Post-harvest longevity of leaves of the sea lavender (*Limonium latifolium* (Sm.) Kuntze) after application of growth regulators

B. Janowska, R. Grabowska, E. Ratajczak

Department of Ornamental Plants, Faculty of Horticulture and Landscape Architecture, Poznań University of Life Sciences, Poznań, Poland

Abstract

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Conditioning is a simple and effective method of post-harvest longevity of both flowers and florists' greens. Performing this treatment immediately after harvest by the producer increases the quality of floral products expressed as their post-harvest longevity. The purpose of this study was to assess the influence of four growth regulators from the gibberellin and cytokinin groups applied as a 4-h conditioning treatment of leaf blades and to determine any effects on post-harvest longevity of leaves of *Limonium latifolium*. The leaves were harvested early in the morning from the department of ornamental plants collection. Selected leaves were fully-developed and had no damage or discolouring. Gibberellic acid, benzyladenine, *meta*- methoxytopolin and its riboside at the concentrations of 25, 50 and 75 mg/dm^3 were taken up in a solution for 4-h leaf-conditioning of *Limonium latifolium* at the temperature of 18–20°C. After the conditioning treatment the leaves were placed in distilled water. Leaves placed into distilled water immediately after cutting served as control. Gibberellic acid, benzyladenine and topolins applied as leaf conditioning treatment extended the post-harvest longevity of leaves of *Limonium latifolium.* Examined growth regulators, with the exception of riboside of *meta*-methoxytopolin, also had a favourable effect on the index of leaf greenness.

Keywords: florists' greens; vase live; index of leaf greenness; gibberellic acid; benzyadenine; topolins

Conditioning is a simple and effective method of post-harvest longevity of both flowers and florists' greens. Performing this treatment immediately after harvesting increases the quality of floral products expressed as their post-harvest longevity. Conditioning usually takes between 4 and 24 h in a room at the temperature of 18–20°C or in a cool room. Short-term leaf blades soaking in conditioning solutions is also possible (Janowska et al. 2012). Due to the differences in ageing processes in leaves as compared to flowers, standard conditioning mediums are usually not very effective and they may even lower the decorative values (Skutnik et al. 2001). Experiments with growth regulators from gibberellin and cytokinin groups were carried out in order to improve the post-harvest longevity of florists' greens (Janowska, Jerzy 2003; Skutnik et al. 2004; Janowska, Schroeter-Zakrzewska 2008; Janowska 2010; Janowska, Śmigielska 2010).

Limonium latifolium is a species in which the effectiveness of gibberellic acid and benzyladenine was proven to extend the post-harvest longevity of the leaves (Janowska, Schroeter-Zakrzewska 2010). Topolins used in the study are a new group of endogenous, aromatic cytokinins isolated from poplars at the Palacky University in Olomouc and

at the Institute of Experimental Botany in the Academy of Science of the Czech Republic. Topolins used are derivatives of benzylamino-purine. In their benzene ring there is a hydroxyl group in either the ortho- or the meta- position. So far, topolins have been tested only in a few studies conducted to assess their usefulness in *in vitro* cultures. In standard biological tests it was determined that these substances strongly prevent leaf ageing (Palavan-Ünsal et al. 2002), which can suggest their further use in extending post-harvest longevity of florists' greens.

The purpose of this study was to assess the influence of four growth regulators from gibberellin and cytokinin groups applied as 4-h conditioning treatment on the post-harvest longevity of *Limonium latifolium* leaves.

MATERIAL AND METHODS

The experiment was conducted at the Department of Ornamental Plants of Poznań University of Life Sciences (Poland) from September to October 2011 and 2012. Leaves of sea lavender (*Limonium latifolium* (Sm.) Kuntze) were the subject of the study. The leaves were harvested early in the morning from the department of ornamental plants collection. Under vegetation plants were regularly watered and fertilized. After harvest of inflorescences *Limonium latifolim* remains rosette leaves which could constitute important addition to bouquets. Selected leaves were fully-developed and had no damage or discolouring.

Gibberellic acid (GA_3), benzyladenine (BA), *meta*-methoxytopolin (MemT) and its riboside (MemTR) at the concentration of 25, 50 and 75 mg/dm^3 were taken up in a solution for 4-h leaf-conditioning of *Limonium latifolium* at the temperature of 18–20°C in solutions of growth regulators at the concentrations mentioned above.

After conditioning the leaves were placed in distilled water. Leaves put into distilled water immediately after cutting served as control.

One treatment (year × growth regulator concentration) comprised 15 leaves; 5 leaves in 3 replications.

Post-harvest longevity was determined in the room at the temperature of 18–20°C, during a 10-hour photoperiod and under fluorescent light with quantum irradiance of 25 μmol/m^2·s. Relative air humidity was kept at the level of 70%.

