'Alaska' the increased pedicel length decreased plant quality slightly because it resulted in drooping of some flowers.

Except for reducing length of pedicels of the other cultivars, SADH treatment was beneficial only with 'Chimes'. SADH at 3000 ppm delayed and reduced flowering of 'Red Wing', 'Alaska', and 'Gloria' with photoperiodically controlled flowering.

Photoperiodic control of flowering of responsive azalea cultivars depends on rapid and uninterrupted development of flower buds. Maintenance of moderately warm temp throughout and the use of 6 to 10 weeks of short photoperiods prior to shifting to long photoperiods appear to be essential. Because of varietal differences, photoperiod control alone may not provide the complete solution to forcing azaleas without cold. But even with a cultivar such as 'Chimes' which did not respond satisfactorily to photoperiodic treatment alone, it offers a more compatible complement to GA_3 treatment than partial cooling.

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Reducing Water Loss of Potted Chrysanthemums with Pre-Sale Application of Antitranspirants[1]

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Abstract. Several film forming antitranspirants were applied to salable, flowering chrysanthemum plants prior to placement in a controlled environment devised to simulate the interior of a home. Significant reductions in water loss resulted with all applications, with over a 40% reduction at highest concentrations. No discernable increase in floral display life was observed with any treatment. Higher concentrations of chemicals caused yellowing of foliage, and in some cases imparted a sticky residue or in some way impeded normal floral expansion. Film effectiveness persisted for at least 2 weeks with consistantly high transpiration losses for non-treated plants.

A saving in maintenance effort, possible avoidance of damage, and extension of usefulness would be achieved if potted plants could be safely and efficiently protected against moisture stress. The application of an antitranspirant shortly before sale of a potted plant might be useful in this respect.

A number of reports[2,3,4] and reviews (2, 3, 4, 7) dealing antitranspirants categorize them, trace their evolution, and summarize their uses and effects. In recent years, various multi-molecular film antitranspirants have been introduced purporting to reduce transpiration. Some hope is raised that these compounds may also be effective in increasing the display life of potted plants such as *Chrysanthemum morifolium* Ramat.

Substantial reductions in water loss have been reported (4, 5 6, 10, 13) on a wide range of crops using wax, latex, plastic, and silicone, but in many cases the benefits have been of short duration or the treatments were phytotoxic. There is very little data reporting the effects of these films on floral display life. While a few papers (9, 12) report increased vase and display life, others (4, 11) cite no discernable effect.

This study was initiated to investigate several antitranspirant materials in terms of their efficiency in reducing water loss from potted chrysanthemum and their possible lengthening of floral display life under a controlled environment devised to simulate the interior of a home.

Materials and Methods

Cuttings of *Chrysanthemum* cvs. Mandalay and Mermaid were rooted in sterilized sand under intermittent mist using .3% IBA for root promotion. After rooting, 96 of the most uniform plants were selected and potted in 10.16 cm (4") square plastic pots. Production of flowering single-stemmed plants followed commercial practice, without the use of growth retardants or fungicides. Plants were placed in a controlled environment chamber when the first rows of florets opened away from the center to form approximately a 145° angle. After the soil had been watered and allowed to drain, pots were sealed using waterproof tape and poly-bags, limiting water loss to exposed plant parts. Pots were weighed immediately after sealing to

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[6]W. A. Cleary Corp., New Brunswick, N. J.

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[8]Miller Chemical and Fertilizer Corp., Hanover, Pa.

establish an initial wt at 'container capacity'. Water was replenished as transpiration dictated, returning pots to their initial wt.

Temperature within the chamber was maintained at 24 ± 2.5°C (75.2 ± 4.5°F). Relative humidity was not controlled but averaged 43%. Temperature and humidity were recorded using a hydrodynamics 15-4050E humidity-temp recorder. A 14-hr photoperiod with an abrupt light-dark change was maintained using a bank of cool-white fluorescent lamps (GE-F96PG17-CW) suspended 1.98 meters (6.4 ft) above the plants, supplying 120 ± 9 ft.c (approx 37 ± 3 $\mu W/cm^2$ for fluorescent lamp used). A GE multi-range light meter, model MR-100, was used to measure light intensity in foot candles. Over-head fans provided a gentle air circulation in the chamber but air speed was not measured.

