EVALUATION OF SEVERAL CHEMICAL AGENTS FOR PROLONGING VASE LIFE IN CUT ASPARAGUS GREENS

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A B S T R A C T

The aim of this study was to determine whether the selected chemical agents can be used to preserve post-harvest quality in asparagus greens. The agents evaluated were Chrysal RVB®, Chrysal SVB®, gibberellic acid, benzyladenine, and a preservative solution containing hydroxyquinoline and sucrose. The agents were tested on three asparagus taxa: *A. densiflorus* 'Meyerii', *A. densiflorus* 'Myriocladus', and *A. setaceus.* Chrysal RVB® and Chrysal SVB® were applied by pulsing for 24 hours. Gibberellic acid and benzyladenine were applied both by pulsing for 24 hours, and by dipping for a few seconds. With the 8-HQC and sucrose solution, the shoots were placed directly in the preservative solution. After pulsing or dipping, the shoots were placed in distilled water. The shoots placed in the preservative solution were not transferred to distilled water, but kept in the solution for the duration of the experiment. The shoots were transferred to a climate control storage room under a 12 hour photoperiod. Vase life was recorded, and chlorophyll content was monitored throughout the storage period. Chrysal RVB® doubled vase life in 'Meyerii', had no effect in 'Myriocladus', and actually shortened vase life in *A. setaceus.* Chrysal SVB® tripled vase life in 'Meyerii', and doubled vase life in 'Myriocladus'. However, it shortened vase life in *A. setaceus.* Chlorophyll content also remained high in 'Meyerii' and 'Myriocladus' shoots treated with Chrysal SVB®. Gibberellic acid prolonged vase life in 'Meyerii' and 'Myriocladus', but had no effect in *A. setaceus.* Chlorophyll content also remained high in 'Meyerii' and 'Myriocladus' shoots treated with GA_3. Benzyladenine prolonged vase life in all three taxa tested, even in *A. setaceus.* Chlorophyll content also remained high in shoots *A. setaceus* treated with BA. The 8-HQC and sucrose solution doubled vase life in 'Meyerii', had no effect in 'Myriocladus', and shortened vase life in *A. setaceus*. All of the agents tested prolonged vase life in at least one of the asparagus taxa tested. Most of them, however, had no effect or even shortened vase life in other taxa. The effects differed widely depending on the taxon in question.

Key words: *Asparagus*, vase life, preservatives, 8-HQC, gibberellic acid, benzyladenine

INTRODUCTION

Asparagus greens are commonly used in floristry. The delicate cladophylls fill out bouquets and form an attractive backdrop for flower arrangements.

Vase life varies, depending on the taxon, the stage of maturity, and the season. For example, average vase life is about ten days in *Asparagus densiflorus* 'Meyerii', and about twenty days in *A. densiflorus* 'Myriocladus' and *A. setaceus* (Skutnik and Łukaszewska, 2001).

The globalization of the cut flower market means that asparagus greens have to be transported over greater distances. This increases the amount of time that passes between harvest and delivery to the customer. If transport time is prolonged, quality suffers as the asparagus greens turn yellow and shed their cladophylls. Therefore, effective techniques are needed for preserving post-harvest quality in asparagus greens.

Various conditioners, growth regulators and preservatives are used to preserve post-harvest quality in cut flowers. Some of these can be used to prolong vase life in florist greens (Łukaszewska and Skutnik, 2003).

The aim of this study was to determine the whether selected chemical agents can be used to preserve post-harvest quality in asparagus greens.

MATERIAL AND METHODS

The asparagus taxa used in this study were *Asparagus densiflorus* Jessop 'Meyerii', *A. densiflorus* Jessop 'Myriocladus', and *A. setaceus* Jessop.

All taxa were harvested at the same stage of development. The shoots were picked in the morning, dressed, treated with the agents under study, and placed in vases. The vases were kept under controlled conditions in a storage room with a temperature of 20°C, a relative humidity of 60%, and a 12-h photoperiod with an intensity of 35 $\mu mol \cdot m^{-2} \cdot s^{-1}$. Each agent was applied in 8 to 15 replicates, each consisting of one individually tagged shoot.

