Terminating fertilization during the last 3 weeks of production increased longevity from 6 to 10 days, depending on shipping temperature and duration (Table 2). Shipping duration had little effect at 4 and 16C, but decreased longevity up to 7 days when duration was extended from 4 to 7 days at 24C at the continued fertilization treatment and when extended from 2 to 7 days at the terminated treatment. Plants shipped at 4C that had fertilization continued until flowering, had an increase in longevity from 1 to 7 days when compared to the same fertilization treatment shipped at 24C. At the terminated fertilization treatment, longevity increased 9 days when plants were shipped for 7 days at 4C, compared to plants shipped for the same amount of time at 24C. Minimal storage time, even at low temperatures, combined with termination of fertilization is best for extending the longevity of pot chrysanthemums.

Our data suggest that a sustained high level of fertilization until flowering and low production PAR levels decreases postharvest quality and longevity of pot chrysanthemums. Although fertilizing until flowering provided better harvest characteristics, it resulted in reduced longevity under postharvest conditions. Since plant demand for nutrients decreases as flowering occurs, supplying unneeded nutrients resulted in a build-up of soluble salts. The higher soluble salt levels associated with the continued fertilization treatments may have caused root injury, reducing their ability to absorb water and nutrients and thus reducing postharvest quality and longevity. Fertilization termination may have limited value if lower fertilization rates are used throughout crop production.

The results also indicate that production PAR and fertilization duration influence the postharvest performance of pot chrysanthemums. Plants grown under high PAR with termination of fertilization 3 weeks before flowering were found to be best for postharvest quality and longevity of pot chrysanthemums.

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Effect of Pre-treatments on Transpiration of *Chrysanthemum morifolium* in the Dark

Nihal C. Rajapakse[1], David William Reed[2], and John W. Kelly[3]
Department of Horticultural Sciences, Texas A&M University, College Station, TX 77843

Additional index words. water loss, ornamental plants

Abstract. **Experiments were conducted to determine the effect of pre-treatments with abscisic acid (ABA), silver thiosulfate (STS), or ethylene on transpiration rate of *Chrysanthemum morifolium* L. cv. Bright Golden Anne during the dark. ABA and STS reduced subsequent dark transpiration, while exposure to ethylene increased it. Treatment with STS partially reduced the influence of ethylene. These results indicate the possibility of using pre-treatments to reduce water loss under dark shipping/storage conditions.**

Unfavorable shipping/storage environments increase transpirational water loss and reduce plant quality and recovery from storage stress. Water stress also has been reported to increase the production of ethylene, which is a major problem in shipping/storage conditions (Graves and Gladen, 1985; McMichael et al., 1972).

The use of chemical antitranspirants to decrease water loss has been investigated under production conditions, but little information is available regarding use of these chemicals during dark storage/shipping conditions of intact plants (Ackerson, 1980). Stomates of many plant species close in dark or low light conditions, but the degree of closing may vary among species (Rajapakse et al., 1988). Because of the incomplete closing of stomata in dark, water loss could continue. Exposure to ethylene, which is a common problem during shipping and storage, also has been reported to impair stomatal movement of some species (Mayak et al., 1977). For these reasons, chemicals that induce stomatal closure possibly could be used to reduce water loss during shipping and storage of plants.

The objectives of these experiments were to determine the effect of ABA, ethylene, and the ethylene action inhibitor STS on the transpiration rate of chrysanthemum in the dark.

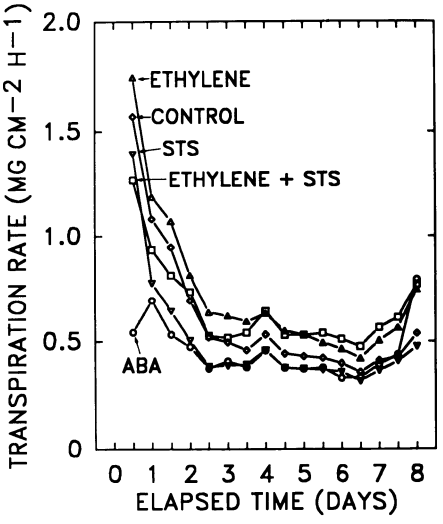

Fig. 1. Effect of chemical pre-treatments on transpiration rate of *Chrysanthemum morifolium* during the dark at 25C.

