Journal of Fruit and Ornamental Plant Research Vol. 11, 2003: 69-76

EFFECT OF GIBBERELLIC ACID ON POST-HARVEST LEAF LONGEVITY OF *Zantedeschia elliottiana* (W. WATS.) ENGL.

Beata Janowska and Marek Jerzy

Department of Ornamental Plants, Agricultural University
Dąbrowskiego 159, 60-594 Poznań, POLAND

(Received October 23, 2002/Accepted September 8, 2003)

A B S T R A C T

In 2000-2001 the Department of Ornamental Plants, University of Agriculture, (Poznań) carried out two experiments which aimed at defining the effect of gibberellic acid on post-harvest leaf longevity of *Zantedeschia elliottiana* (W. Wats.) Engl.: 'Florex Gold' and 'Black Magic'.

The leaves were conditioned and held in vase solutions. Conditioning, in water solutions of Gibrescol (98%) at the concentrations of 100, 200 and 300 mg 1^{-1}, took 20 hours. Then the leaves were placed into water or vase solutions: 8HQC or 8HQS at 200 mg 1^{-1}.

Conditioning and post-harvest leaf longevity was examined in a growth room at 18-20°C with 12-hour photoperiod and inflorescence light of the quantum irradiance of 25 µmol $m^{-2}s^{-1}$, while the air relative humidity was maintained at 70%.

The gibberellic acid enhanced the post-harvest leaf longevity of *Zantedeschia elliottiana*. In 'Florex Gold' and 'Black Magic' cultivars the longest-lasting decorative properties were observed in leaves conditioned in a solution of gibberellic acid at the concentration of 300 mg 1^{-1} and then placed into water. The gibberellic acid limited the degradation of chlorophyll.

Key words: *Zantedeschia*, gibberellic acid, cut leaves, vase-life

INTRODUCTION

Zantedeschia is valued all over the world because of its beautiful and long lasting flowers. The demand for flowers of the commonly cultivated *Zantedeschia aethiopica* has been decreasing for several years. On the other hand, cultivars originating from *Zantedeschia elliottiana* and *Z. rehmannii* gain great popularity because of their beautiful and colourful

spathe and their charming, frequently spotted leaves that may contribute a valuable florist green to bouquets.

So far rather limited studies indicate that the inflorescence of *Zantedeschia* with coloured spathe can be improved by soaking its rhizomes in gibberellic acid before planting (Corr and Widmer, 1991; Funnell et al., 1992; Funnell and Tjia, 1998; Janowska and Krause, 2001; Janowska and Schroeter, 2002).

However, not only flower yield but also vase life of cut flowers and leaves are today a very important factor. Because of great competition, the basic condition for the acceptance of cut flowers and their green additions by customers is their high quality. Next to their external appearance, the vase life of flowers and leaves is actually one of the main criteria in the evaluation of their quality. Some studies on the increase of the longevity of cut flowers and leaves concern *Zantedeschia aethiopica* (Skutnik, 1998; Łukaszewska, 2000; Skutnik et al., 2001). The longevity of cut leaves of other *Zantedeschia* species has not yet been investigated in Poland.

MATERIALS AND METHODS

In the years 2000-2001, at the Department of Ornamental Plants, University of Agriculture in Poznań, two experiments were carried out to investigate the effect of gibberellic acid on leaf longevity of *Zantedeschia elliottiana* cultivars: 'Florex Gold' and 'Black Magic'. Plants were grown in plastic containers of 20 l capacity filled with a peat-bark substrate. Leaves selected for the experiment were mature, healthy and undamaged.

The leaves were conditioned and then kept in water or in a vase solution. Conditioning in water solutions of Gibrescol (98% GA_3) at 100, 200 and 300 mg l^{-1} lasted 20 hours. Subsequently, the leaves were placed into water or solutions of 8-hydroxyquinoline citrate (8HQC) or 8-hydroxyquinoline sulphate (8HQS) at 200 mg l^{-1}, pH 5.0.

Conditioning and post-harvest longevity of leaves was examined in a growing room at 18-20°C, RH 70%, in 12 h photoperiod (luminescence light with quantum irradiance of 25 μmol $s^{-1}m^{-2}$). Water was replaced every day and the preservative solutions were supplemented.

