

Plant Growth Regulators Reduce Postproduction Leaf Yellowing of Potted Asiflorum Lilies

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Abstract. The postharvest quality of potted Asiflorum lily 'Donau' (*Lilium* hybrid) was evaluated after plants were sprayed with 0, 50, 250, or 500 mg·L⁻¹ (BA equivalent) of Promalin (GA₄₊₇ to BA ratio was 1:1) or Accel (GA₄₊₇ to BA ratio 1:10) and stored at 2 to 3 °C for 0, 10, or 20 days. As storage was prolonged, more leaves senesced once plants were removed for evaluation. Leaf senescence declined with increasing concentrations of either Promalin or Accel, but Promalin was more effective. Application of 250 mg·L⁻¹ Promalin completely eliminated leaf senescence over the 20-day shelf-life evaluation period, irrespective of duration of cold storage. The treatments did not affect flower bud opening or plant height. Chemical names used: gibberellin (GA₄₊₇); benzyladenine (BA).

Asiflorum hybrids of *Lilium*, resulting from crosses between Easter lily (*Lilium longiflorum* Thunb.) and Asiatic hybrids, are grown as potted plants to diversify the market currently dominated by Easter lily. Leaf senescence during both the greenhouse and postproduction phases is a problem with Easter lily and the hybrids. Application of gibberellin (GA₃), BA, or both to individual leaves and entire plants of Easter lily alleviates postproduction leaf senescence (Han, 1995), and the combination treatment has a synergistic effect. Application of a combination of GA₄₊₇ and BA as Promalin (Abbott Chemical Co., Chicago) to entire plants also has alleviated leaf senescence in the greenhouse phase of production (Heins et al., 1996), with Promalin being more effective than GA₃ (Han, 1996).

Because of the variable nature of market demand and the natural disparity in the timing of flowering of lily crops, plants are often stored at 2 to 3 °C for as long as 21 d prior to shipment. Under these conditions, leaf senescence in Easter lily is further accelerated, but can most effectively be alleviated by applications of Promalin (Han, 1997). However, to date no research in any of these areas has been conducted on the Asiflorum hybrids.

Differences in the effectiveness of Promalin and Accel (Abbott Chemical Co.) in alleviating leaf senescence have been suggested for Easter lily (Han, 1996). Hence, before they can be recommended for use, the relative performance of Promalin and Accel with Asiflorum hybrids needs to be assessed.

The objectives of this experiment were twofold: first, to evaluate the ability of Promalin and Accel to reduce leaf senescence of an Asiflorum hybrid lily during the postproduction phase; second, to quantify plant quality as affected by concentration of these plant growth regulators, plant storage duration, and any possible interactions between concentration and storage duration.

Materials and Methods

Plants of the *Lilium* Asiflorum hybrid 'Donau', potted as three bulbs per 17.5-cm-diameter (1.7-L) plastic pot in a commercial, soilless growing medium, were delivered to Michigan State Univ. (MSU) by a commercial producer on 2 July 1997, 1 week prior to flower bud coloration. Before and after shipment to MSU, plants were grown at a density of ≈28 pots/m² and, at MSU, at a daily average temperature of 25 °C.

Once the first primary bud on 70% of the plants had commenced coloration, pots of three plants were selected for uniformity of maturity and bud count per stem (i.e., three buds). Treatment solutions were applied by spraying all three plants with 16 mL of 0, 50, 250, or 500 mg·L⁻¹ (BA equivalent) of either Promalin or Accel. All treatment solutions contained 0.1% wetting agent (Olympic; Olympic Horticultural Products Co., Mainland, Pa.). Complete foliage coverage (flower buds were not sprayed) was ensured by rotating the pot on a revolving platform and spraying until runoff. Each pot was removed from the cultivation benches, any existing senesced leaves

were removed, and the plants were sprayed and returned when dry.

Once the first primary bud on 70% of the plants had reached the colored puffy-bud stage (i.e., 2 d after spray application), plants were placed at 3 ± 2 °C for 0, 10, or 20 d.

Upon removal from cold storage and subsequently after 7, 14, or 20 d, one randomly selected plant in each pot was evaluated for the number of senesced leaves. Evaluation of shelf-life quality was conducted in a room maintaining 20 ± 2 °C, 60% ± 10% relative humidity, about two air changes per hour, and a 12-h photoperiod with an irradiance of ≈10 μmol·m⁻²·s⁻¹ at bench height from cool-white fluorescent lights. A leaf was regarded as senesced when ≥50% of its surface area had become chlorotic or necrotic. At the final evaluation (20-d shelf life), both the number of flower buds that had failed to open and final plant height were recorded.