The agents tested included:

- two commercial conditioners: Chrysal RVB® and Chrysal SVB® (Pokon and Chrysal, The Netherlands);
- two growth regulators, gibberellic acid (GA_3) and benzyladenine (BA); and
- a preservative solution containing containing 200 ppm 8-hydroxyquinoline citrate (8 HQC) and 2% sucrose.

In the first experiment, the following treatments were applied:

- pulsing for 24 hours with either Chrysal RVB®, Chrysal SVB®, GA_3 (0.25 mmol dm^{-3}), or BA (0.10 mmol dm^{-3});
- dipping for several seconds in either GA_3 (1.00 mmol dm^{-3}) or BA (1.00 mmol dm^{-3}); and
- placing the shoots directly in a preservative solution containing 200 ppm 8-HQC and 2% sucrose.

After pulsing or dipping, the shoots were placed in distilled water. The shoots placed in the preservative solution were not transferred to distil-

led water, but kept in the solution for the duration of the experiment.

Vase life was recorded in days. The end of vase life was defined as the point when 30% of the shoots showed signs of yellowing or drying out.

In the second experiment, 'Meyerii' and 'Myriocladus' shoots were pulsed for 24 hours with either Chrysal SVB® or GA_3 (0.25 mmol dm^{-3}). *A. setaceus* shoots were pulsed for 24 hours with either Chrysal SVB® or BA (0.10 mmol dm^{-3}). After pulsing, the shoots were placed in distilled water and transferred to the controlled storage room. Untreated shoots served as the control, and were placed directly in distilled water.

Chlorophyll content was monitored during storage. Chlorophylls A and B were extracted with dimethylformamide and measured using the method of Moran and Porath (1980), as modified by Inskeep and Bloom (1985). Chlorophyll content was recorded in terms of milligrams per gram dry weight.

All results were statistically elaborated using analysis of variance, followed by means separation using the Least Significant Difference (LSD) test and Student's t-test at $P \leq 95\%$.

RESULTS AND DISCUSSION

Many commercial preparations are used to prolong vase life in cut flowers. However, not all of them are useful in preserving post-harvest quality in florist greens.

Chrysal RVB® is recommended by the manufacturer as a conditioner for cut roses, *Bouvardia* and chrysanthemums (Molenaar, 1998).

In this study, Chrysal RVB® doubled vase life in 'Meyerii', had no effect in 'Myriocladus', and actually shortened vase life in *A. setaceus* (Tab. 1).

In previous studies, Chrysal RVB® had no effect on vase life in other florist greens, including *Moluccella laevis* (Skutnik and Rabiza-Świder, 2004) and *Nephrolepis exaltata* (Skutnik and Rabiza-Świder, 2005).

Chrysal SVB® is recommended by the manufacturer as a conditioner for leafy shoots of *Alstroemeria*, *Euphorbia* and lilies (Molenaar, 1998). Not surprisingly, it was generally more effective in preserving post-harvest quality in asparagus greens than Chrysal RVB®. In this study, Chrysal SVB® tripled vase life in 'Meyerii', and doubled vase life in 'Myriocladus'. However, it shortened vase life in *A. setaceus* (Tab. 1). In a previous study, Chrysal SVB® prolonged vase life in *Moluccella laevis* (Skutnik and Rabiza-Świder, 2004).

Chlorophyll content also remained high in 'Meyerii' and 'Myriocladus' shoots treated with Chrysal SVB®. Chlorophyll content at the end of vase life was 2.1 times higher in 'Meyerii' than in the control, and 2.6 times higher in 'Myriocladus' than in the control (Tab. 2 and 3).

Growth regulators such as gibberellins and cytokins can also be used to prolong vase life in florist greens. Effectiveness varies depending on the specific growth regulator used, the concentration, the method of application, and the plant in question (Skutnik and Łukaszewska, 2001).