Post-harvest longevity was determined in days. Loss of decorative value was determined as the moment in which 30% of leaf surface turned yellow or was wilted (Janowska 2010; Janowska, Schroeter-Zakrzewska 2010). Moreover, index of leaf greenness was determined (SPAD) and correlated with chlorophyll content (Gregorczyk, Raczyńska 1997; Gregorczyk et al. 1998) by means of N-Tester apparatus.

The results were statistically calculated by means of two-factor analysis of variance. Means were grouped with the use of the Duncan's test with the significance level of $\alpha = 0.05$.

RESULTS AND DISCUSSION

A positive influence of gibberellic acid on both quality, expressed as index of leaf greenness, and post-harvest longevity of *Limonium latifolium* was determined (Table 1). Application of this growth regulator as 4-h leaf conditioning resulted in extending the longevity by 5.3–5.6 days. Positive effect of gibberellic acid on the index of leaf greenness was also observed. The application of gibberellic acid at the examined concentrations reduced chlorophyll degradation effectively. Effectiveness of gibberellic acid in extending the longevity of *Limonium latifolium* leaves is reported by Janowska and Schroeter-Zakrzewska (2010). Application of gibberellic acid at the concentration of 25 and 50 mg/dm^3 as leaf conditioning treatment resulted in prolonging post-harvest longevity of leaves significantly. Moreover, leaf conditioning treatment in gibberellic acid retarded the process of chlorophyll degradation. Effectiveness of gibberellic acid in prolonging florists' greens post-harvest longevity was determined in a number of species cultivated both in ground and under covers. In studies conducted by Janowska and Schroeter-Zakrzewska (2008) the extension of leaf longevity after application of gibberellic acid was recorded in *Arum italicum.* For this species favourable influence of GA_3 on the index of leaf greenness was also recorded. In studies conducted by Janowska and Jerzy (2003) gibberellic acid had a favourable influence on cut leaves of calla (*Zantedeschia*) with colourful spathes. In cultivars Florex Gold and Black Magic leaves conditioned in gibberellic acid at the concentration of 300 mg/dm^3 kept their decorative values for the longest period of time. Comparable leaf longevity was recorded in cultivar Florex Gold placed in water after being conditioned in GA_3 at the concentration of 200 mg/dm^3. Prolonging leaf longevity was connected with delay

Table 1. Effect of growth regulators on post-harvest longevity (days) and on the index of leaf greenness (SPAD) of *Limonium latifolium* leaves

	Concentration (mg/dm^3)	Year 2011	Year 2012	Mean
GA_3	Post-harvest longevity (days)			
	0	6.2^a	7.2^a	6.7^a
	25	12.4^b	12.2^b	12.3^b
	50	11.2^b	12.8^b	12.0^b
	75	11.8^b	12.4^b	12.1^b
	Mean	10.4^a	11.1^a	
	Leaf greenness (SPAD)			
	0	61.9^a	60.1^a	61.0^a
	25	65.3^b	66.3^b	65.8^b
	50	64.6^b	65.4^b	65.0^b
	75	65.2^b	66.2^b	65.7^b
	Mean	64.3^a	64.5^a	
BA	Post- harvest longevity (days)			
	0	6.2^a	7.2^a	6.7^a
	25	13.0^b	11.2^b	12.1^b
	50	12.0^b	12.2^b	12.1^b
	75	11.8^b	13.0^b	12.4^b
	Mean	10.8^a	10.9^a	
	Leaf greenness (SPAD)			
	0	61.9^a	60.1^a	61.0^a
	25	64.4^b	64.6^b	64.5^b
	50	65.2^b	66.0^b	65.6^b
	75	65.0^b	65.8^b	65.4^b
	Mean	64.1^a	64.1^a	
MemT	Post-harvest longevity (days)			
	0	6.2^a	7.2^a	6.7^a
	25	11.4^b	10.0^b	10.7^b
	50	11.5^b	10.8^b	11.5^b
	75	10.6^b	12.6^b	11.6^b
	Mean	9.9^a	10.1^a	
	Leaf greenness (SPAD)			
	0	61.9^a	60.1^a	61.0^a
	25	66.5^b	65.0^b	65.8^b
	50	65.2^b	66.2^b	65.7^b
	75	64.8^b	66.8^b	65.8^b
	Mean	64.6^a	64.5^a	
MemTR	Post-harvest longevity (days)			
	0	6.2^a	7.2^a	6.7^a
	25	11.6^b	13.0^b	12.3^b
	50	11.7^b	11.8^b	11.8^b
	75	10.8^b	11.0^b	10.9^b
	$LSD_{0.05}$	4.31		3.62
	Mean	10.0^a	10.7^a	

Table 1 to be continued

	Concentration (mg/dm^3)	Year 2011	Year 2012	Mean
MemTR	Leaf greenness (SPAD)			
	0	61.9^a	60.1^a	61.0^a
	25	59.7^a	59.6^a	59.7^a
	50	59.6^a	61.1^a	60.4^a
	75	60.2^a	60.8^a	60.5^a
	Mean	60.4^a	60.4^a	

means followed by the same letter do not differ significantly at $\alpha = 0.05$

of chlorophyll degradation, which, in turn resulted in keeping green colour of the leaves for a longer period of time. Similarly in *Zantedeschia aethiopica* the use of gibberellic acid resulted in six-fold extension of post-harvest longevity (Skutnik et al. 2001). In a study conducted by Skutnik et al. (2004) gibberellic acid delayed chlorophyll degradation in leaves of both *Zantedeschia aethiopica* and *Zantedeschia elliottiana*, simultaneously extending their post-harvest longevity.

