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Study on the effect of aluminum sulfate treatment on postharvest life of the cut rose 'Boeing' (*Rosa hybrida* cv.Boeing)

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Abstract This experiment was carried out to investigate the effect of aluminum sulfate on postharvest life of a cut rose cultivar (*Rosa hybrida* ' Boeing').Flower stems were placed in aluminum sulfate solutions(0, 150 mgl^{-1}, 300 mgl^{-1}, 150 mgl^{-1}+sucrose 3%, 300 mgl^{-1}+sucrose 3%) until the end of vase life as a standard treatment and distilled water was used as control treatment. Aluminum sulfate treatment (150 and 300 mgl^{-1}) extended the vase life of flowers from 9 days (control) to 12 and 12.3 days respectively. Aluminum sulfate (150 and 300 mgl^{-1}) application resulted in a significant solution uptake until the end of the vase life. At last measurement the relative fresh weight of flowers treated with 150 and 300 mgl^{-1} aluminum sulfate showed significant higher values than the other levels of treatment due to more water uptake. Aluminum sulfate (150 and 300 mgl^{-1}) had positive effect on flower bud opening and increased flower diameter compared to control.

Key words

cut flower, relative fresh weight, solution uptake, vase life

Application of some germicides has been suggested to prevent rapid proliferation of microorganisms and to decrease the longevity of cut flowers. Cut flower species respond to germicides variously. $Al_2(SO_4)_3$ has been recommended for maintaining the vase life of several cut flowers (Liao et al., 2001) and is used as an antimicrobial compound in commercial preservative solutions (Ichimura et al., 2006). Aluminum sulfate acidifies vase solution, diminishes bacterial proliferation and enhances water uptake (Tjeerd and Jaap, 2003; Hassanpour Asil et al., 2004). Diminished water movement from the vase to different parts of the flower stem may cause water stress to be followed by bent neck, wilting and premature senescence. Stem plugging is one of the main factors determining longevity of
roses and can be caused by physiological occlusion due to plant itself, microorganisms or air embolism (Van Doorn et al., 1989). Also aluminum sulfate can decrease cut rose petal acidity and cause fixation of anthocyanin pigments and increase cut rose flower's vase life (Put Henriette et al., 1992; Tjeerd and Jaap, 2003; Hassanpour Asil et al., 2004).
The role of aluminum sulfate to increase the vase life of cut flowers is not limited to lowering the pH of vase solution. Its effect is based at least in part, on its action as an antimicrobial agent in the solution (Liao et al., 2001). More study is necessary to determine the effect of aluminum sulfate on vase life of cut flowers, specially cut roses as one of the most important cut flowers in the world.
Carbohydrates are necessary for turgor pressure maintenance and also they are important energy sources facilitating flower opening (Särkkä, 2005). Low carbohydrate levels in stem and leaves will reduce vase life which can be partially remedied by presence of sugar in the holding and vase solutions (Wilkins and Dole, 1996; Gast, 1997; Särkkä, 2005; Hashemabadi and Gholampour, 2006). Sugars are essential precursors for cut flower respiration. Sucrose is the main transporting form of sugar to flower bud (Särkkä , 2005). In several experiments application of aluminum sulfate alone or in combination with sucrose have kept quality and vase life of cut flowers at postharvest stage (Cho and Lee, 1979; Stigter, 1981; Gowda, 1990a,b; Reddy and Singh, 1996; Hassanpour Asil et al., 2004; Ichimura et al., 2006). The purpose of this work was investigation of the effect of aluminum sulfate (alone or with sucrose) on quality and vase life of cut rose flowers 'Boeing' at postharvest stage.

Material and Methods

Cut Rose flowers (*Rosa hybrida* cv. Boeing) were obtained from a commercial greenhouse in Yazd, Iran. Flowers were harvested early in the morning at commercial bud opening stage and were transported to laboratory in Tehran by airplane immediately. Flower stem ends were recut under water to remove air emboli and to prevent vascular blockage. The room temperature was 21-23º C and relative humidity was about 70% and a 12 h photoperiod was maintained using fluorescent lamps during experimental period. The aluminum sulfate solution was used alone (150, 300 mgl^{-1}) or in combination with sucrose 3% (150 mgl^{-1} + 3% sucrose, 300 mgl^{-1} + 3% sucrose). Distilled water was used as control treatment. Flower stems were placed in 500 ml flasks. Aluminum sulfate treatment was used as a standard (continuous) treatment and flower stems were kept in solutions until the end of vase life. Vase life was determined according to previous studies on cut rose flowers (Liao et al., 2000; Chamani et al., 2005). Solution uptake and relative fresh weight were calculated according to the experiment on "First Red" rose. (Chamani et al., 2005). Vernier caliper was used for measuring flower diameters. The Factorial design with three factors and four replications was used in this experiment and the least significant difference (LSD) was used for data analysis.