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[1]Graduate Research Assistant.
[2]Associate Professor; to whom reprint requests should be addressed.
[3]Associate Professor. Present address: Dept. of Horticulture, Clemson Univ., Clemson, SC 29634.

Table 1. Effect of pre-treatments with growth regulators on average transpiration rate of *Chrysanthemum morifolium* under greenhouse conditions and a subsequent 8-day dark period.

Growth regulator	Transpiration rate (mg H_2O/cm² per hr)[z]		
		Greenhouse	
	Dark	Day	Night
ABA	0.46 a[z]	5.65 b	1.11 c
STS	0.50 b	7.42 ab	1.31 c
Control (water)	0.61 c	8.28 a	1.38 cb
Ethylene + STS	0.66 d	7.09 ab	1.71 ab
Ethylene	0.72 e	7.15 ab	1.81 e

[z]Mean separation within columns by LSD test, $P = 0.05$.

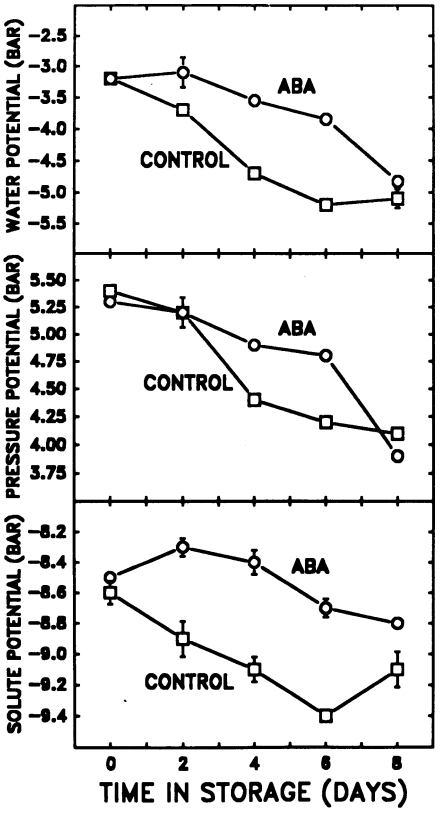

Fig. 2. Effect of ABA at 10^{-4} M on water potential (**A**), pressure potential (**B**), and solute potential (**C**) during the dark. Bars indicate SD.

Rooted 'Bright Golden Anne' chrysanthemum shoot cuttings with three to four leaves (Yoder Bros., Barberton, Ohio) were planted (28 Jan.) in 10-cm standard plastic pots containing 50 to 60 g (dry weight) 1 peat : 1 perlite (v/v) medium amended with (kg·m^{-3}) 4.8 each of dolomite, gypsum, and superphosphate (0N–20P–0K); 1.1 Magamp; 0.8 KNO_3; and 13.2 g fritted trace element/m^3. Plants were allowed to become established in the greenhouse for 2 weeks before being placed in the dark. All plants were watered as needed and fertilized at a rate of 200N–87P–165K mg·liter^{-1} from Peter's (W.R. Grace Co., Fogelsville, Pa.) 20–20–20 fertilizer. Environmental conditions during the greenhouse growth period were days 27 ± 3C and nights 20 ± 2C, day and night relative humidity of 38% ± 15% and 70% ± 10%, respectively, and natural light intensity of 300 to 1000 μmol·s^{-1}·m^{-2} (400 to 700 nm). After plants were well-established, the growing medium was watered to field capacity, excess water was drained off overnight, and initial weight of plants plus pots was recorded before treatment.

Plants were then subjected to one of the following treatments at field capacity: ABA spray at 1 mM; STS spray at 4 mM; exposure to ethylene gas at 1 μl·liter^{-1} for 24 hr in an enclosed plexiglass chamber; STS spray plus exposure to ethylene for 24 hr; and control with water spray. Plants were sprayed to runoff.