Transpiration was determined gravimetrically using a Mettler P6 Balance and expressed as g of water lost per cm^2 of leaf area for the period of study. After treatment, plants were weighed daily for a 14-day period and transpiration losses recorded. Floral longevity for each plant was recorded as the number of days from initial placement in the controlled environment chamber until visual discoloration or browning of approximately 50% of the lower petal rows had occurred. Total leaf area was calculated for each plant during a 4-day period prior to treatment modifying a procedure reported by Cocking and Tukey (1).

Plants were statistically blocked prior to treatment according to water lost per leaf area during this 4-day period. For each test the 84 most uniformly transpiring plants were divided equally among 3 blocks: high, medium, and low transpiration blocks, respectively. A randomized complete block design was used. Attempts to measure the transpiration rates of floral parts were not successful. Therefore, the transpiration rates on a leaf area basis are higher than actual.

Chemicals were applied using a hand pressure sprayer. Distilled water was used to dilute all chemicals except Amchem 71-18 which was diluted with methyl ethyl ketone. Plants were sprayed with a fine mist of antitranspirant till run-off, with care being taken to cover all plant parts including petal surfaces. Because of the phytotoxic qualities of its solvent, Amchem 71-18 could not be sprayed till runoff but rather was applied in numerous light applications. A control group, sprayed with distilled water, was used to check chemical effectiveness in each block.

From 7 film antitranspirants studied in preliminary phytotoxicity tests[4], four, Amchem 71-18[5], a urethane prepolymer (R-14) using MEK as the solvent, Clear Spray[6], a latex based emulsion, Folicote[7], a hydrocarbon wax emulsion, and Vapor Gard[8], a polyterpene compound, were selected for experiments reported here.

Two experiments were conducted. In the first Folicote and Vapor Gard were used. The experiment consisted of 4 controlled environment tests. A test was conducted separately for each of the 2 cvs. Mermaid and Mandalay and was repeated once. Three concentrations (high, medium and low) of each chemical were used; 2.5, 5, and 10% for Folicote and 1.25, 2.5, and 5% for Vapor Gard.

In the second experiment Amchem 71-18 and Clear Spray were used. This consisted of 2 controlled environment tests with 'Mermaid'; the test was repeated once.

Tests in an experiment were analyzed together for simplicity of presentation, utilizing combined analysis of variences. Means were separated using Duncan's multiple range test with significance being accepted at the .05 level of probability.

Results

Experiment 1. Folicote and Vapor Gard at all concentrations applied, significantly reduced transpiration of single-stemmed, single-flowered plants of both *Chrysanthemum* cultivars (Table 1) as compared to control groups. Folicote was more effective in reducing transpiration than Vapor Gard at any concn, with mean reductions of 43 and 24%, respectively. The highest concn of both antitranspirants was more effective in reducing transpiration than the lowest concn.

Neither chemical significantly affected floral longevity[4] but slight reductions in floral life were observed with the highest concn. While immediate phytotoxicity was not observed, plants treated with the high concn of either chemical appeared to be lighter green in color at the conclusion of tests. Vapor Gard at its highest concn imparted an undesirable sticky film to plants. Neither antitranspirant affected petal expansion, and all flowers matured normally. From the 14 daily readings it was concluded that films of both chemicals were effective in reducing transpiration throughout the major portion of useful display life. In all tests useful display life was approx 3 weeks for all treatments.

Folicote was consistently superior in reducing water loss, and, for the 2 cultivars, effectiveness was not statistically different. With Vapor Gard transpiration suppression was not as consistent and varied by over 12% between cultivars.

Experiment 2. Amchem 71-18 (R-14) and Clear Spray, at all concentrations, significantly reduced transpiration of

Table 1. Effects of antitranspirants Folicote and Vapor Gard on water loss[z] of *Chrysanthemum* cvs. Mandalay and Mermaid when applied in progressive concentrations (Experiment 1).

