AOA and BA Influence on Floral Development and Longevity of Potted 'Victory Parade' Miniature Rose

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Abstract. Miniature rose (*Rosa hybrida* L. cv. Victory Parade) plants were treated with AOA, BA, or STS before simulated shipment and display in an interior environment. Although AOA-treated plants lasted slightly longer than nontreated plants, their postproduction quality, evaluated as floral longevity, bud drying, and bud abscission, was not as satisfactory as that of STS- or BA-treated plants. In this ethylene-sensitive cultivar, BA treatment was almost as satisfactory as STS treatment. Flowers that opened in the greenhouse before shipping lasted longer than those that opened in the interior environment room. STS and BA treatments increased the longevity of both flower types. However, these treatments did not eliminate the difference between flowers that opened before or after transport simulation. Chemical names used: aminooxyacetic acid (AOA); benzyladenine (BA); silver thiosulfate (STS).

The postproduction performance of flowering potted plants is of utmost importance for their acceptability and trade value, regardless of species or cultivar (Weltering, 1987). This important characteristic can be influenced by several production and postproduction measures (Nell and Noordegraf, 1991). Miniature potted roses are among the best-selling flowering potted plants in Denmark, and extensive efforts are being taken to improve the quality and increase the production of these attractive plants (Andersen et al., 1992; Serek and Andersen, 1992).

'Victory Parade' is ethylene sensitive and responds favorably to STS treatments (Serek, 1993). Since silver may be considered environmentally unacceptable, other means to prolong floral life should be investigated. AOA inhibits endogenous ethylene biosynthesis in plants by inhibiting the action of ACC synthase (Yu et al., 1979). In tests with this compound on flowering potted *Impatiens*, Dostal et al. (1991) showed that AOA inhibited corolla abscission by 20%. BA, a growth regulator, may retard leaf and floral organ senescence (Halevy and Kofranek, 1976). BA has been used as a postharvest treatment for cut flowers for many years (Harkema et al., 1987), and recently it also has been tested as a way to

prevent leaf drop in potted roses (Clark et al., 1991). We examine here AOA and BA in relation to the longevity and other postproduction characteristics of potted 'Victory Parade' miniature rose.

Potted rose plants (10-cm pots, 0.55-liter volume, four plants per pot) were produced in a commercial greenhouse. The plants were pinched 5 weeks after rooting, then transferred to the university greenhouse: 22/21C $\pm$ 2C day/night, 21-h (0200–2300 HR) photoperiod, daylight supplemented with 150 $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$ photosynthetic photon flux (PPF) of artificial

light from SON-T high-pressure sodium lamps (Philips, The Netherlands).

At the marketing stage (five to eight open flowers per pot), the plants were sprayed to runoff ($\approx$ 30 ml/pot) with aqueous solutions of the test compounds. AOA was applied at five concentrations (1, 2, 4, 6, or 8 mM) and BA at four (0.2, 0.4, 0.6, or 0.8 mM). As controls, we used distilled water and a 0.4-mM STS solution. All treatment solutions, including controls, contained 0.1 % Lissapol (ICI Denmark, Copenhagen) as a surfactant.

Four hours after treatment, the plants were moved to a room where they remained for 3 days in darkness at 8C, without irrigation, but in high relative humidity (RH; $\approx$ 80%), to simulate typical transport conditions. The plants were then placed randomly in the interior environment room (20 $\pm$ 2C, 60% $\pm$ 5% RH, light from cool-white fluorescent tubes at 12 h $\cdot\text{day}^{-1}$ and 15 $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$ PPF). The plants remained in the interior environment room for 1 month. They were watered with tap water as needed.

All flowers were counted at harvest and after simulated shipping in darkness, and every fourth day thereafter. Flowers were labeled as they opened, and the total number of flowers opening on each plant was recorded. Individual-flower longevity (number of days from anthesis to petal drying or abscission) was recorded separately for flowers that opened in the greenhouse and for those that opened during the first 5 days in the interior environment. Plant longevity was considered to be the number of days from harvest to the day when only three flowers remained on the plant. Statistical procedures were performed using the PC-SAS software package (SAS Institute, 1985). The variance of the experimental data was tested, and orthogonal comparisons were

Table 1. Plant and individual-flower longevity, and accumulated number of flowers per plant of *Rosa hybrida* 'Victory Parade', treated with various AOA, BA, or STS concentrations at marketing stage (day -3).

