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The Use of Silver Thiosulfate Anionic Complex as a Foliar Spray to Prevent Flower Abscission of Zygocactus[1]

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***Abstract*. After 4 days, zygocactus plants (*Schlumbergera truncata*) exposed to air containing 0.5, 5 and 50 µl/liter C_2H_4 or held in the dark at 26°C dropped all their buds and flowers. Foliar application of silver thiosulfate (STS) significantly reduced flower and bud abscission of zygocactus plants stressed by exposure to C_2H_4 or 26°C plus dark even 4 weeks after application. Phytotoxicity was negligible when the silver concentration was 2 mM or less.**

Abscission of flower parts is commonly a limiting factor during the postharvest handling of potted flowering plants. Examples include flower drop in snapdragon and calceolaria (6), petal drop in geranium (2) and bractiole drop in bougainvillea (7). Environmental factors such as heat, cold, low humidity, low light, water stress, and exposure to ethylene (C_2H_4) induce abscission in sensitive plants (2, 4). Since environmental stresses normally enhance C_2H_4 production in plants and since exogenous application of C_2H_4 commonly induces abscission, C_2H_4 is widely held to mediate this process (1).

Beyer (3) noted that foliar-applied silver nitrate prevented C_2H_4-induced leaf, flower, and fruit abscission. The usefulness of silver nitrate has been limited by its relative immobility within the plant tissue and by the phytotoxicity which generally follows application of concentrations which are high enough to be effective (3). However, Veen and van de Geijn (10) found that silver complexed with thiosulfate was extremely mobile within the plant and significantly extended the vase life of cut carnations. Even short pulses of STS prolonged the vase life of cut carnations (8), indicating that the silver remains active within the tissue for an extended period. STS also prevented shattering of cut snapdragon florets (5).

We have initiated experiments to test the usefulness of STS as a foliar spray to protect potted plants from abscission-related problems. Zygocactus is a potted plant commonly called Christmas Cactus which, according to local growers, drops up to 30% of its flowers and buds during long distance transit. The environmental factors thought to induce abscission are similar to those listed for other sensitive plants (4), and include high temperature and low light intensity (9). Here we report the protective ability of STS on flower and bud drop of zygocactus.

Zygocactus plants in the tight bud stage were obtained from a local nursey and transferred to a greenhouse with a day/night temperature of 21/16°C. STS solutions (2 and 4mM) were prepared by mixing silver nitrate with sodium thiosulfate in a molar ratio of 1:4 (8) with the addition of 0.1% Tween 20. Plants were sprayed to runoff (5 to 10 ml per plant) in the greenhouse and allowed to dry for at least a day before transfer to the laboratory. Plants were exposed to C_2H_4 in large glass chambers at 21°C under fluorescent lighting. Ethylene was introduced into air streams of 1 to 2 liters/min; the final concentration was verified with a gas chromatograph.

To test the residual ability of STS to protect against future stress-induced bud and flower drop, 'Marie Red' and 'Weiss' plants were sprayed with 2 and 4 mM STS 2, 3 or 4 weeks prior to stressing with C_2H_4 (0.5 µl/liter) or heat (26°C in the dark for 4 days). The first set of plants sprayed were in the tight bud stage (< 5mm in length) and at the time of stressing, over 50% of the flowers had opened on all the plants. Controls were sprayed with water plus 0.1% Tween 20 before stressing. Every treatment was applied to at least 4 replicate plants of each cultivar.

Effect of C_2H_4 on flower abscission. Plants exposed to 50 µl/liter C_2H_4 had dropped all flowers and buds (Fig. 1) within 24 hr and were reduced to a pile of buds, flowers and leaflets after 48 hr. C_2H_4 at 5 and 0.5 µl/liter also induced complete abscission of buds and flowers after slightly longer time periods. On plants exposed to 0.5 µl/liter C_2H_4, the flower petals rolled and wilted prior to abscission, in contrast to the direct abscission observed in response to higher concentrations. Control plants held in air still retained most of their flowers and buds after 7 days.

Effect of STS on C_2H_4-induced abscission. After 7 days of exposure to 0.5 µl/liter C_2H_4, the controls had dropped all of flowers and 85% of their buds (Fig. 2). In contrast, plants pretreated with a 4 mM STS spray still retained almost 90% of their flowers and 80% of their buds.