Results

Vase life of cut rose flowers 'Boeing' extended significantly by application of 150 and 300mgl^{-1} aluminum sulfate compared to control (distilled water). Vase life of aluminum sulfate treated flowers (150,300 mgl^{-1}) were more than flowers treated by aluminum sulfate 150 mgl^{-1} + 3% sucrose significantly. Flowers treated with sucrose containing solutions did not have any significant differences with control. The vase life of aluminum sulfate treated flowers (150, 300 mgl^{-1}) were 12 and 12.3 days respectively whereas the vase life of control treatment was 9 days (Table1).

Table1

Effect of aluminum sulfate on vase life of cut rose 'Boeing'

Treatment	Vase life (Day)
control	9.0
Aluminum sulfate 150 mgL^{-1}	12.0
Aluminum sulfate 300 mgL^{-1}	12.3
Aluminum sulfate150 mgL^{-1}+Sucrose3%	9.0
Aluminum sulfate300 mgL^{-1}+Sucrose3%	9.8

LSD1%=2.6

- Values are the means of 4 replications.

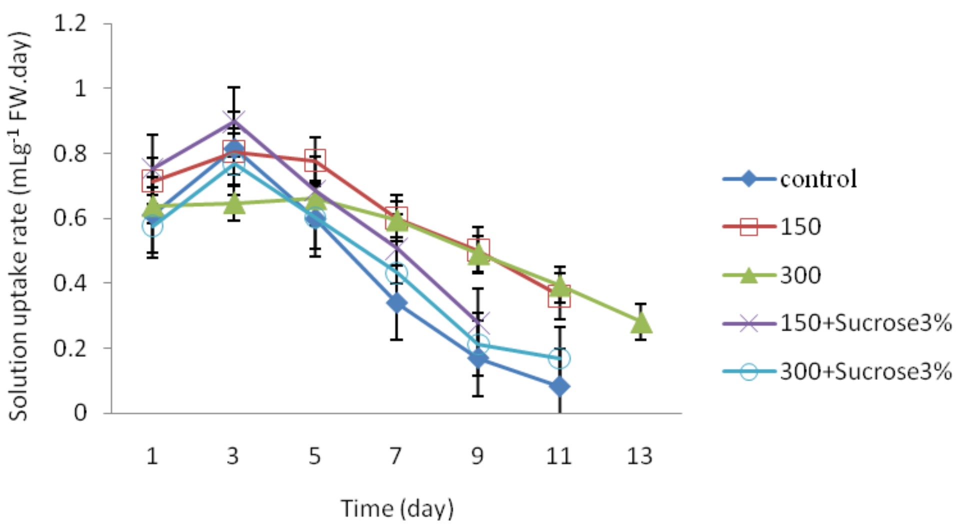

Fig. 1 Effect of aluminum sulfate (0,150,300,150+sucrose 3%, 300+sucrose 3%) on solution uptake rate of cut rose 'Boeing'.

Application of aluminum sulfate solutions (150, 300 mgl^{-1}) resulted in improvement of water uptake. Different levels of treatment showed significant differences in solution uptake rate. At ninth day, aluminum sulfate treated flowers (150, 300 mgl^{-1}) showed more solution uptake compared to control and 3% sucrose contained treatments significantly. At the same day, 150 and 300 mgl^{-1} treatments didn't show significant differences. Aluminum sulfate (150, 300 mgl^{-1}) treatment caused higher solution uptake at seventh day compared to control, but there were no significant differences between other treatment levels at the same day. At 11th day, aluminum sulfate (150, 300 mgl^{-1}) treated flowers showed more solution uptake significantly compared to control and aluminum sulfate 300 mgl^{-1} +3% sucrose (Figure 1).

Table 2

Effect of aluminum sulfate and sucrose on relative fresh weight of cut rose 'Boeing'

Treatment	Relative fresh weight (%)					
	Time (Day)					
	1	3	5	7	9	11
Control	107.0	94.7	86.7	79.4	61.1	49.6
Aluminum sulfate 150 mgL^{-1}	102.3	102.6	93.1	82.1	76.3	70.8
Aluminum sulfate 300 mgL^{-1}	103.7	103.8	101.2	92.0	82.1	71.1
Aluminum sulfate150 mgL^{-1}+Sucrose3%	106.9	105.9	95.2	78.8	60.1	31.2
Aluminum sulfate300 mgL^{-1}+Sucrose3%	99.6	99.0	93.7	84.9	67.6	39.5
LSD1%=14.5						

- Values are the means of 4 replications.