Chemical and concn (mM)	Plant longevity (days)	Longevity (days) of flowers opened in		Accumulated flower no.
		Greenhouse	Interior environment	
AOA				
1	21.9	20.3	12.4	12.1
2	24.2	21.6	13.0	15.0
4	23.1	21.4	12.7	14.9
6	21.6	20.0	11.9	12.6
8	20.9	18.8	11.8	11.8
BA				
0.2	24.8	22.7	13.2	17.9
0.4	25.2	22.9	14.1	19.0
0.6	25.8	22.9	14.1	19.6
0.8	27.7	23.0	14.9	19.8
STS				
0.4	30.2	22.6	15.0	26.7
Control	21.6	19.9	12.2	10.3
Significance				
Control vs. others	***	***	*	***
STS vs. BA	***	NS	*	***
STS vs. AOA	***	***	***	***
BA vs. AOA	***	***	***	***
AOA linear	***	***	*	NS
AOA quadratic	**	***	NS	*
BA linear	***	NS	**	NS
BA quadratic	*	NS	NS	NS

NS, ***, ****, *****Nonsignificant or significant at $P \leq 0.05$, 0.01, or 0.001, respectively.

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used to examine differences between means.

STS-treated plants kept longer than those from other treatments (Table 1), but BA-treated plants were almost as satisfactory, especially those treated with 0.8 mM BA. Plant longevity increased quadratically with increased BA concentration; concentrations >0.8 mM may, therefore, improve plant life more than lower concentrations. Longevity also was quadratically correlated with AOA concentration, with an optimal concentration of ≈ 2 mM. AOA-treated plants kept longer than control plants, but significantly shorter than STS- or BA-treated plants.

Expressing plant behavior as flower longevity produced similar effects (Table 1). Clearly, flowers that opened in the greenhouse lived longer than those that opened after transport. Better light conditions in the greenhouse environment probably influenced bud development. Flower life was longest for STS- and BA-treated plants, and there was no statistical difference between these treatments for flowers that had opened in the greenhouse. For flowers that opened in the interior environment, 0.8 mM BA was as beneficial as STS. Because flower life was linearly correlated with BA concentration, higher concentrations might give longer flower life than STS pretreatment (Table 1). AOA treatment only increased single flower life slightly.

Buds from STS- or BA-treated plants were

less prone to abscise and wither than buds sprayed with AOA or the controls (data not shown). This means that these buds were capable of developing further and opening eventually—a result that would produce more flowers per plant in the interior environment room. AOA-treated and control plants, however, developed many dry buds and many abscised buds (data not shown). These plants, therefore, had fewer flowers throughout the experiment (Table 1). This paucity of flowers also is evident from the data on the number of flowers that developed during the keeping period in the interior environment (Table 2), where only the STS- and BA-treated plants still had flowers after 20 days. None of the spray treatments was phytotoxic.

Because 'Victory Parade' is ethylene sensitive (Serek, 1993; Serek and Andersen, 1992), it is not surprising that the plants responded to STS treatment with increased individual flower and whole-plant longevity. Since the plants were not exposed to exogenous ethylene, the STS effect must result from reduced response to endogenously produced ethylene.

AOA treatments should, in principle, hinder endogenous ethylene production through inhibition of ACC synthase (Yu et al., 1979). While AOA treatment does improve longevity slightly, its effect does not last (Table 2). Possibly, this compound is not stable in the plants for the required 3 to 4 weeks. The data

indicate an optimum concentration of 2 to 4 mM for all quality attributes measured, so an increase in treatment concentration would not have been helpful. In contrast, it appears that higher BA concentrations may improve plant quality and flower longevity. These results agree with previous findings that showed improved quality in plants sprayed with cytokinins (Clark et al., 1991; Halevy and Kofranek, 1976), which are known to reduce ethylene sensitivity (Zacarias and Reid, 1990). Also, BA is less phytotoxic than STS and has been approved for use on some food crops.

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Table 2. Number of *Rosa hybrida* 'Victory Parade' flowers per plant during storage in an interior environment room (IER) in relation to preharvest treatments with various chemicals.

Chemical and concn (mM)	Storage in IER (days)			
	12	16	20	24
AOA				
1	10.8	7.4	0	0
2	13.9	13.9	2.8	0
4	16.8	15.9	2.3	0
6	11.3	8.4	0	0
8	10.5	7.0	0	0
BA				
0.2	15.9	16.9	5.3	0
0.4	17.8	19.3	5.2	0
0.6	15.9	18.3	5.8	1.0
0.8	15.6	17.8	8.7	2.4
STS				
0.4	15.5	17.3	9.5	6.8
Control	8.7	7.9	0	0
Significance				
Control vs. others	***	***	***	***
STS vs. BA	NS	NS	***	***
STS vs. AOA	*	***	***	***
BA vs. AOA	***	***	***	***
AOA linear	NS	*	*	NS
AOA quadratic	**	***	*	NS
BA linear	NS	NS	***	***
BA quadratic	NS	NS	*	*

NS,*,**,*Nonsignificant or significant at $P \leq 0.05$, 0.01, or 0.001, respectively.