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USE OF SILVER THIOSULFATE TO PREVENT FLOWER ABSCISSION FROM POTTED PLANTS

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ABSTRACT

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Abcission of petals from the flowers of the seedling geranium (*Pelargonium hortorum* Bailey) cultivars 'Sprinter White', 'Sooner Deep Salmon', 'Ringo Scarlet' and 'Carefree Red' was almost completely suppressed by 0.5 mM foliar sprays of the silver thiosulfate complex (STS). STS was effective whether applied to entire plants or just to the individual developing inflorescences. Foliar sprays of 0.5 mM STS on *Calceolaria herbeohybrida* Voss reduced flower abcission following 4 days in the dark or 2 days exposure to 1 $\mu l\ l^{-1}$ ethylene. *Bougainvillea glabra* Chois. bracteole drop following 3 days of drought was also reduced by foliar sprays of 0.5 mM STS. Phytotoxicity was never observed on any of these species following STS application at concentrations of 0.5 mM or less.

INTRODUCTION

Abscission of flower parts (shattering) is often a serious problem during the handling of potted flowering plants. This abscission is normally increased by environmental stresses such as drought, low humidity, heat, or mechanical perturbation, any one of which could be encountered during harvest, transit or retail display. Treatments which could prevent, or at least reduce, the abscission would be of considerable value to the floriculture industry.

Silver nitrate was shown by Beyer (1976) to prevent the abscission of fruits, leaves and flowers caused by ethylene (C_2H_4). However, silver nitrate cannot be used commercially since it is relatively immobile in plant tissues and is phytotoxic at effective concentrations. Veen and Van de Geijn (1978) found that silver complexed as silver thiosulfate (STS) moved rapidly through stems of cut carnations and significantly extended their vase life. Recently, we have shown that foliar application of STS significantly reduced abscission of zygocactus flowers and buds following exposure to 1 $\mu l\ l^{-1}$ C_2H_4 or to 26°C in the dark as compared to plants sprayed with water (Cameron and Reid, 1981). Abscission was reduced even when the plants were stressed 3 weeks after STS application.

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Encouraged by these results, we applied foliar sprays of STS to other potted plants where flower shattering has been reported to be a problem. Here we report that STS can eliminate, or at least reduce, abscission of flower parts from geraniums, calceolaria and bougainvilleas following imposition of certain stresses.

MATERIALS AND METHODS

Geranium plants *(Pelargonium hortorum* Bailey, cultivars 'Ringo Scarlet', 'Sprinter White', 'Sooner Deep Salmon' and 'Carefree Red') were grown from seed, and plant size was limited by a Cycocel drench. The day before treatment with STS, all inflorescences with pedicels longer than 3—5 cm were removed. Calceolaria plants *(Calceolaria herbeohybrida* Voss) were grown from seed and were stripped of all open flowers prior to treatment with STS. Bougainvillea plants *(Bougainvillea glabra* Chois.) were grown from stem cuttings, drenched with Cycocel, and induced to flower under short days. Bracteoles were not removed prior to treatment with STS.

Solutions of STS were prepared as reported previously (Cameron and Reid, 1981). Geranium plants were treated in the greenhouse with sprays of water, 0.1, 0.5 or 0.2 mM STS applied either to entire plants or restricted solely to the young inflorescences. About 25 ml treatment solution was used when spraying an entire plant and about 5—10 ml when spraying only young buds, with some variation in amount depending on plant size. After some flowers had opened (2—3 weeks later), the geranium plants were transferred from the greenhouse to the laboratory (21°C and continuous fluorescent lighting). Buds continued to develop while the plants were under observation in the laboratory, with up to 10 new flowers opening per day. Geranium inflorescences were gently shaken daily to remove loose petals, and the fallen petals were counted.

Calceolaria plants were sprayed to run-off in the greenhouse with a fine mist of 0.5 mM STS (approximately 20 ml per plant) 1 day after all open flowers had been removed. Plants were moved to the laboratory after a significant number of flowers had opened (approximately 1 week later) and were stressed either by 2 days exposure to 1 $\mu l\ l^{-1}$ C_2H_4 or by 4 days simulated transportation (25°C in the dark). Plants were exposed to C_2H_4 in large glass chambers at 21°C under fluorescent light. C_2H_4 was introduced into air streams of 1—2 l min^{-1}; the final concentration was verified with a gas chromatograph. The percentage of abscised calceolaria flowers was determined immediately after removal from each stress condition.

Bougainvillea plants were sprayed with a fine mist of 0.5 mM STS (25 ml per plant) after a significant number of flowers had opened. At the time of spraying, some flowers had already senesced although the bracteoles had not yet abscised. Plants were moved to the laboratory 3 weeks later and stressed by withholding water for 3 days. The abscised bracteoles were counted daily.

