Polyamine Uptake Does Not Affect Floral Longevity in Miniature Potted Roses

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Abstract. Postharvest life of *Rosa hybrida* L. 'Elegance Parade' was increased by 0.2 mM silver thiosulfate and decreased by ethephon at 500 $\mu\text{l}\cdot\text{liter}^{-1}$. In contrast, spraying the plants with various polyamine (PA) concentrations (spermine, spermidine, or putrescine) or the PA-synthesis inhibitor methylglyoxal-guanyldiazide did not affect postharvest life. Investigation of PA-uptake patterns showed that the compounds were entering the petal tissue.

Polyamines (PAs) retard senescence in several plant systems (Galston and Sawhney, 1987). Wang and Baker (1980) showed that carnation cut-flower longevity was increased when the flowers were treated with three PAs. In contrast, when Downs and Lovell (1986) investigated the relationship between PAs and ethylene-induced senescence in carnation flowers, they concluded that none of the compounds inhibited ethylene synthesis or tissue senescence; however, high PA concentrations (10 mM) augmented ethylene emanation and hastened senescence. Suttle (1981) observed a reduction in ethylene production in senescing *Tradescantia* petals after PA administration. Although the widespread use of carnation flowers as a model in floral senescence has implied that results can be applied to other species, carnations have been found to be peculiar in relation to senescence (Sacalis, 1986).

Because of the difference between cut-flower and intact-flower senescence and the described effects of PAs on leaf senescence (Galston and Sawhney, 1987), these compounds were included in our investigation of alternatives to silver thiosulfate (STS) as an anti-ethylene treatment for potted miniature roses (Serek, 1993; Serek and Anderson, 1993). As a model system we selected the miniature rose *Rosa hybrida* 'Elegance Parade' (yellow).

Methods and Results

'Elegance Parade' plants were rooted in 0.55-liter pots (10-cm pots) with four plants per pot. The plants were transferred from a commercial grower to the The Royal Veterinary and Agricultural Univ. greenhouse for the final production period (≈ 4 weeks). The

conditions in the greenhouse were as follows: 22/21C ± 2 C day/night, photoperiod for 21 h (0200-2300 HR), 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 (Philips, Holland) high-pressure sodium lamps.

Ethylene effects. Flowering plants were sprayed to run off with 0.2 mM STS or 500 μl ethephon/liter. After treatment, the plants were moved to an interior environment (20 ± 2 C, 60% ± 5 % relative humidity, 15 $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$ PPF light from cool-white fluorescent lamps for 12 h/day). During the following month, the plants remained in the interior environment where they were watered with tap water as needed. Open flowers and abscised buds were counted every 2 days. Statistical procedures were performed using SAS software (SAS Institute, 1985). The experimental data variance was tested, and orthogonal comparisons were used to examine differences between means.

Bud abscission was accelerated by ethephon and prevented by STS (Fig. 1). This response resulted in more open flowers on the STS-treated plants throughout the keeping period (Fig. 2). Similar results have been obtained with other cultivars of miniature rose, but are not universal (Serek, 1993).

PA effects on postharvest characteristics. Flowering 'Elegance Parade' plants (five to eight open flowers per pot) were sprayed to

Fig. 1. *Rosa hybrida* 'Elegance Parade' abscised bud count per control plant and pretreated [0.2 mM silver thiosulfate (STS) or 500 μl ethephon/liter] plant. Plants were evaluated during display life in an interior environment.