It was determined that benzyladenine applied at given concentrations significantly influenced post-harvest longevity and leaf quality of *Limonium latifolium* (Table 1). After its application leaf longevity increased by 5.4–5.7 days. Moreover, in leaves treated with benzyladenine a higher index of leaf greenness was observed in comparison with the leaves from the control group. Studies conducted by Janowska and Schroeter-Zakrzewska (2010) showed that in *Limonium latifolium* placing the leaves in benzyladenine solution – at the concentration of 25 or 50 mg/dm^3 only, or after the first conditioning of leaves in gibberellic acid and then placing them in benzyladenine solution had a favourable effect. Similarly, favourable effect of benzyladenine in extending post-harvest longevity of leaves and their better quality expressed as the index of leaf greenness was recorded in *Arum italicum* (Janowska, Schroeter-Zakrzewska 2008). In studies conducted by Koziara and Suda (2008) on three cultivars of *Cordyline* benzyladenine solution at the concentration of 1 mmol/dm^3 significantly prolonged only the longevity of the leaves of *Cordyline* cv. Glauca. In the case of fruit bearing shoots of *Hypericum* cv. Magical Beauty their conditioning in benzyladenine solution at the concentration of 100 mg/dm^3 prolonged their post-harvest longevity by 8 days. Moreover, benzyladenine at the concentration of 50–150 mg/dm^3

had an influence on higher index of leaf greenness (Janowska, Śmigielska 2010). *Cordyline* cv. Glauca (Koziara, Suda 2008), *Asparagus falcatus* (Skutnik, Rabiza-Świder 2008), *Spathiphyllum* (Koziara, Sikora 2006) and *Arum italicum* (Janowska, Schroeter-Zakrzewska 2008) react favourably to benzyladenine as well. Similarly to gibberellic acid benzyladenine may have a retarding effect on chlorophyll degradation in leaves. This phenomenon was also recorded among others in *Cordyline australis* cv. Red Star (Koziara, Suda 2008) and *Asparagus setaceus* (Skutnik et al. 2006).

Comparison of leaf longevity after the application of topolins allowed a determination that both *meta*-methoxytopolin and its riboside significantly extended the post-harvest leaf longevity (Table 1). Application of *meta*-methoxytopolin at given concentrations to 4-h leaf conditioning prolonged the post-harvest longevity by 4.0–4.9 days and simultaneously increased the index of leaf greenness. Significant influence of riboside of *meta*-methoxytopolin onto the index of leaf greenness of *Limonium latifolium* was not observed. However, after the application of this growth regulator the leaf longevity increased by 4.2–5.6 days. Effectiveness of topolins in extending the post-harvest longevity of leaves was reported by Janowska et al. (2012). The authors used MemT and MemTR for leaf conditioning of *Zantedeschia albomaculata* cv. Albomaculata. They proved that both topolins at the concentration of 25–75 mg/dm^3 extend post-harvest leaf longevity and retard protein decomposition, however, they do not influence the index of leaf greenness. Moreover, both growth regulators at the concentration of 25 to 50 mg/dm^3 applied to leaf blade short-term soaking of *Z. albomaculata* cv. Albomaculata had a more favourable effect than 24-h conditioning. The authors also demonstrated the effectiveness of combining *meta*-methoxytopolin with gibberellic acid. In that study, the mixture of MemT with GA_3 at the concentration of 25 + 25 and 50 + 50 mg/dm^3 applied as leaf blade short-term soaking prolonged the post-harvest leaf longevity by 14–24 days on average and retarded protein decomposition; however, it did not influence the index of leaf greenness.

CONCLUSION

In conclusion, gibberellic acid, benzyladenine and topolins applied to leaf conditioning extend the post-harvest longevity of leaves of *Limonium latifolium*. Examined growth regulators, with the exception of ribosides of *meta*-methoxytopolin, also had a favourable effect on the index of leaf greenness.

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Corresponding author:

Dr. Eng. Beata Janowska, Poznań University of Life Sciences, Faculty of Horticulture and Landscape Architecture, Department of Ornamental Plants, Dąbrowskiego 159, 60 594 Poznań, Poland
phone: + 48 618 487 983, fax: + 48 0061 848 7999, e-mail: beataj@up.poznan.pl