		Mandalay		Mermaid		
Treatment	Concn (%)	Total water loss g/cm^2/14-days	% Reduction from control	Total water loss g/cm^2/14-days	% Reduction from control	Mean % reductions from controls
Control	--	.50	0 e[y]	.45	0 e	0 e[x]
Folicote	2.5	.31	36 b	.30	33 b	34.5 b
	5	.28	44 a	.25	44 a	44 a
	10	.26	48 a	.23	49 a	48.5 a
Vapor Gard	1.25	.37	26 c	.38	16 d	21 d
	2.5	.34	32 cd	.37	18 d	25 cd
	5	.32	34 b	.36	20 d	27 c
				Means		
Control		.50	0 d	.45	0 d	0 c
Folicote		.28	44 a	.26	42 a	43 a
Vapor Gard		.35	30 b	.37	18 c	24 b

[z]Each observation is the mean of 24 single-stem single-flowered potted plants.

[y]Letters in common for cultivars are not significantly different at the 5% level of probability as determined by Duncan's multiple range test.

[x]Mean separation, within columns by Duncan's multiple range test, at 5% level.

Table 2. Effects of antitranspirants Amchem R-14 and Clear Spray on Water loss[z] of *Chrysanthemum* cv. Mermaid when applied in progressive concentrations (Experiment 2).

Treatment	Concn (%)	Total water loss g/cm/14-days	% Reduction from control
Control	–	.38	0 e[y]
Amchem R-14	2.5	.34	10 d
	5	.34	10 d
	10	.32	15 c
Clear Spray	5	.31	18 bc
	10	.30	21 b
	20	.28	24 a
		Means	
Control		.38	0 c
Amchem R-14		.34	13 b
Clear Spray		.30	21 a

[z]Each observation is the mean of 24 single-stem single-flowered potted plants.

[y]Mean separation, within columns by Duncan's multiple range test, at 5% level.

single-stemmed, single-flowered plants of 'Mermaid' (Table 2). Clear Spray was superior to Amchem 71-18. The highest concn of experimental Amchem 71-18 did not suppress transpiration significantly more than Clear Spray at its low rate.

Mean reductions in transpiration for the low, medium, and high rates were, respectively, 10%, 10%, and 15% for Amchem 71-18, and 18%, 21%, and 24% for Clear Spray. The high rates of both chemicals reduced transpiration significantly more than either the low or medium which were not different from each other. Readings over a 14 day period indicated that both chemicals were effective in suppressing transpiration throughout the major portion of useful display life.

Discussion and Conclusion

These results show that film forming antitranspirants can significantly reduce plant water loss in an indoor environment, and suggest that a single pre-sale application could remain effective, in this respect, throughout the duration of useful display life.

According to Hagan and Davenport[3], longevity of antitranspirant effectiveness is dependent on a number of factors including foliar growth, and abilities of films to withstand environmental elements. The overall effectiveness of an antitranspirant spray may be of short duration if applied to actively growing plants. The environmental conditions under which the mature flowering chrysanthemum plants were placed were not demanding on the films and were not conducive to active growth. Light intensity and its destructive ultra-violet fraction was low, extremes of temp were not present, and transpiration was relatively low compared to more actively growing plants out of doors. Gale and Hagan (7) state that solar ultra-violet radiation, temp extremes, oxidation, microorganisms, etc., cause degradation of antitranspirant films.

Hagan, and Davenport[2] report that an experimental film material, CS-6432, and a wax emulsion, Mobileaf, were effective in reducing transpiration of essentially nonexpanding mature ivy leaves for more than 12 and 18 days, respectively. These data agree with film longevity reported on mature potted chrysanthemum.

Davenport et al. (4), report that an antitranspirant film may also be a barrier to CO_2 exchange, thereby decreasing photosynthesis and growth. Although growth reductions often may be undesirable, rapid growth of plants for interior use is not always desired.

Effectiveness of materials to reduce transpiration varied in some cases from test to test and between cultivars. Variability of completeness in film coverage among antitranspirants might account for variations in their effectiveness from plant to plant. Smith et al. (13) found that on *Weigelia* and *Euonymus*, film antitranspirants on the upper leaf surface reduced transpiration approx 10% while lower surface application reduced water loss 40%. While the distribution of stomates of the 2 *Chrysanthemum* cultivars was not established, the importance of adequate coverage of material to all plant parts, including the flower, is apparent. A problem with Amchem 71-18 was that because of its phytotoxic solvent, MEK, complete coverage was difficult and may not have been obtained, resulting in low effectiveness in suppressing water loss.