Source of variation:

Treatment:
STS vs. others ***
Control vs. ethephon ***

Days:
Linear (L) ***

Treatment $\times$ days:
STS vs. others $\times$ L ***
Control vs. ethephon $\times$ L ***

***Significant at $P \leq 0.001$.

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runoff (≈ 30 ml/pot) with aqueous solutions of test compounds. We tested three PAs [putrescine (Put), spermidine (Spd), and spermine (Spin), each at 0.01, 0.1, or 1.0 mM] and

methylglyoxal-guanylhydrazine (MGBG; at 0.001, 0.01, or 0.1 g-liter⁻¹). All treatments, including a deionized water control, contained 0.1 % Lissapol (ICI Denmark, Copenhagen,

Denmark) as a surfactant. After 4 h, treated unpacked plants were moved to an interior environment for 3 days and kept at 8°C, in darkness and without irrigation, and in high humidity to simulate typical transport conditions. Then the plants were placed randomly in the interior environment previously described (see *Ethylene effects.*). The longevity of individual flowers that had opened before or after simulated shipping was determined by counting the days from anthesis to petal drying or abscission. Plant quality was determined as the total number of open flowers per plant. Plant longevity was recorded as the number of days from treatment to when only three flowers remained on the plant.

None of the PAs had any significant influence on flower or plant longevity (11–13 or 13–15 days, respectively). Some PAs reduced the flower count by two to four flowers per plant. None of the differences were statistically significant. The PA synthesis inhibitor MGBG also did not affect the measured characteristics.

The plants' lack of response to MGBG and different PA spray treatments supports the conclusions of Downs and Lovell (1987). Roberts et al. (1986) warned that exogenous plant-tissue PA treatments should be corroborated with inhibitor studies. Also, sprayed PAs may not have entered the tissues. Previous investigations have examined the effects of PAs added to cut-flower holding solutions, where the chemicals are delivered to leaf and petal cells by transpiration. We investigated PA ability to penetrate the cuticle and epidermis of rose petals.

PA uptake. Single drops (5 μ l) of ¹⁴C-labeled 0.1 mM Put, Spd, or Spm [≈ 0.055 μ Ci (1 Ci = 37 GBq); Amersham International, Buckinghamshire, England], with and without Lissapol as a surfactant, were placed on individual rose petals (n = 10). Petals were incubated at 20°C for 2, 30, 60, 120, or 240 min, after which the petal surface was washed with 1 ml distilled water to remove the nonabsorbed, labeled PAs. The distilled water wash was diluted with 20 ml scintillation fluid (Ecoscint National Diagnostics, Mauville, N.J.), and its radioactivity was determined using a liquid scintillation counter (121 7 Rackbeta LKB, Wallace, Finland). PA uptake was calculated as the difference between total applied activity and activity in wash.

Discussion

All PAs appeared to enter the petal tissue (Fig. 3), although the extent to which they reached the target tissue or cells cannot be determined. The uptake was greater and faster with added surfactant, suggesting that PAs were entering the internal petal tissues. The concentrations generally used in PA experiments have been in the millimolar range (Downs and Lovell, 1986). We found 80% to 90% uptake of 0.1 mM PA applied to petals; thus, it seems that enough PA entered the tissue to stimulate physiological response. We conclude that the inability of applied PAs to affect senescence indicators of an ethylene-

Fig. 2. *Rosa hybrids* 'Elegance Parade' open-flower count per control plant and pretreated [0.2 mM silver thiosulfate (STS) or 500 μ l ethephon/liter] plant. Plants were evaluated during display life in an interior environment.

Source of variation:

Treatment:

STS vs. others ***

Control vs. ethephon *

Days:

Linear (L) NS

Quadratic (Q) ***

Treatment $\times$ days:

STS vs. others $\times$ L ***

Control vs. ethephon $\times$ L NS

STS vs. others $\times$ Q ***

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

Fig. 3. Miniature-rose (*Rosa hybrida* 'Elegance Parade') petal uptake of ¹⁴C-labeled 0.1 mM putrescine, spermidine, or spermine [≈ 0.055 μ Ci (1 Ci = 37 GBq)]. Polyamides were applied with and without Lissapol (0.1%) as a surfactant.

sensitive cultivar did not result from lack of uptake. PAs do not appear to have the ethylene-antagonist effects in miniature roses as those reported in other systems (Galston et al., 1987; Wang and Baker, 1980).

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