The longevity of leaves was defined in days. Loss of decorative values was indicated by the moment of turning yellow and/or by the wilting of 30% of the leaf surface. After the termination of the experiment, chlorophyll content in the leaves was determined. Samples were taken from the particular replications within the treatment when the leaves lost their decorative value. The samples were ground adding 5 ml of acetone and a bit of calcium carbonate ($CaCO_3$) in order to prevent the formation of pheophytin. The optical density was determined at 652 nm wave length in relation to acetone as the control. Spectrophotometer Spekol 11 was used. The obtained readings were converted into mg g^{-1} of fresh weight (f.w.).

Table 1. Effect of gibberellic acid and vase solutions on post-harvest longevity of 'Florex Gold' leaves [days]

Conditioning	Vase solution			Mean for GA_3
Concentration of GA_3 [mg l^{-1}]	water	8HQC	8HQS	
0	10.3 ab*	6.1 a	6.2 a	7.5 **a**
100	9.5 a	5.9 a	6.5 a	7.3 **a**
200	14.2 bc	6.2 a	6.3 a	8.9 **a**
300	15.1 c	5.6 a	7.1 a	9.3 **a**
Mean for preservative solution	12.3 ***b***	5.9 ***a***	6.5 ***a***	

*Means followed by the same letters do not differ significantly at P=0.05

The experiment with 'Florex Gold' cultivar consisted of 12 treatments with three replications carried out on July 10, 14 and 18, 2000. For one treatment (GA_3 concentration x type of vase solution) on each date. Each treatment included 5 leaves, so a total for 3 replications was 15 leaves. The schedule of the experiment with 'Black Magic' was identical. It was replicated three times on July 16, 19, and 23, 2001. The results were statistically analysed with Federer-Zelen's test.

RESULTS

Analysis of the mean values for gibberellic acid did not show any significant differences in post harvest longevity of 'Florex Gold' leaves (Tab. 1). Conditioning of leaves in gibberellic acid at 200 and 300 mg l^{-1} extended their longevity by 4-5 days but only for those kept in water afterwards. In the treatments in which the leaves were kept in solutions of 8-hydroxyquinoline sulphate (8HQS) or 8-hydroxyquinoline citrate (8HQC) a decrease of their longevity was observed in spite of their earlier conditioning in gibberellic acid. No significant differences occurred in the longevity of *Zantedeschia* leaves placed into 8HQS and 8HQC.

The mean content of chlorophyll in the leaves of this cultivar depended to a significant degree only on the concentration of gibberellic acid applied for their conditioning (Tab. 2). The most favourable GA_3 concentration was 300 mg l^{-1}. Statistical analysis did not show any differences in chlorophyll content between the leaves preserved in water, 8HQC and 8HQS. A favourable interaction of these compounds was observed with gibberellic acid at the highest concentration (300 mg l^{-1}). Leaves of these treatments had the greatest chlorophyll content.

In 'Black Magic', decorative values were preserved the longest by leaves conditioned in solution of GA_3 at 300 mg l^{-1} and kept in water (Tab. 3). Solutions of 8HQC and 8HQS

Table 2. Chlorophyll a+b content [mg g^{-1} f.w.] in 'Florex Gold' leaves at the end of experiment

Conditioning	Vase solution			Mean for GA_3
Concentration of GA_3 [mg l^{-1}]	water	8HQC	8HQS	
0	6.2 abc	6.2 ab	6.2 a	6.2 **a**
100	7.6 abc	9.0 abc	7.6 abc	7.6 **ab**
200	7.6 abc	9.7 abc	7.6 abc	8.3 **ab**
300	7.6 abc	10.4 bc	10.4 c	9.7 **b**
Mean for preservative solution	7.6 ***a***	8.3 ***a***	7.6 ***a***	

Initial chlorophyll content – 20 mg g^{-1} f.w.

