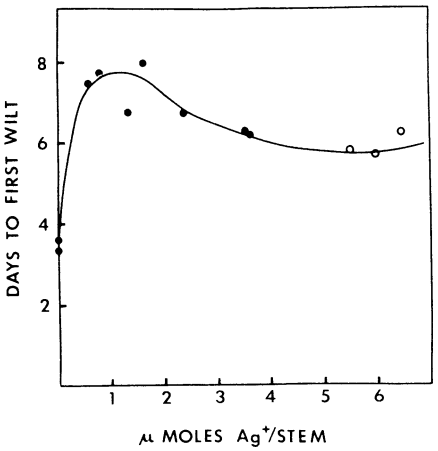

Fig. 2. Effect of silver content on vase life of miniature carnations (days to first wilted floret). Silver content was calculated from the volume of 4 mM STS taken up by each stem.

mM STS (providing about 1-1.5 μmoles Ag^+ per spray).

The active ingredients of most commercial vase preservatives are 8-hydroxyquinoline (about 200 μg/ml) and sucrose (1.5-2%). These materials can improve the vase life of untreated miniature carnations (Table 2). As with standard carnations (2), while STS pretreatment can substitute for a vase preservative its benefits are additive to those obtained from the preservative alone. Thus, when flowers pretreated with STS were evaluated in preservative solutions there was further substantial improvement in their vase life.

Table 2. Effect of STS pretreatment and of commercial flower preservatives on the vase life of cut 'Barbi' carnations. Carnations were pretreated with 4 mM STS for 20 min or deionized (DI) water, then placed in different solutions for evaluation of their vase life.

Vase solution	Mean days to first wilted bloom on each spray: Pretreatment DI	STS
DI	3.5a[z]	7.5b
Everbloom	6.7b	12.2c
Viva la Fleur	4.3ab	10.5c

[z]Mean separation by Duncan's multiple range test, 5% level.

Table 3. Effect of STS on the vase life of stored miniature 'Barbi' carnations. Carnations were treated for 20 min with 4 mM STS either before or after storage, then held in different solutions for evaluation of vase life.

Pretreatment	Treatment after 5 days	Vase life (days to first wilted floret)
None	DI	2.9a[z]
STS	DI	7.0b
STS	Everbloom	11.9c
STS	Viva la Fleur	10.1c
None	STS DI	8.0bc

[z]Mean separation by Duncan's multiple range test, 5% level.

The vase life of miniature carnations ('Barbi') after storage for a simulated shipping period of 5 days at 2°C was also improved by STS treatment, either before or after the storage period (Table 3). Significant further improvement in vase life was again obtained by including floral preservatives in the vase water. The time to wilting of the first flower in sprays treated this way was as much as 4 times that of control flowers.

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Effects of Leaf Position and Storage Conditions on Pressure Bomb Measurement of Leaf Water Potential in Chrysanthemums[1]

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Abstract. **There were generally no decreases in water potential when leaves of chrysanthemum (*Chrysanthemum morifolium* Ramat.) were stored in plastic bags for 1-5 hours, individually or together, provided a moist towel was included. Decreases in water potential occurred after 1 and 3 hours in leaves stored individually or together without a moist towel. Maximum stress was observed in the third negative at 0600 hours with values increasing to a maximum of −8.1 bars at 1400 hours.**

Physiological reactions to water stress, such as photosynthesis reduction or stem elongation, usually occur before visible, morphological changes become apparent (2, 3). Stomatal aperture is reduced, with a decline in transpiration and photosynthetic rates, when a plant is subjected to reduced water availability (2). Reestablishment of growth after a period of stress depends on recovery of leaf water potential after watering (6).