Table 3

Effect of aluminum sulfate and sucrose on flower diameter of cut rose 'Boeing'

Treatment	Flower diameter (mm)						
	Time (Day)						
	1	3	5	7	9	11	13
Control	80.0	113.0	123.5	105.5	83.7	62.0	38.5
Aluminum sulfate 150 mgL^{-1}	56.2	98.0	114.0	117.0	117.0	110.0	97.3
Aluminum sulfate 300 mgL^{-1}	62.5	104.2	123.5	125.7	118.3	114.5	94.3
Aluminum sulfate150 mgL^{-1}+Sucrose3%	69.7	117.7	103.5	95.5	73.7	-	-
Aluminum sulfate300 mgL^{-1}+Sucrose3%	55.7	64.0	70.5	66.0	41.9	36.1	-
LSD1%=28.5							

- Values are the means of 4 replications

Aluminum sulfate (150, 300 mgl^{-1}) treated flowers had higher relative fresh weight than control and sucrose contained treatments significantly at last evaluation. 150 and 300 mgl^{-1} aluminum sulfate treatments showed significant superiority compared with control on ninth and fifth, ninth ,11th day respectively (Table 2). The most flower diameter was observed at 150 and 300 mgl^{-1}solutions on ninth day. At the same day 150 and 300 mgl^{-1} aluminum sulfate treatments didn't have any significant differences, also control treatment showed significant higher flower diameters than aluminum sulfate 300 mgl^{-1} + 3% sucrose (Table 3).

Discussions

According to our results, aluminum sulfate extended the vase life of cut rose flower 'Boeing' compared to control. The most common reason of vase life termination in cut flowers is water stress. Stem plugging is one of the main factors determining longevity and can be caused by physiological occlusion due to plant itself, air embolism or microorganisms (Särkkä, 2005). It is well known that bacterial proliferating in the vase water shortens the vase life of cut flowers (Liao et al., 2001). The effect of aluminum sulfate (150, 300 mgl^{-1}) is related to its antimicrobial effect. The effect of aluminum sulfate to increase the vase life of cut flowers has been proved in several experiments (Cho and Lee, 1979; Stigter, 1981; Gowda, 1990a, b; Reddy and Singh, 1996; Liao et al., 2001; Hassanpour Asil et al., 2004).

Aluminum sulfate application resulted in more water uptake than other treatments. Antimicrobial compounds like metal salts prevent and slowdown bacterial growth, ensure proper water uptake and delay senescence (Liao et al., 2001; Särkkä, 2005). Aluminum sulfate application acidifies the solution and diminishes bacterial growth (Hassanpour Asil et al., 2004). This compound acts as a bacterial filter by forming Al $(OH)_3$ sediment on the cut surface of stem (Put Henriette et al., 1992). Sugars accelerate the bacterial growth in the vase solution (Särkkä, 2005). The proliferation of microbial population in the vase, results in vascular plugging. Flow rate of sucrose solution in the vessels becomes slower and water uptake decreases (Särkkä, 2005). A decline in water uptake rate in sucrose contained treatments compared with pure aluminum sulfate solutions may because of slow solution uptake rate and higher bacterial population. Probably applied concentrations of aluminum sulfate were not enough to neutralize the effect of sucrose on bacterial nutrition and proliferation. Our findings are in agreement with results of an experiment that aluminum sulfate application caused continuous water uptake in various temperatures between 20 –30º C in cut rose flowers (Ichimura and Ueyama, 1998). Aluminum sulfate (150 mgl^{-1}) application enhanced water uptake significantly compared to control in eustoma cut flowers (Liao et al., 2001). Effectiveness of aluminum sulfate application has been proved in cut gladiolus flowers (Gowda, 1990b).

Relative fresh weights of treatment levels were significantly different. Because of more water absorption, aluminum sulfate treated flowers had more relative fresh weight than control. Aluminum sulfate acts as an antimicrobial agent in vase solution (Halvey and Mayak, 1981) by inhibiting of bacterial vessel blockage. It is in agreement with results of eustoma flowers that aluminum sulfate (150 mgl^{-1}) had increased water uptake and fresh weight of flowers (Liao et al., 2001).

Flower diameters had higher values and flower bud opening were easier due to more water uptake and more relative fresh weight of flowers in 150 and 300 mgl^{-1}solutions. Aluminum sulfate application (300 ppm or in combination with sucrose 2%, 4%) in cut gladiolus “Pink friendship” flowers had shown an increase in flower diameter (Pal and Kumar, 2004). Other investigations have also shown similar results about positive effect of aluminum sulfate on flower diameter (Ahn and Joon, 1996; Liao et al., 2001; Bhattacharjee and Jaipur, 2005; Singh and Sharma, 2008).

Aluminum sulfate (150 and 300 mgl^{-1}) application improved all measured traits and extended the vase life of cut rose flower ‘Boeing’. It could be concluded that the application of sucrose had not positive effect on keeping quality of flowers that is because of slowdown of solution uptake and enhance microorganism proliferation and vascular blockage. Further work is required to understand the mechanism of aluminum sulfate effect on postharvest life of cut roses.

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