so far responded well to conditioning with 1 mM GA_3 as this resulted in a 2- to 3.5-fold increased leaf longevity as compared to the unconditioned stems (Łukaszewska et al., 2008). Similarly, in this experiment leaves of 'Dancing Queen' treated continuously with 0.1 mM GA_3 had their longevity prolonged up to 3-4 times, and the floral model had no impact on the range of leaf response to the treatment. However, the efficiency of gibberellic acid was less pronounced when it was used together with the standard preservative (SP: 8HQC+S). The sugar from the preservative usually accumulates in leaves during transport from the vase solution to the flower causing water stress in the mesophyll cells

and accelerating chlorophyll degradation (Skutnik and Łukaszewska, 2001). Little of this negative sugar effect was seen in alstroemerias from both harvesting dates and the floral model had little effect on the leaf response to sugar feeding. The exception was the March harvest when leaves in the whorl supporting the flower umbel on defoliated stems had their longevity reduced by one half as compared to stems with foliage held in water. The latter had the lifespan twice as long as in other "models". A different effect of the floral model on leaf senescence was observed in the November-harvested alstroemerias: removal of inflorescences from stems held in the standard preservative significantly accelerated leaf yellowing (by 4.3 days relative to complete flowering stems held in SP), a phenomenon not observed in the GA_3-treated stems standing in SP where leaves from both models lasted over 21 days. It was earlier demonstrated that the developing buds are not important for the chlorophyll loss in cut alstroemerias in the presence of GA_3 (Jordi et al., 1993).

The long distance transport in vascular tissue did not appear to limit the effects of GA_3: similar results with the GA treatment were obtained in leaves attached to stems and in detached leaf tips (Jordi et al., 1995). In 'Dancing Queen', the plant growth regulator (PGR) delayed leaf yellowing even more in attached leaves than in detached ones.

Smart (1994) stated that a decrease in photosynthesis below some threshold level may function as a signal to induce leaf senescence. The photosynthetic rates of alstroemeria's cut flowers are low and after harvest, the flowering stems are severely limited in the usage of energy provided by the photosynthetic processes. The GA_3 treatment delayed the decline in the photosynthetic rates (Jordi et al., 1994) and a similar PGR action might have resulted in retarded leaf senescence in 'Dancing Queen'.

There are some discrepancies in the effects of the postharvest treatments on flower longevity in alstroemeria. According to Michalczuk et al. (1992), the combination of 8-HQC+S+GA_3 extended the vase life in several Polish cultivars. The presence of sucrose in the holding solution extended longevity of primary florets in the experiment of Chanasut et al. (2003). Commercial preservatives and conditioners, as well GA_3, positively affected longevity of the Hawaii-grown alstroemerias (Dai and Paull, 1991), However, there was no significant effect of conditioning with 1 mM GA_3 on the flower vase life in the trials of Łukaszewska et al. (2008) even though the floret diameter was visibly increased by the SP. Alstroemeria's response to preservative solutions varied in both flower batches used in the present trial on 'Dancing Queen': while in the autumn-harvested flowers both the preservative and GA_3 extended vase life, the spring harvested alstroemerias generally did not respond to the treatments. Due to more favourable light conditions in the spring, the flowering stems harvested in March were visibly in a better physiological condition, probably with optimal

levels of endogenous carbohydrates and hormones. Perhaps for this reason they did not need any exogenous boost. Some preharvest environmental conditions do affect the postharvest performance of cut flowers, and the most important of these factors appears to be the total light energy (Halevy and Mayak, 1979). It is worth noting that the differences between two batches of alstroemeria 'Dancing Queen' had a larger impact on the flower postharvest quality than the treatments themselves. The role of such endogenous quality factors is also supported by the observation that the florets on complete stems were of the best quality while those on stems with leaves removed responded better to solutions. Chanasut et al. (2003) also reported better longevity of florets on complete leafy stems as compared to those on isolated cymes. The latter authors underline the fact that the younger buds in a cyme represent a significant sink for the metabolites and compete for the metabolites with the primary floret. Removal of all floral buds in each cyme, with the exception of the largest bud, extended floret longevity and increased its fresh weight four times over that in untrimmed cymes. However, the authors admit that once the younger buds are removed there is no chance of extending the vase life of inflorescence beyond that of the initial flower. For this reason this particular option was not included in the present trial.

The results from this study indicate that the vase life of the second floret was shorter by 30-50% relative to the primary florets in all flower models and vase solutions used. A longer vase life of the primary floret relative to second floret may be a consequence of its better development on the plant, as alstroemerias are harvested when the primary floret is mature and with intense colour. The growth and opening of the second floret depends mainly on the nutrients provided in the vase solution as the cut flowers usually produce little new assimilates (Jordi et al., 1994). Limited supply of carbohydrates and the ageing of tissues are not optimal conditions for growth and development of flowers on cut stems thus the vase life of the second floret is shorter compared to the primary floret. The weaker development of the second floret was more obvious when the different flower models were held in distilled water.