The experiment was a completely randomized design with a factorial arrangement of two plant growth regulators, four concentrations, and three storage durations. Each treatment contained 10 replicates, with each replicate being an individual plant in a separate pot. Senesced leaf data were transformed by the following formula to stabilize variance: $\sqrt{(y + 0.5)}$. Data were subjected to analysis of variance using the general linear models (GLM) procedure of SAS (SAS Institute, Cary, N.C.). Means reported are based on the back-transformed data.

Results and Discussion

Even without storage, senescence of the lower leaves occurred, reaching a maximum of between three and four leaves after 20 d of evaluation on plants not treated with Promalin or Accel (Fig. 1 A and B).

Except for the first evaluation following removal from cold storage, interactions between plant growth regulator and concentration ($P < 0.01$), as well as between storage duration and concentration ($P < 0.05$), were evident with respect to the number of senesced leaves. No leaves were senescent immediately after removal from cold storage of any duration (data not presented). However, for control plants (no Promalin or Accel), increasing duration of cold storage significantly ($P < 0.01$) increased the number of senesced leaves that developed over the following 20 d of evaluation (Fig. 1 A–F). This trend was most evident after 20 d of cold storage when between 12 and 16 leaves had senesced after 20 d of evaluation (Fig. 1 E and F).

The application of either Promalin or Accel reduced the incidence of leaf senescence, with higher concentrations resulting in greater reductions ($P < 0.001$). However, Promalin was more effective than Accel. After 20 d cold storage and 20 d shelf life, no leaves were senescent in plants treated with 250 mg·L⁻¹ (BA equivalent) Promalin, compared with between three and four leaves at the same BA equivalent concentration of Accel (Fig. 1 E and F). With both 10 and 20 d cold storage, none of the Accel treatments eliminated leaf

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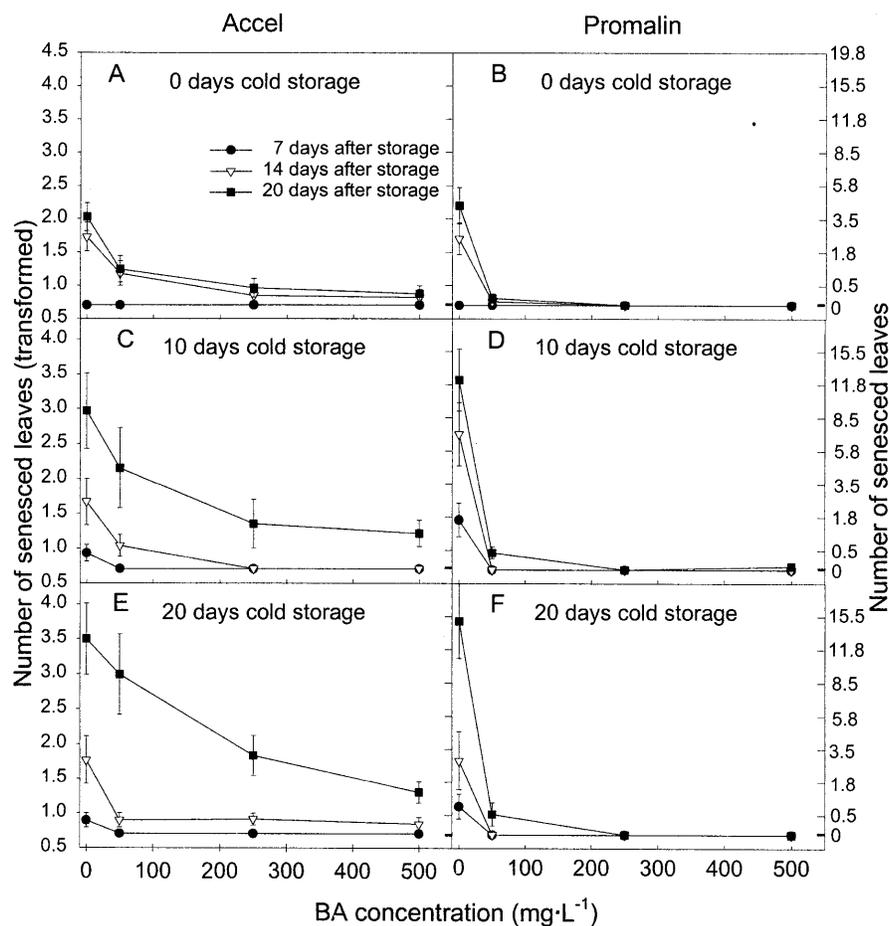