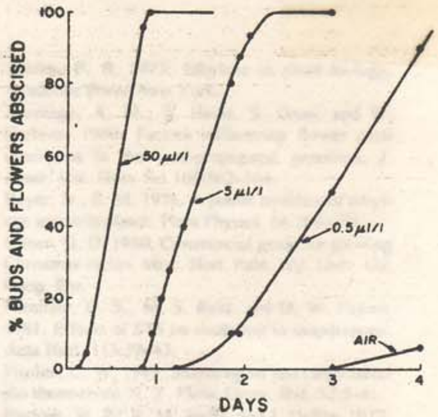

Fig. 1. Percent drop of 'Marie Red' zygocactus buds and flowers with time following treatment with air, or 0.5, 5 and 50 µl/liter C_2H_4.

Occasionally, 4 mM STS sprays caused blisters on the leaves, which eventually sunk leaving darkened depressions. The incidence seemed to be greater when the plants were sprayed and subsequently held in dark, humid conditions. Further tests showed that 2 mM sprays were just as effective as 4 mM sprays in preventing C_2H_4-induced abscission. After 7 days exposure to 0.5 µl/liter C_2H_4, control plants of 'Marie Red' and 'Weiss' had dropped over 90% of their buds and flowers while none had fallen from plants which had been sprayed prior to C_2H_4 treatment with 2 or 4 mM STS. In no instance did 2 mM STS cause significant phytotoxicity. Concentrations of STS lower than 2 mM gave only partial protection against C_2H_4-induced abscission (data not shown).

Effect of time of spraying on stress-induced abscission. A 7 day exposure to 0.5 µl/liter C_2H_4 or a 4 day exposure to 26°C in the dark induced complete shedding of buds and flowers of control plants (Table 1). Foliar sprays of 4 mM STS, whether applied 2, 3, or 4

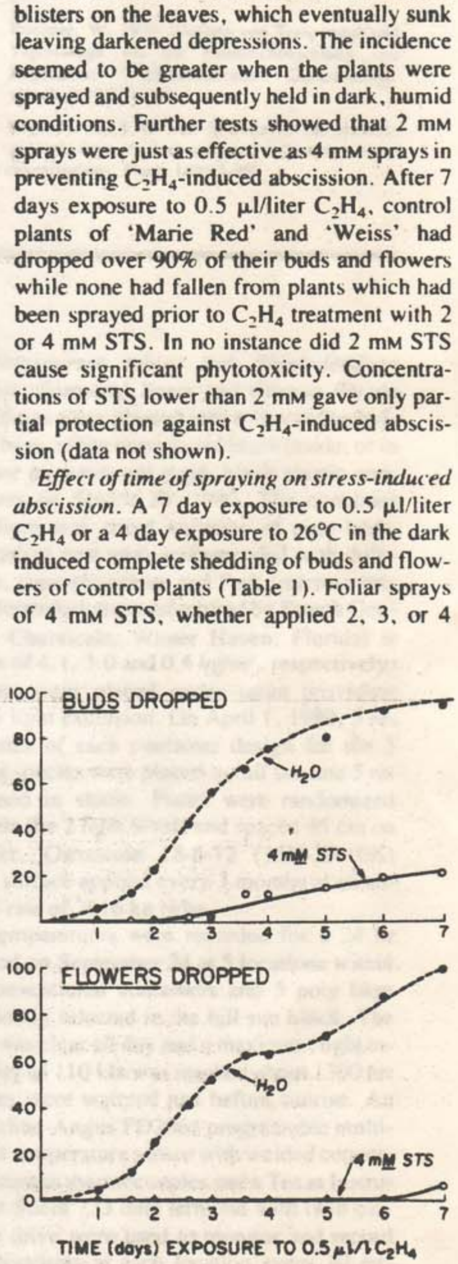

Fig. 2. Percent drop of 'Marie Red' zygocactus flowers and buds with time following treatment with 0.5 µl/liter C_2H_4. Plants were pretreated with sprays of either water or 4 mM STS 1 day prior to the start of ethylene treatment.

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Table 1. Effect of 4mM STS on percent bud and flower drop following exposure to 0.5 µl/liter C_2H_4 for 7 days, or to 26°C in the dark for 4 days. Plants were held 2, 3 or 4 weeks between treatment with STS and stressing.