The prolongation of alstroemeria vase life was mainly due to the supplementation of the exogenous sucrose in the vase solution. Sucrose provides the respiratory substrate for the continuous growth and development of cut stems while 8HQC acts as an antibacterial agent to prevent xylem occlusion resulting from the microbial growth (Halevy and Mayak, 1981). Increased flower longevity of cut alstoemerias by sugar application has been attributed to the increase in the uptake of water by the flowers (Hicklenton, 1991). The increase of water uptake by sucrose treatments could be due to an increase in the osmotic concentration in the florets and leaves (Pun and

Ichimura, 2003). Unobstructed water uptake is indispensable for bud opening (van Doorn and van Meeteren, 2003) and this was provided by the standard preservative. Florets in all flowers models used in these experiments held in the standard preservative with or without GA_3 opened better and had larger diameters than those held in water, similarly as reported by Michalczuk et al. (1992).

Gibberellic acid has been reported to stimulate pedicel elongation thus increasing inflorescence diameter, for example in cut *Nerine* flowers (Łukaszewska, 1997). In 'Dancing Queen', the effect of GA_3 on the pedicel elongation was insignificant both in the March- and November harvested flowers. However, in the latter batch the increase in pedicel length was produced by the preservative but only in complete flowering stems.

In conclusion, although the growing conditions can substantially modify the response of cut alstroemerias to holding solutions, a sugar-containing preservative together with gibberellic acid improves the postharvest performance of cut alstroemerias 'Dancing Queen' so with the above treatment applied there is no need for foliage removal to prolong the display life of cut flowering stems.

CONCLUSIONS

- Responses to postharvest treatments of alstroemerias from two harvest dates differed, that of the spring grown flowers being negligible
- Responses to holding solutions were modified by the flower model and were more pronounced in defoliated flowering stems while florets on stems with foliage were generally of better quality than those in other flower models.
- Longevity of the primary and secondary florets of the November harvested alstroemerias was increased by the standard preservative while it had no effect in alstroemerias harvested in March; GA_3 was ineffective on both dates, except in leafy flowering stems in November.
- GA_3 and the standard preservative significantly increased the diameter of the second floret in all flower models but there was no additive effects of both treatments
- In general, a flower model had a significant effect on leaf longevity. GA_3 significantly postponed leaf yellowing while the sugar-containing preservative little affected this phenomenon.

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WPŁYW ZABIEGÓW POZBIORCZYCH NA JAKOŚĆ I TRWAŁOŚĆ KWIATÓW CIĘTYCH ALSTROEMERII ‘DANCING QUEEN’

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S T R E S Z C Z E N I E

Dzięki długiej posprzętnej trwałości i szerokiej gamie barw alstroemeria jest jednym z najbardziej popularnych gatunków uprawianych w Europie na kwiat cięty. Niestety, przedwczesne żółknięcie liści obniża wartość dekoracyjną ciętych pędów kwiatostanowych jeszcze przed otwarciem się drugiego pąka w sierpiku. Celem badań było określenie wpływu sacharozy, kwasu giberelinowego i cytrynianu 8-hydroksychinoliny na cięte alstroemerie ‘Dancing Queen’. Wykorzystano kilka “modeli kwiatowych”, aby określić wpływ związków chemicznych na starzenie kwiatów i liści. Reakcja na zabiegi kwitnących pędów alstroemerii ciętych w listopadzie 2011 i marcu 2012 roku była różna: podczas gdy trwałość pierwszego i drugiego kwiatu została przedłużona przez 8-HQC+S jesienią, wiosną nie stwierdzonego tego efektu. Na pędach ciętych w marcu pąki drugorzędowe otwierały się szybciej niż te z listopadowego zbioru, gdzie z kolei 8-HQC+S przyśpieszał rozkwitanie. Model kwiatu wpływał na trwałość i modyfikował reakcję na pożywki: kwiaty na pędach pozbawionych liści lepiej reagowały na pożywkę niż te na pędach ulistnionych. Średnica kwiatów różniła się zależnie od modelu kwiatowego: te na ulistnionych pędach były istotnie większe od kwiatów z odciętych kwiatostanów. Kwiaty drugorzędowe były znacznie mniejsze od pierwszorzędowych, szczególnie w odciętych kwiatostanach. Zarówno GA_3, jak i standardowa pożywka (8-HQC+S) istotnie zwiększyły średnicę kwiatów we wszystkich modelach kwiatowych, nie było jednak addytywnego działania obu zabiegów. GA_3 istotnie opóźnił żółknięcie liści we wszystkich modelach kwiatowych, podczas gdy pożywka zawierająca cukier miała niewielki wpływ na to zjawisko. Ogólnie, “model kwiatowy” wpływał istotnie na trwałość liści.

Słowa kluczowe: pożywka standardowa, GA_3, model kwiatowy, starzenie kwiatów i liści