RESULTS

Geranium. — Petals fell steadily from the flowers of water-sprayed 'Carefree Red' geraniums (Fig. 1) and also (although only after 6 days) from flowers of plants sprayed only on developing flower heads with 0.5 mM STS. Spraying the developing flower heads with 2.0 mM STS almost completely prevented petal drop (Fig. 1a). When entire plants were sprayed to run-off, shattering was almost entirely suppressed by both 0.5 and 2.0 mM STS (Fig. 1b).

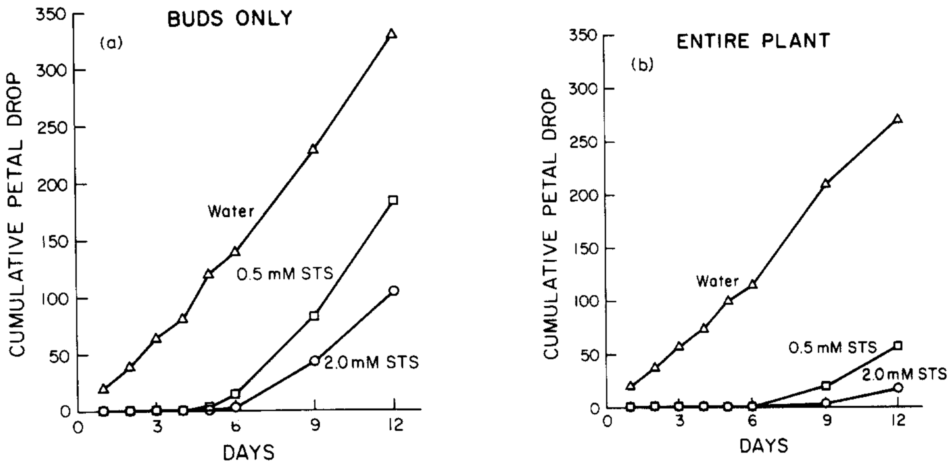

Fig. 1. Effect of spraying with STS on petal drop in seedling geranium plants. Geranium plants ('Carefree Red') were sprayed 3 weeks before flowering with 2 concentrations of STS applied either to the developing inflorescences alone (1a) or as a foliar spray to the entire plant (1b). When the plants were in full bloom, they were held in continuous light at 25° C and fallen petals were counted each day after the inflorescences had been shaken gently. Data are the means for 3 replicate plants.

'Sprinter White' geraniums sprayed with water dropped a substantial number of petals every day of observation (Table I). After 1 week, they were unsaleable despite the opening of additional flowers. STS (0.1, 0.5 or 2.0 mM) applied to the buds consistently delayed shattering and reduced petal drop during the period of observation (Table I). Foliar applications completely prevented shattering of 'Sprinter White' (Table I), and at 0.5 mM also reduced shattering in 'Sooner Deep Salmon' (Fig. 2) and 'Ringo Scarlet' (results not shown).

Phytoxicity was sometimes observed when 2.0 mM STS was applied to geranium foliage. The injury, appearing as small, dark circular areas near the margins of the leaves, was never observed on plants when the spray was restricted to the developing inflorescences or when plants were sprayed with a concentration of 0.5 mM STS or lower.

TABLE I

Loss of petals from 'Sprinter White' geraniums in the laboratory. Plants were sprayed with their respective treatments 3 weeks prior to flower opening. Each value is the mean of 4 replicate plants

	Days in the laboratory						
Treatment	0	1	2	3	4	5	6
Only buds sprayed							
Water	21	84	113	132	178	194	211
0.1 mM STS	0	0	15	36	59	85	110
0.5 mM STS	0	0	0	0	0	0	4
2.0 mM STS	0	0	0	0	0	0	0
Entire plants sprayed							
0.1 mM STS	0	0	0	0	0	0	0
0.5 mM STS	0	0	0	0	0	0	0
2.0 mM STS	0	0	0	0	0	0	0