In this study, GA_3 prolonged vase life in 'Meyerii'. Vase life was 1.5 times longer than the control with both pulsing and dipping. GA_3 also

Table 1. Effect of selected chemical agents on vase life in asparagus greens

Treatment	Vase life [days]		
	A. densiflorus 'Meyerii'	*A. densiflorus* 'Myriocladus'	*A. setaceus*
Chrysal RVB® (pulsing)	28.9	24.3	21.7
Chrysal SVB® (pulsing)	39.9	58.1	24.7
GA_3 (pulsing)	23.4	82.7	19.6
GA_3 (dipping)	22.0	34.6	25.0
BA (pulsing)	16.7	33.3	60.0
BA (dipping)	18.3	34.4	44.4
8HQC + sucrose solution	32.1	29.4	23.0
Control	**13.6**	**24.4**	**36.7**
$LSD_{0.05}$	7.86	10.92	7.23

Table 2. Effect of selected chemical agents on chlorophyll content in *Asparagus densiflorus* 'Meyerii' shoots during storage. Chlorophyll content at harvest was 1.45 $mg \cdot g^{-1}$ DW

Treatment	Day of storage			Mean ($LSD_{0.05}$ = 0.164)
	Chlorophyll content [$mg \cdot g^{-1}$DW]			
	10	15	20	
Chrysal SVB® (pulsing)	1.25	1.42	1.31	1.33
GA_3 (pulsing)	1.43	1.10	1.10	1.21
Control	**0.96**	**0.56**	**0.63**	**0.72**
Mean ($LSD_{0.05}$ = 0.164)	1.21	1.03	1.01	

To compare means within the table, $LSD_{0.05}$ = 0.224

Table 3. Effect of selected chemical agents on chlorophyll content in *Asparagus densiflorus* 'Myriocladus' shoots during storage. Chlorophyll content at harvest was 2.60 $mg \cdot g^{-1}$ DW

Treatment	Day of storage			Mean ($LSD_{0.05}$ = 0.138)
	Chlorophyll content [$mg \cdot g^{-1}$ DW]			
	20	30	55	
Chrysal SVB® (pulsing)	1.99	1.87	1.42	1.76
GA_3 (pulsing)	1.80	1.66	1.53	1.66
Control	**1.08**	**0.92**	**0.55**	**0.85**
Mean ($LSD_{0.05}$ = 0.138)	1.62	1.48	1.16	

To compare means within the table $LSD_{0.05}$ = 0.232

Table 4. Effect of selected chemical agents on chlorophyll content in *Asparagus setaceus* shoots during storage. Chlorophyll content at harvest was 6.76 mg·g^{-1} DW

Treatment	Day of storage			Mean ($LSD_{0.05}$ = 0.366)
	Chlorophyll content [mg·g^{-1}DW]			
	23	37	50	
Chrysal SVB® (pulsing)	6.04	4.78	4.97	5.27
BA (pulsing)	5.95	5.81	4.92	5.56
Control	**4.13**	**4.37**	**4.29**	**4.26**
Mean ($LSD_{0.05}$ = 0.366)	5.37	4.99	4.73	

To compare means within the table $LSD_{0.05}$ = 0.216

prolonged vase life in 'Myriocladus', but only when it was applied by pulsing. Vase life was three times longer than in the control, and 2.5 times longer than in shoots pulsed with BA. GA_3 had no effect in *A. setaceus*, regardless of how it was applied (Tab. 1). In previous studies, gibberellins preserved post-harvest quality in *Zantedeschia* (Skutnik and Łukaszewska, 2001; Janowska and Jerzy, 2003), *Hippeastrum* (Skutnik, 1998, Skutnik and Łukaszewska, 2001), *Cimicifuga racemosa, Ligularia clivorum* and *Phalaris arundinacea* (Pogroszewska et al., 2001). GA_3 preserves post-harvest quality in cut leaves of *Zantedeschia* by delaying several processes involved in senescence, including chlorophyll degradation, proteolysis, ammonium accumulation, and proline accumulation (Skutnik et al., 2001; 2004; Rabiza-Świder et al., 2003; 2004ab).

Chlorophyll content also remained high in 'Meyerii' and 'Myriocladus' shoots treated with GA_3. In 'Meyerii', chlorophyll content at the end of vase life was 1.7 times higher than in the control. This represented an overall loss in chlorophyll content of 24% after harvest. In 'Myriocladus', chlorophyll content at the end of vase life was 2.8 times higher than in the control. This represented an overall loss in chlorophyll content of 41% after harvest (Tab. 2 and 3).

In this study, BA prolonged vase life in all three taxa tested, whether it was applied by pulsing or by dipping. Unlike all of the other agents tested, BA increased vase life even in *A. setaceus.* In *A. setaceus,* vase life was 1.6 times higher than the control with pulsing, and 1.2 times higher than the control with dipping (Tab. 1).