Table 3. Effect of gibberellic acid and vase solutions on post-harvest longevity of 'Black Magic' leaves [days]

Conditioning	Vase solution			Mean for GA_3
Concentration of GA_3 [mg l^{-1}]	water	8HQC	8HQS	
0	9.9 a*	9.3 a	10.9 a	10.0 **a**
100	13.4 ab	11.5 a	11.9 a	12.3 **a**
200	14.3 ab	11.7 a	10.3 a	12.1 **a**
300	18.7 b	11.1 a	10.3 a	13.3 **a**
Mean for preservative solution	14.0 ***b***	10.9 ***a***	10.8 ***a***	

*Explanations see Table 1

significantly decreased the post-harvest leaf longevity. Independent of GA_3 concentration, the longevity of leaves kept in the preservative solutions was decreased by 21.1-22.8%. Between the leaf longevity of 'Black Magic' kept in the solutions of 8HQC and 8HQS, no significant differences were found.

The chlorophyll content after conditioning in the GA_3 solution at 100, 200 and 300 mg l^{-1} amounted to 26.5; 26.8; 31.1 mg g^{-1} f.w., respectively. The slowest degradation of chlorophyll was observed in leaves that were conditioned in gibberellic acid at 300 mg l^{-1}. In spite of the fact that some differences were observed between the mean values, they proved to be statistically insignificant. In leaves conditioned in the solution of gibberellic acid at 300 mg l^{-1} and kept in the solution of 8HQC or 8HQS the greatest amount of chlorophyll was determined. No differences were found for the preservative solutions 8HQC and 8HQS. In both cases, the mean content of chlorophyll in the leaves was similar (Tab. 4).

Table 4. Chlorophyll a+b content [mg g^{-1} f.w.] in 'Black Magic' leaves at the end of experiment

Conditioning	Vase solution			Mean for GA_3
Concentration of GA_3 [mg l^{-1}]	water	8HQC	8HQS	
0	7.6 a	9.7 ab	9.0 ab	8.7 **a**
100	9.0 abc	9.7 abc	11.1 abc	9.9 **a**
200	9.0 abc	9.7 abc	11.1 abc	9.9 **a**
300	9.7 abc	11.8 c	11.8 c	11.1 **a**
Mean for preservative solution	8.8 ***a***	10.2 ***a***	10.8 ***a***	

Initial chlorophyll content – 35.4 mg g^{-1} f.w.

DISCUSSION

Leaves or leafy stems are indispensable decorative elements, therefore, their longevity should match the vase-life of flowers when joined together (Skutnik, 1998; Łukaszewska, 2000). However, the aging processes of cut leaves take a different course than those of flowers, therefore, agents extending the longevity of cut flowers frequently have little effect on leaves (Łukaszewska, 2000; Skutnik et al., 2001).

An important component of preparations designed for conditioning are growth regulators of the cytokinin and gibberellin groups. In our study, gibberellic acid was used for conditioning the leaves of *Zantedeschia elliottiana* 'Florex Gold' and 'Black Magic'. Its favourable action has proven to be unquestionable, but a better effect was obtained with higher GA_3 concentrations. 'Black Magic' leaves, conditioned in the solution of gibberellic acid at 300 mg l^{-1} and kept in water, were by 89% more durable than the control. 'Florex Gold' leaves reacted positively to the conditioning in the solution of gibberellic acid at 300 mg l^{-1} and their longevity increased by 47%. Furthermore, gibberellic acid reduced the loss of chlorophyll and therefore leaves preserved their colour longer

Experiments with cut leaves and shoots show that, when treated with cytokinin or gibberellin, they preserve their green colour longer because they have more chlorophyll. The favourable action of gibberellic acid was observed in leaves of *Zantedeschia aethiopica* (Łukaszewska, 2000; Skutnik et al., 2001). GA_3 caused a six-fold extension of their longevity in comparison with the control and it prevented chlorophyll degradation. The quickest decrease of the total chlorophyll content took place in leaves kept in the preservative solution. In this case, gibberellic acid showed a higher effectiveness than the synthetic cytokinin – benzyladenine. At the same

time, conditioning gave a better effect than a short-term soaking.