The weight loss from plants plus pots in the greenhouse was measured for 24 hr before placement in the dark to establish greenhouse transpiration rates. Water loss directly from the soil surface was prevented by covering the pots with Saran wrap. After 24 hr in the greenhouse, all plants were transferred to the dark, maintained at 25 ± 2C and 80% ± 10% RH. Weight loss in the dark was recorded twice daily, at 0700 and 1900 HR. A green safelight was used during weighing to prevent any light effect. Transpiration rate was calculated from the weight loss data. Total leaf area was measured using a LI-COR 30501 area meter (Lincoln, Neb.). Leaf water potential of control and ABA-treated plants was determined with a pressure chamber (Soil Moisture Corp. 3000 Series, Santa Barbara, Calif.) (Boyer, 1967, 1979; Spomer, 1985) every 48 hr at 1400 to 1500 HR on shoots with two to three leaves of five representative plants. To minimize transpiration between shoot excision and measurement, the shoot cuttings were sealed in the pressure chamber as quickly as possible, with the cut end extending outside of the chamber. The pressure was increased at a slow rate to minimize temperature changes and avoid false endpoints (Boyer, 1968; Kirkman, 1985). The pressure required to moisten the cut surface was considered as the xylem water potential. Following the water potential measurement, the same shoot samples were used to measure solute content. Shoot samples were placed in a plastic vial and were frozen to −70C in an ultralow freezer. The frozen samples were thawed, and the sap was extracted by squeezing onto a filter paper disk. Solute content was measured using a Wescor 5100C osmometer (Logan, Utah). Solute content values (mM·kg^{-1}) were converted to solute potential (ψ_s-bars). Pressure potential (ψ_p) was determined by the difference between xylem water potential and solute potential.

The experimental design was completely randomized with five single-plant replicates per treatment. The data were analyzed using analysis of variance. Least square means were computed and differences in the means were tested using LSD.

Transpiration rate of chrysanthemum was significantly altered by the pretreatments (Table 1). Abscisic acid and STS alone reduced the rate of transpiration 25% and 18%, respectively, during the dark period, while ethylene treatments significantly increased the rate. However, under greenhouse conditions, before placement in the dark, only ABA significantly reduced the daytime transpiration rate compared to the control. Night transpiration rates in the greenhouse were not affected by ABA or STS (Table 1). Plants treated with ABA showed the lowest transpiration rate soon after the beginning of darkness (Fig. 1). These results indicate a possible alteration of stomatal movement during the subsequent dark period due to the pre-treatments. Abscisic acid has been shown to induce stomatal closure in many plant species (Ackerson, 1980; Borochov et al., 1976; Rajapakse et al., 1988). Water-stress-induced stomatal closure has been attributed to ABA production (Ackerson, 1980; Cornish et al., 1985). Abscisic acid has been used externally to induce stomatal closure under experimental conditions (Halevy and Mayak, 1974; Jordan et al., 1984), including chrysanthemum under low light (Cornish et al., 1985; Rajapakse et al., 1988). Abscisic acid may have caused partial closure of stomata in the daytime under greenhouse conditions and facilitated complete closure in the dark (Table 1).

Ethylene and STS treatments did not influence transpiration in the greenhouse during the day, but altered transpiration in the dark chamber and in the greenhouse at night (Fig. 1). Silver thiosulfate alone reduced the transpiration rate in the dark within 1 day after treatment. The transpiration rate of STS- and ABA-treated plants was similar throughout the dark period. The major difference between ABA and STS treatments during the dark was the rate of transpiration reduction. Abscisic acid reduced the transpiration rate faster than the STS treatment. This difference could be due to partial closure of stomata in the ABA treatment during the day in the greenhouse, before placement in the dark. Plants treated with ethylene or ethylene + STS and the controls had a slow reduction in the transpiration rate during storage (Fig. 1). Plants exposed to ethylene transpired more rapidly than the control. Treatment with STS reduced the influence of ethylene, but did not totally reverse the action of ethylene (Fig. 1).

These data indicate that treatment with compounds that inhibit ethylene action (STS) decrease transpiration and might be used to slow the development of water stress during the dark, such as during dark shipping or storage. Many silver compounds have been shown to reduce the effects of ethylene in postharvest storage of cut flowers (Halevy and Mayak, 1974; Paul and Goo, 1985; Veen, 1979). Application of aminooxyacetic acid (AOA), an inhibitor of ethylene production,

has been reported to delay onset of water saturation deficit and wilting of carnation petals (Borochov et al., 1976). Application of CO_2 with ethylene has been shown to prevent the decline in water uptake of carnations (Borochov et al., 1976).