Chlorophyll content also remained high in shoots *A. setaceus* treated with BA. Chlorophyll content was about 30% higher than the control throughout the storage period (Tab. 4).

In previous studies, cytokinins preserved post-harvest quality in cut leaves of *Hosta* (Skutnik and Łukaszewska, 2001), *Nephrolepis* (Skutnik and Rabiza-Świder, 2005), *Cimicifuga racemosa, Ligularia clivorum* and *Phalaris arundinacea* (Pogroszewska et al., 2001).

A solution containing 8-HQC and sucrose is routinely used to prolong vase life in cut flowers

(Łukaszewska and Skutnik, 2003). 8-HQC prevents microbiological and physiological blockage of the stem vessels. Sucrose serves as a substrate for respiration, and is widely used to delay deterioration in cut flowers (Armitage and Laushman, 2003). In this study, this solution doubled vase life in 'Meyerii', had no effect in 'Myriocladus', and shortened vase life in *A. setaceus* (Tab. 1). In a previous study, this solution was tested on nineteen species of florist greens. The solution prolonged vase life in three species, had no effect in five species, and shortened vase life in eleven species. In the asparagus greens included in that study and earlier, the solution prolonged vase life in *A. falcatus* and *A. virgatus*, had no effect in *A. densiflorus* 'Sprengeri', and shortened vase life in *A. setaceus* (Skutnik and Łukaszewska, 2001).

CONCLUSION

All of the agents tested prolonged vase life in at least one of the asparagus taxa tested. Most of them, however, had no effect or even shortened vase life in other taxa. The effects differed widely depending on the taxon in question. Further study is needed with these and other agents on a wider range of asparagus taxa before reliable advice can be given on which agents are most effective for particular taxa.

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REGULACJA POZBIORCZEJ TRWAŁOŚCI CIĘTYCH PĘDÓW TRZECH GATUNKÓW SZPARAGA (*Asparagus* L.)

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

W doświadczeniach sprawdzono wpływ preparatów handlowych Chrysal RVB® i Chrysal SVB®, cytrynianu 8-hydroksychinoliny (8HQC) z dodatkiem 2% sacharozy (pożywka stosowana standardowo do przedłużania trwałości kwiatów ciętych) oraz benzyloadeniny (BA) i kwasu giberelinowego (GA_3) na pozbiorczą trwałość trzech gatunków szparaga: *Asparagus densiflorus* 'Meyerii', *A. densiflorus* 'Myriocladus' i *A. setaceus.* Chrysal RVB® i Chrysal SVB® oraz regulatory wzrostu podawano w formie 24-godzinnego kondycjonowania lub moczenia pędów, po czym liście przekładano do wody destylowanej. W roztworze 8HQC z dodatkiem 2% sacharozy (S) liście umieszczano na stałe.

Preparaty firmy Pokon & Chrysal, tj. Chrysal RVB® i Chrysal SVB® przedłużyły pozbiorczą trwałość pędów jedynie u szparaga Meyera (*A. densiflorus* 'Meyerii'). Chrysal SVB® okazał się także skuteczny w przypadku szparaga modrzewiowego (*A. densiflorus* 'Myriocladus'). Pożywka stosowana standardowo do przedłużania pozbiorczej trwałości kwiatów ciętych (8HQC + 2%S) przedłużyła trwałość ciętych pędów tylko u szparaga Meyera. Skuteczność regulatorów wzrostu zależała nie tylko od badanego gatunku, ale również od sposobu aplikacji. Zastosowanie GA_3 przedłużyło trwałość ciętych pędów szparaga modrzewiowego, ale jedynie wtedy, gdy pędy poddano 24-godzinnemu kondycjonowaniu w 0,25 $mmol \cdot dm^{-3}$ roztworze. W przypadku szparaga Meyera obie formy stosowania GA_3, tj. 24-godzinne kondycjonowanie i moczenie pędów, spowodowały wzrost długości okresu dekoracyjności. U szparaga pierzastego (*A. setaceus*) skuteczne okazało się zarówno kondycjonowanie, jak i moczenie pędów w roztworze cytokininy. Zabiegi, które zwiększały trwałość pędów szparaga, hamowały degradację chlorofilu w gałęziakach.

Słowa kluczowe: *Asparagus*, trwałość, pożywki, 8HQC, benzyloadenina, kwas giberelinowy