Similar results were obtained with *Hippeastrum hybridum*, in which the longevity of leaves conditioned in GA_3 solution increased eight times. Thereby, better results were obtained in a shorter 4-hour treatment of leaves with a higher concentration of gibberellic acid (Skutnik, 1998; Łukaszewska, 2000). For the leaves of *Hosta plantaginea*, the most effective is the treatment with a solution of cytokinin and the method of its application has an important impact on their longevity. In this species, regardless of the kind of treatment, gibberellic acid did not improve the decorative value of leaves (Skutnik et al., 1999 and 2000; Łukaszewska, 2000). In *Alstroemeria*, the leaves tend to quickly turn yellow, decreasing significantly the quality of cut flowers. Gibberellic acid added to the solution impedes the degradation of chlorophyll, thereby increasing the decorative value of flowers (Goszczyńska et al., 1988; Hicklenton, 1991; Łukaszewska, 2000). As in *Alstroemeria*, also in lilies gibberellic acid prevents premature yellowing of leaves impeding the degradation of chlorophyll (Łukaszewska and Kokosa, 1997; Funnell and Heins, 1998). It agrees with the statement of Łukaszewska and Kokosa (1997) pointing that the loss of chlorophyll in leaves is prevented by conditioning in the solution of gibberellic acid or by application of a preservative solution containing this acid as a constant component.

In our study, both 8-hydroxyquinoline citrate and 8-hydroxyquinoline sulphate significantly decreased the leaf longevity of *Zantedeschia elliottiana* 'Florex Gold' and 'Black Magic'. In spite of the proved effectiveness of these compounds for many cut flowers, on cut leaves and leafy shoots they usually have little effect. This has been confirmed by Skutnik (1998), Łukaszewska (2000) and Skutnik et al. (2001). The majority of cut leaf species negatively reacted to a preservative solution that contained saccharose and 8-hydroxyquinoline citrate. According to Łukaszewska (1997), the shoots of *Nerine bowdenii* kept in a solution of 8-hydroxyquinoline citrate turned yellow and became soft at the end of the experiment, and even a pulse treatment with 8-hydroxyquinoline citrate did not improve flower longevity. Also, Nowak and Grzesik (1997) argue that on one hand, 8-hydroxyquinoline esters impede the enzymatic processes leading to the blocking of conductive vessels and decrease the pH of the solution extending the longevity of flowers kept it, but on the other hand, they can cause damage to leaves and stalk ends in some plants and yellowing of white flowers.

CONCLUSIONS

1. Gibberellic acid had a favourable effect on the post-harvest longevity of *Zantedeschia* leaves.
2. In 'Florex Gold' and 'Black Magic' cultivars, the decorative

value was preserved the longest by leaves conditioned in gibberellic acid solution at 300 mg l^{-1} and kept in water.

3. Gibberellic acid impeded the loss of chlorophyll in leaves. The greatest amount of chlorophyll was found in leaves conditioned in gibberellic acid at 300 mg l^{-1} and kept in a solution of 8-hydroxyquinoline citrate or 8-hydroxyquinoline sulphate.
4. No differences in the action were found between 8-hydroxyquinoline citrate and 8-hydroxyquinoline sulphate, hence the latter could have a wider application as an easier available agent.

REFERENCES

Corr B.E., Widmer R.E. 1991. Paclobutrazol, gibberellic acid and rhizome size affect growth and flowering of *Zantedeschia*. HORTSCIENCE 26(2): 133-135.

Funnel K.A., Tjia B.O. 1988. Effect of storage temperature, duration and gibberellic acid on the flowering of *Zantedeschia elliottiana* and *Z.* 'Pink Satin'. J. AM. SOC. HORTIC. SCI. 113,6: 860-863.

Funnell K.A., Heins R.D. 1998. Plant growth regulators reduce postproduction leaf yellowing of potted asiflorum lilies. HORT SCIENCE 33(6): 1036-1037.

Funnell KA., MacKay B.R., Lawoko C.R.O. 1992. Comparative effects of promalin and GA_3 on flowering and development of *Zantedeschia* 'Galaxy'. ACTA HORTIC. 292: 173-179.

Goszczyńska D., Nowak J., Wawrzyńczak A., Michalczuk B. 1998. Polskie odżywki do przedłużania trwałości kwiatów ciętych. Mat. Konf. „Najnowsze metody przedłużania trwałości ciętych kwiatów". Warszawa, pp. 13-14.

Hicklenton P.R. 1991. GA_3 and benzyloaminopurine delay leaf yellowing in cut *Alstroemeria* stems. HORTSCIENCE 26(9): 1198-1199.

Janowska B., Krause J. 2001. Wpływ traktowania bulw kwasem giberelinowym na kwitnienie cantedeskii. ROCZ. AR POZNAŃ CCCXXXII, OGRODN. 33: 61-67.