Water potential and solute potential changes during the dark were measured in the control and ABA-treated plants. Water potential decreased during the dark in the control and ABA treatments, but reduction of water potential was faster in the control (Fig. 2, top). Solute potential of control plants decreased during the dark, but that of ABA-treated plants remained high (Fig. 2, bottom). Although solute accumulated during the dark, accumulation was not enough to maintain constant turgor potential in the ABA-treated plants (Fig. 2, bottom). The lack of photosynthesis and slow uptake of water due to slow transpiration may have prevented sufficient osmotic adjustment in the dark. As a result of slow solute accumulation and drop in water potential, pressure potential dropped during the dark in both control and ABA-treated plants (Fig. 2, middle).

The data obtained in this experiment suggest that pre-treatment with ABA and STS significantly decreased the transpiration rate of chrysanthemum during storage. Cost would limit the practical use of ABA. Although stomata are assumed to close in the dark, reduction of transpiration rate by pre-treatments indicates incomplete closure of stomata in the dark. Complete closure of stomata or prevention of stomatal opening by pre-treatment may have caused the reduction of transpiration rate of treated plants. Pre-treatment with ethylene increased water loss during the subsequent dark period, which can induce water stress conditions. Therefore, eliminating the build-up of ethylene or preventing its action, with compounds such as STS, likely would lessen water stress during dark shipping or storage.

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Phony Disease Influences Peach Leaf Characteristics

D.R. Evert[1] and D.A. Smittle[2]

Horticulture Department, Coastal Plain Experiment Station, University of Georgia, Tifton, GA 31793

Additional index words. Prunus persica, Xylella fastidiosa

Abstract. **Midshoot peach [*Prunus persica* (L.) Batsch.] leaves were collected in 1984 and 1985 from phony-diseased [presumably infected with *Xylella fastidiosa* (Wells et al.)] and healthy trees of several cultivars at intervals during the summer. Leaves were evaluated for specific chlorophyll content, specific leaf weight, and color (lightness, hue, and saturation). The darker green of diseased trees reported previously could not be attributed to the quantitative changes in the leaf characteristics measured in this study. Midshoot leaves from diseased trees were more yellow and less green than midshoot leaves from healthy trees.**

Phony disease of peach occurs in orchards in the Coastal Plain from North Carolina to Texas (Hutchins, 1933). The disease is caused by a xylem-limited bacterium (*Xylella fastidiosa* strain phony disease of peach) (Wells et al., 1987). These bacteria are usually more abundant in peach roots than in stems or leaves (Davis et al., 1981; French et al., 1977; Wells et al., 1980). Roots of trees with obviously reduced shoot growth usually contain an abundance of this bacterium (Evert et al., 1981). Several species of xylem-feeding leafhoppers spread the bacterium from tree to tree (Davis et al., 1981; Turner and Pollard, 1959).

Symptoms of phony disease include small fruit and low yield (Hutchins, 1933), apparently because fruit fail to swell normally as they mature (Evert, 1985). The reduction in fruit size and yield, as well as other symptoms, develop 18 months or more after the initial infection (Hutchins, 1933; Turner and Pollard, 1959). Tree color is also affected by phony disease, with several reports describing diseased trees as darker green than healthy trees (Wells and Raju, 1984; Hutchins, 1933; Turner and Pollard, 1959; Bertrand, 1982). Hutchins (1933) gives a detailed description of the symptoms of phony disease, of which the most obvious symptom is reduced terminal shoot growth. The reduced shoot growth of diseased trees is routinely used for field identification during the summer beginning in July (Bertrand, 1982; Hutchins, 1933).

The current method of field identification of diseased trees has several problems. Field identification of diseased trees is subjective and, therefore, observer-dependent. Infected trees may be a reservoir of infection during the 18-month or longer incubation period before disease symptoms develop.

A rapid, quantitative method for field identification of diseased trees would eliminate observer bias and might permit the identification of infected trees sooner than is currently possible. Leaf color can be measured rapidly and quantitatively with a tristimulus cold meter. We selected leaf color for study because of the reports that phony disease affects leaf color.

We examined the effects of phony disease of peach on specific leaf dry-weight (SLW), specific chlorophyll-content (SCC), and leaf color attributes (hue-angle, saturation, and lightness). SLW and SCC were examined because changes in SLW and SCC might be related to color changes.

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[1]Associate Professor.

[2]Professor.