Chrysanthemums grown under high light intensities and fertilization require relatively large amounts of water and wilt rapidly when water is withheld. The exact timing of watering is difficult to determine and is usually based on visual observations. Watering schedules ideally should be determined by measuring stress levels within plants using physiological indicators, such as leaf water potential, osmotic potential, or stomatal aperture. Halevy (2) reported stomatal aperture to be a reliable and convenient guide for irrigation of gladioli. The pressure bomb is a relatively simple and fast method for determining leaf water potential but improper handling of plant samples frequently leads to incorrect values resulting in widely variable readings (1, 8). Maturity of sampled leaves, time of day, transpiration rate, light intensity and handling conditions prior to taking water potential readings may affect water potential values obtained with the pressure bomb (1).

Rooted cuttings of 'Bright Golden Anne' chrysanthemums were planted 5 per 15 cm pot on June 11 in a mixture of 1 sand: 1 peat: 1 perlite (by volume) amended with 5.6 kg dolomite, 2.9 kg superphosphate and 1.8 kg Perk (a micronutrient blend manufactured by Estech General Chemical Corp., Chicago, Ill.) /m^3, respectively. Pots were watered and placed in a lightly shaded glass greenhouse with fan and pad cooling in Gainesville, Florida. Pinching occurred at time of planting and short day treatments (SD) were initiated 4 days later by covering the greenhouse bench with a black, light opaque woven cloth from 1700-0800 hr. A 5000 ppm foliar spray of butanedioic acid mono-(2,2-dimethylhydrazide) (daminozide) was applied when shoots were 4.5 cm in length.

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Plants were watered as needed and fertilized with 200 ppm N from a 20N–8.7P–16.6K fertilizer at every watering. Water potential of leaves was determined at time of disbudding (6 weeks after beginning of SD) by excising each leaf near the base of the petiole with a razor blade and inserting into a PMS Instrument Co. (Corvallis, Oregon) pressure chamber.

Water potential was measured on the most recently matured leaf below the apical meristem (node 3, the youngest leaf with sufficient petiole length for examination) stored in plastic bags on ice in the dark for 1, 2, 3, 4 or 5 hr. The leaves were stored with or without moist paper towels and 1 leaf per bag or all leaves for each measurement time placed together in a bag. This constituted a 5 × 2 × 2 factorial experiment in split plot design with 2 leaves removed from each of 4 pots resulting in 8 leaf samples tested for each treatment. Eight leaves were also removed at time of harvesting (1000 hr on July 31) and analyzed immediately for water potential.

A comparison was made of leaf location on the stem to determine effects on water potential. One lateral shoot was chosen from the same side of 12 pots grown under the same conditions and 3 specific locations were removed. These corresponded to leaves 3 and 10 below the apical meristem and the lowermost leaf on the shoot. Leaves were removed with a razor blade and stored separately on ice in plastic bags containing moist paper towels. Water potential was measured within 90 min.

Water potential values were recorded at 4 different times during the day (0600, 1000, 1400 and 1800 hr). Leaves for the 0600 and 1800 hr readings were collected from plants covered by a black cloth (dark conditions). For each time of observation, 12 leaves from the 3rd node below the apical meristem were removed from separate pots. Each leaf was stored on ice in a separate plastic bag with a moist paper towel until a water potential reading could be obtained (30 min or less).

Excised leaves stored separately with moist towels had water potential values similar to leaves analyzed at time of harvest, even after leaves had been maintained on ice for 5 hr (Table 1). A decrease in water potential values occurred in all treatments during leaf storage, but the decrease was insignificant in leaves stored with a moist towel for 2 to 5 hr. Leaves stored with a moist towel had increased water potential values at the 1 hr measurement time, but decreased thereafter. The availability of free moisture to the cut petiole surface probably accounted for the increase at 1 hr time. Karlic and Richter (4) coated leaf surfaces with vaseline prior to storage to avoid moisture uptake by the leaf, but results varied with plant materials. Plant with sclerophyllous leaves gave satisfactory results but vaseline infiltrated the stomates of deciduous trees and caused a false rise in water potential.