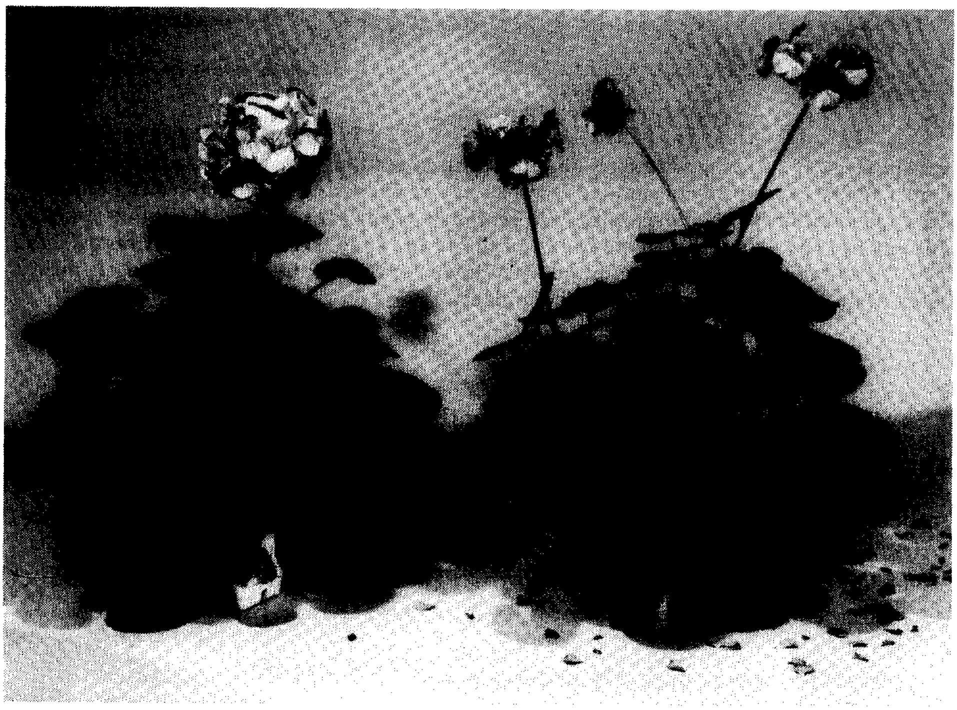

Fig. 2. Petal drop in seedling geranium plants ('Sooner Deep Salmon') after 7 days at 25° C in continuous light. Control plant (right) was sprayed with water, treated plant (left) was sprayed to run-off with 0.5 mM STS 3 weeks before full bloom.

Calceolaria. — A large proportion of water-treated calceolaria flowers abscised when stressed by either 4 days of drought in the dark or 2 days exposure to 1 $\mu l\ l^{-1}$ C_2H_4. Although 0.5 mM STS treatment did not offer complete protection against these stresses, it reduced the percentages of dropped flowers from 83 to 22 in plants stressed by 4 days of drought in the dark at 25° C, and from 91 to 36 in those exposed for 2 days to C_2H_4.

Bougainvillea. — Bracteole drop from bougainvillea was found to be extremely sensitive to drought conditions (Table II). The control plants continued to drop bracteoles even after watering was resumed. Foliar sprays of 0.5 mM STS offered good protection against the drought-induced abscission of bracteoles.

TABLE II

The percentages of bracteoles dropped from bougainvillea plants water-stressed for 3 days in the light at 25° C. The plants were watered during the second 3-day period. Values are the means of duplicate plants

Treatment	3 days drought (%)	Next 3 days (%)	Total (%)
Water	56	34	90
0.5 mM STS	17	12	29

DISCUSSION

Shattering is a severe problem during the handling of seedling geraniums (Armitage et al., 1980) and of a number of other potted flowering plants. Our results show that foliar application of low concentrations of STS can reduce flower abscission. Plants treated 2—3 weeks prior to harvest with STS were still protected during simulated harvest, transit and retail display.

We noted that geranium inflorescences not yet visible at the time of STS treatment and hence not directly sprayed were nonetheless protected during the observation period, even when the STS sprays were restricted only to young developing inflorescences. This indicates that STS was freely mobile in the plant over a prolonged period.

The results demonstrate the marked effect of water stress on flower-part abscission of potted flowering plants. In addition to calceolaria and bougainvillea, preliminary evidence suggests that geranium, impatiens and mimulus are extremely sensitive to drought conditions. Impatiens were so sensitive to drought that some leaves and stems abscised under severe conditions (A.C. Cameron and M.S. Reid, unpublished results, 1981). The heat-plus-dark treatment used to induce flower and bud drop in zygocactus (Cameron and Reid, 1981) might also have been primarily a drought stress, since the plants were not watered during the 4-day stress period.

Application of STS at low concentration avoids phytoxicity and minimizes cost. At the present cost of silver, the cost per plant is less than $U.S. 0.001 at the concentrations and volumes used. The demonstrated effectiveness of STS as an anti-abscission agent in potted flowering plants, its relative ease of application, the potential for pre-harvest application (long-term effectiveness) and the low cost per plant suggest that foliar application of STS has great potential as a means of reducing abscission problems in potted flowering plants.

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REFERENCES

Armitage, A.M., Heins, R., Dean, S. and Carlson, W., 1980. Factors influencing flower petal abscission in the seed-propagated geranium. J. Am. Soc. Hortic. Sci., 105: 562—564.

Beyer, E.M., Jr., 1976. A potent inhibitor of ethylene action in plants. Plant Physiol., 58: 268—271.

Cameron, A.C. and Reid, M.S., 1981. The use of silver thiosulfate complex as a foliar spray to prevent flower abscission in zygocactus. HortScience, 16: 761—762.

Veen, H. and Van de Geijn, S.C., 1978. Mobility and ionic form of silver as related to longevity of cut carnations. Planta, 140: 93—96.