Fig. 1. Influence of Promalin and Accel concentration (BA equivalent) and of duration of storage at 3 ± 2 °C on the number of senesced leaves per *Asiflorum* lily plant after increasing periods at 20 °C following storage (● = 7 d; ▽ = 14 d; ■ = 20 d). Each data point represents the mean for 10 stems. Vertical bars represent the mean \pm SE of transformed data (left axis of each plot). Numbers on the right side of each plot represent equivalent nontransformed values.

senescence after 7 d of evaluation (Fig. 1 C and E). In contrast, Promalin at 250 mg·L⁻¹ (BA equivalent) and higher concentrations completely eliminated leaf senescence throughout the 20 d of evaluation, irrespective of storage duration (Fig. 1 B, D, and F). When plants were not stored, differences between Promalin and Accel were less pronounced, with plants carrying a maximum of two senesced leaves at 50 mg·L⁻¹ (BA equivalent) Accel compared with less than one leaf on plants sprayed with the same BA equivalent concentration of Promalin (Fig. 1 A and B).

Both gibberellins (GA₃) and cytokinins

(BA) independently reduce leaf senescence in Easter lily, with evidence of a synergistic effect when both are present (Han, 1995, 1996). Evidence exists that both of these plant growth regulators are interconnected in their influence on the endogenous concentrations of both gibberellins and cytokinins in leaf tissue and their involvement in senescence (Aharoni and Richmond, 1978). The application of Promalin containing a 1:1 ratio of both GA₄₊₇ and BA more effectively reduced leaf senescence in Easter lily than the equivalent concentration of BA alone (Han, 1997), adding support to this theory. Since the concentra-

tions used in the experiment reported here were based upon the BA content of the two commercial products, we conclude that it is the resultant 10-fold greater concentration of GA₄₊₇ in Promalin that is the basis for its greater efficacy.

While transformation of the senesced leaf data reduced the heterogeneity of variance, the number of senesced leaves per plant was more variable as storage duration and period of evaluation increased, but decreased as concentration of Promalin and Accel increased (Fig. 1A–F). Since predictable reliability of product quality is desirable, this reduced variability at higher concentrations is in itself a noteworthy response for the commercial application of these plant growth regulators.

The absence of any treatment effect on flower bud opening (data not presented) confirms the observations of Han (1997). However, contrary to our earlier findings with Easter lily (Heins et al., 1996), plant height was not influenced by treatment (data not presented). Apart from the obvious difference in plant material, this dichotomy in results probably originated from application at a later stage of plant development in the current experiment, i.e., after stem elongation was virtually completed (Lieth and Carpenter, 1990).

In conclusion, recommendations for eliminating postproduction leaf senescence in *Asiflorum Lilium* 'Donau' include spraying the foliage of plants in each pot with 16 mL of 250 or 500 mg·L⁻¹ Promalin at the commencement of flower bud coloration.

Literature Cited

- Aharoni, N. and A.E. Richmond. 1978. Endogenous gibberellin and abscisic acid content as related to senescence of detached lettuce leaves. *Plant Physiol.* 62:224–228.
- Han, S.S. 1995. Growth regulators delay foliar chlorosis of Easter lily leaves. *J. Amer. Soc. Hort. Sci.* 120:254–258.
- Han, S.S. 1996. Enhancement of post-production quality of Easter lily by growth regulators. *HortScience* 31:912. (Abstr.)
- Han, S.S. 1997. Preventing postproduction leaf yellowing in Easter lily. *J. Amer. Soc. Hort. Sci.* 122:869–872.
- Heins, R.D., T.F. Wallace, and S.S. Han. 1996. GA₄₊₇ plus benzyladenine reduce leaf yellowing of greenhouse Easter lilies. *HortScience* 31:597. (Abstr.)
- Lieth, H. and P. Carpenter. 1990. Modeling stem elongation and leaf unfolding of Easter lily during greenhouse forcing. *Scientia Hort.* 44:149–162.