Table. 1. Effects of storage time and conditions on water potential of excised leaves of 'Bright Golden Anne' chrysanthemum.

Storage[z] time (hr)	Water potential (bars)			
	Leaves together[y]		Leaves separate	
	Moist towel	No towel	Moist towel	No towel
0[x]	−7.1a[w]	−7.1a	−7.1a	−7.1a
1	−3.7b	−7.8a	−7.4a	−8.4a
2	−6.2a	−8.5a	−8.0a	−9.8b
3	−7.1a	−8.6a	−8.0a	−10.9b
4	−5.6a	−9.8b	−7.3a	−10.4b
5	−8.8a	−10.3b	−7.9a	−9.8b

[z]Length of storage on ice.
[y]All 8 leaves sampled were stored in same bag.
[x]Samples from 0 hour collected and water potential determined directly from plant.
[w]Mean separation in columns by Duncan's multiple range test, 5% level.

Decreases in water potential values were greatest in leaves stored without a moist towel. Leaves stored individually or together without a moist towel had values less than harvest readings after 1 and 3 hours, respectively. Leaves stored separately generally had values slightly greater than those stored together suggesting water vapor was lost from individually stored leaves faster. Possibly a buildup of CO_2 in the intercellular spaces caused by a greater CO_2 diffusion coefficient between air and water may have lead to rapid stomatal closure and reduced water vapor loss when more than one leaf was stored per bag. Karlic and Richter (4) felt this was the basis for gymnosperm leaves not absorbing water vapor when placed between two moist mats.

The lowest water potential values were observed in the uppermost leaf (−8.0 bars) with decreasing stress in the tenth leaf (−6.3 bars) to the lowest leaf (−3.6 bars). Upper leaves were exposed to direct light compared to lower leaves which were shaded by adjacent pots or the upper leaf canopy. The microclimate in the lower portion of the pot probably resulted in reduced stress in the lower leaves rather than the presence of a hydrostatic gravity gradient observed in large trees (7) or a large resistance to flow in the transpiration stream (5). The upper chrysanthemum leaf of sufficient size for testing should be used to give an estimate of maximum plant stress levels.

Time of day for measuring plant stress is important (Fig. 1). Plants were the least stressed at 0600 hr under black cloth and stress progressively increased to a maximum at 1400 hr under light conditions. Stress level declined from 1400 to 1800 hr (black cloth). Plants had began to recover by 1800 hr, although water potential values were still lower than the 0600 readings even though samples were taken during dark conditions. These values do not represent a typical diurnal cycle, but these data indicate that time of day must be considered in measuring plant stress.

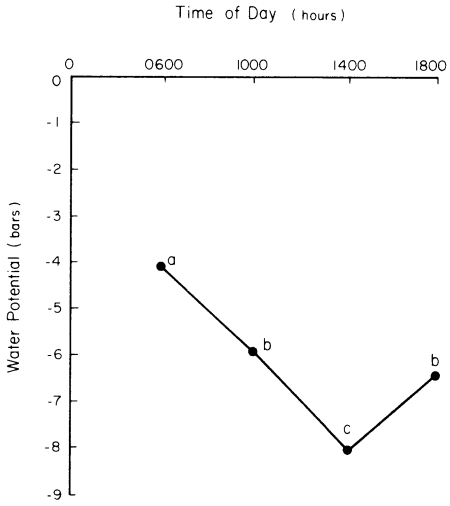

Fig. 1. Diurnal variation in water potential from excised leaves of 'Bright Golden Anne' chrysanthemum. Values are a mean of 12 leaves from the 3rd node below the apical meristem and leaves for the 0600 and 1800 hr were collected from plants covered by a black cloth (dark conditions).

Quick measurements of chrysanthemum water status can be obtained with a pressure bomb provided leaf samples are properly handled following excision. Failure to use these or similar techniques may lead to false evaluations of water status and plant stress levels.

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