Janowska B., Schroeter A. 2002. Wpływ kwasu giberelinowego na kwitnienie cantedeskii Elliota (*Zantedeschia elliottiana* /W. Wats./ Engl. 'Black Magic'. ZESZ. PROBL. POS. NAUK ROL. 483 (in press)

Łukaszewska A.J. 1997. Improving keeping qualities of *Nerine* cut flowers with preservatives. ACTA HORTIC. 430: 439-445.

Łukaszewska A.J. 2000. Przedłużanie trwałości ciętej zieleni. OGRODNICTWO 1: 19-21.

Łukaszewska A.J., Kokosa A. 1997. Przedłużanie trwałości ciętych kwiatów geofitów. OGRODNICTWO 2: 19-20.

Nowak J., Grzesik M. 1997. Regulatory roślinne w uprawie roślin ozdobnych. In: S. Jankiewicz (ed.), Regulatory wzrostu i rozwoju roślin, vol. 2, PWN, Warszawa, pp. 111-136.

Skutnik E. 1998. Gatunki stosowane na zieleń ciętą i próby przedłużania ich pozbiorczej trwałości. Mat. Konf. Nauk. Najnowsze metody

przedłużania trwałości ciętych kwiatów, Warszawa, pp. 45-49.
Skutnik E., Łukaszewska A.J., Serek M., Rabiza J. 2001. Effect of growth regulators on postharvest characteristics of *Zantedeschia aethiopica*. POST-HARVEST BIOLOGY AND TECHNOLOGY 21: 241-246.
Skutnik E., Łukaszewska A. J., Tyborowska K. 1999. Retarding senescence of cut leaves of *Hosta plantaginea* by growth regulators. ANN. WARSAW AGRICULT. UNIV.-SGGW, HORTICULT. LANDSC. ARCHITECT. 20: 3-9.
Skutnik E., Łukaszewska A.J., Tyborowska K. 2000. Wpływ regulatorów wzrostu roślin na pozbiorczą trwałość ciętych liści *Hosta plantaginea*. ZESZ. INST. SADOW. KWIAC. 7: 349-356.

WPŁYW KWASU GIBERELINOWEGO NA TRWAŁOŚĆ POZBIORCZĄ LIŚCI CANTEDESKII ELLIOTA (*Zantedeschia elliottiana* /W. WATS./ ENGL.)

Beata Janowska i Marek Jerzy

STRESZCZENIE

Liście kondycjonowano i przechowywano. Kondycjonowanie, w wodnych roztworach Gibrescolu (98% GA_3) o stężeniu 100, 200 i 300 mg l^{-1}, trwało 20 godzin. Następnie umieszczano liście w wodzie lub w roztworach przechowujących: cytrynianie 8-hydroksychinoliny (8HQC) lub siarczanie 8-hydroksychinoliny (8HQS) w stężeniu – 200 mg l^{-1}.

Trwałość pozbiorczą liści określano w pomieszczeniu o temperaturze 18-20°C, przy 12-godzinnym fotoperiodzie i świetle jarzeniowym o natężeniu promieniowania kwantowego 25 μmol $m^{-2}s^{-1}$, a wilgotność względną powietrza utrzymywano na poziomie 70%.

Kwas giberelinowy korzystnie wpłynął na pozbiorczą trwałość liści cantedeskii. U odmian 'Florex Gold' i 'Black Magic' najdłużej walory dekoracyjne zachowały liście kondycjonowane w roztworze kwasu giberelinowego o stężeniu 300 mg l^{-1}. Porównywalną trwałość miały liście odmiany 'Florex Gold' przechowywane w wodzie, a wcześniej kondycjonowane w 200 mg l^{-1} GA_3. Kwas giberelinowy hamował degradację chlorofilu, przy czym najwolniejszy jego spadek odnotowano w liściach kondycjonowanych w 300 mg l^{-1} GA_3 i przechowywanych w roztworach cytrynianu 8-hydroksychinoliny i siarczanu 8-hydroksychinoliny. Przechowywanie liści w roztworach 8HQC i 8HQS wpłynęło niekorzystnie na ich jakość.

Słowa kluczowe: cantedeskia, kwas giberelinowy, cięte liście, trwałość