Foliar spray treatment	Buds and flowers abscised after stress (%)							
	0.5 µl/liter C_2H_4, 7 days				26°C in dark			
	'Marie Red'		'Weiss'		'Marie Red'		'Weiss'	
	Buds	Flowers	Buds	Flowers	Buds	Flowers	Buds	Flowers
Water	100	100	100	100	100	100	100	100
STS (4mM)								
Held 2 wk	5	0	0	0	3	0	0	0
Held 3 wk	10	0	0	0	5	0	0	0
Held 4 wk	8	0	0	0	0	0	0	0

weeks prior to imposition of the stress, prevented most abscission, although the heat stress caused some flower wilting.

Exogenously applied C_2H_4 caused rapid and complete drop of flowers and buds of zygocactus, an effect not previously reported. High temperature and low light intensity, conditions which can easily occur when plants are transported, also induced abscission. STS invariably reduced the abscission of flowers and buds caused by these 2 stresses. At a concentration of 2 mM, the STS sprays proved to be effective without any obvious phytotoxicity. STS might also prevent abscission following other stresses which act through stimulation of C_2H_4 production.

Since relatively small amounts of silver are used per plant, 2 mM STS sprays would be economical for preventing abscission related problems, costing less than 0.1 ¢ per plant at present prices for silver nitrate. STS retained its protective ability for at least 4 weeks following application to the plants, making commercial application convenient and guarding against stresses incurred during packing, transit and even retail display. STS may thus not only improve the marketability of zygocactus and other commercial crops sensitive to environmental stresses but also allow production of plants previously thought to be too shatter-sensitive for handling.

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Characterization of Temperature Fluctuations and Woody Plant Growth in White Poly Bags and Conventional Black Containers[1]

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Abstract. **White polyethylene bags were superior to black, 6 liter conventional containers for production of *Cornus florida* L., *Rhododendron simsii* Planch. cv. Formosa and *Pittosporum tobira* Banks in full sun. All 3 species grew best in 47% shade, where effects of container design were moderated. Poly bags were brittle within 6 months in full sun and could not withstand rough handling.**

Polyethylene bags are offered by manufacturers as a relatively inexpensive, long lasting, easily stored alternative to conventional, black, rigid, plastic containers for production of nursery crops. Poly bags are available in a multitude of sizes and in black or black inside with a white outside surface. Whitcomb (4) reported poly bags to be acceptable containers for production of *Pyracantha, Elaeagnus, Quercus, Ulmus, Acer, Gymnocladus* and *Pistacia* species but temperatures were not monitored. Young and Hammett (5) reported maximum media temperatures in black poly bags of 49.5°C in Auckland, New Zealand, latitude 36° 54'S, but plant growth was not reported. White rigid plastic containers stayed cooler due to less absorption of light energy compared to black containers (1).

An experiment was conducted in Gainesville, Florida, latitude 29° 41'N, to evaluate a 6 liter white poly bag as an alternative to conventional black rigid containers. This evaluation included plant growth response, the range and distribution of media temperatures and container durability.

Pittosporum tobira and *Rhododendron simsii* 'Formosa' liners and *Cornus florida* seedlings were planted into 6 liter polyethylene bags, white outside and black inside, or in 6 liter conventional rigid, black plastic containers on March 20, 1980. The container medium was equal volumes of pine bark, Canadian peat and sand amended with dolomite, superphosphate and Perk (micro-nutrient formulation manufactured by Estech General Chemicals, Winter Haven, Florida) at rates of 4.1, 3.0 and 0.6 kg/m³, respectively. Plants were placed under saran providing 47% light exclusion. On April 1, 1980, 5 replicates of each container design for the 3 plant species were placed in full sun and 5 remained in shade. Plants were randomized within the 2 light levels and spaced 45 cm on center. Osmocote 18-6-12 (18N-3P-10K) was surface applied every 3 months at an annual rate of 2016 kg N/ha.

Temperatures were recorded for a 24 hr period on September 24 at 5 locations within 5 conventional containers and 5 poly bags randomly selected in the full sun block. The sky was clear all day and a maximum light intensity of 110 klx was reached about 1300 hr. Plants were watered just before sunrise. An Esterline-Angus PD2064 programable multipoint temperature sensor with welded copper-constantan thermocouples and a Texas Instrument Silent 733 data terminal with twin cassette drive were used to monitor and record temperatures at each location every 30 minutes. The 5 locations in container media where temperatures were recorded included the center and the sidewall on the west, east, north and south exposures at a point equal dis-

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