Some undesirable effects such as floret gluing, stickiness, and yellowing were observed following antitranspirant application. Clear Spray has been used on cut Christmas trees and it has been reported (8) that the film over the needles glues them in place. This may explain why at higher concn (20% or more) Clear Spray had the tendency to cause florets to be glued together preventing normal expansion. Vapor Gard caused plant parts to be "tacky" or sticky and at high rates collected dust. This effect may be due to its polyterpene formulation which never appeared to completely solidify.

While effectiveness in reducing transpiration increased significantly as concn increased, higher concn of antitranspirants appeared to be detrimental to plant vigor resulting in lighter green color as compared to untreated plants. Davenport et al. (4) report yellowing of fruit tree leaves after application of a 20% concn of Mobil RD-9 and may have resulted in suffocation since CO_2 intake and perhaps O_2 exchange was drastically reduced by the film. This reduction in gaseous exchange may have been the cause for the light green color of heavily treated chrysanthemums reported here.

Wesenberg and Beck (14) state that a 3-day difference in longevity would be the minimum effect which would be of concern to commercial growers. While there were minor increases in longevity with low concn of some materials tested, these were nonsignificant and in no way approached the 3-day minimum effect set by Wesenberg and Beck.

Results of these experiments suggest the possibility of reducing maintenance of interior plantings by reducing transpiration and water consumption through the use of film antitranspirants. While reducing water loss itself may not increase floral life, it may be a safeguard against damage in the event of neglected watering.

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Lacewing Larvae Control Aphids on Greenhouse Snapdragons[1]

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Abstract. Eight lacewing (*Chrysopa carnea*) larvae per greenhouse snapdragon (*Antirrhinum majus*), released 4 at a time twice during 8 weeks effectively controlled aphids (*Myzus persicae*). Two initial sprays of malathion and nicotine sulfate 1 week apart followed by release of 4 lacewing larvae per plant also were effective. Flowers produced under chemical or biological control systems were equal in quality. Lacewing larvae in a 21°C greenhouse required a week longer to effectively control aphids than those in a 24°C greenhouse.

Green lacewing larvae (*Chrysopa carnea*) have shown potential inundative biological control on several pests of greenhouse and field crops. They are easily mass reared (6), search efficiently (4), and resist some pesticides (1). Ridgway and Jones (5), using lacewings, reported bollworms on cotton reduced 96% and yield increased 300%. Mealy bugs on pears and greenhouse gardenias also have been suppressed by inundative releases of lacewings (2, 3). Scopes (7) has shown the potential of lacewings to control aphids on greenhouse chrysanthemums. We have compared lacewing with chemical control of aphids on greenhouse snapdragons.

Materials and Methods

Release rate study: Individual 'Pan American Summer Pink' snapdragons were grown in 7.6-cm peat pots and subirrigated daily. A slow-release fertilizer (14-14-14) and a 1:1:1 soil, peat moss, haydite mix was used. Greenhouse temperature was maintained at 21 ± 8°C.

Plants were infested at the sixth leaf-pair stage by placing large aphid populations at the seedling base. Infested seedlings were placed on a greenhouse bench under 10 x 15 x 30 cm cages made from wood-framed No. 52 Lumite screen. After 1 week, all aphids were counted on stems and on lower and upper leaf surfaces. Eight plants per treatment were arranged in a completely randomized design. Initial counts ranged from 72-140 aphids per plant among treatments. Data were transposed to control percentages as shown below:

$$\frac{\text{Check population - treatment population}}{\text{Check population}} \times 100$$

First instar *Chrysopa carnea* (purchased from the Rincon-Vitova Insectaries, Inc., Rialto, Calif. 92376) were placed in the cages at 0, 2, 4, 6, 8, or 10 larvae per plant on Dec. 14, 1971. Aphids were counted and their numbers recorded at 3 to 5 day intervals.

Biological vs. chemical control: 'Pan American Summer Pink' snapdragons were infested as described, with 9 plants in each 1 x 1 m greenhouse bench area. Two greenhouses were used with 2 replications of 5 treatments in each house. Initial infestation rates averaged 40 aphids per plant in greenhouse 1 (24 ± 14°C) and 31 aphids per plant in greenhouse 2 (21 ± 14°C). Temperatures in each house were recorded continuously on hygrothermographs. Chrysopid eggs were hatched in Petri dishes and first instar larvae were transferred to biological treatment areas, 4 larvae per plant at the beginning of the experiment Feb. 12, 1972, and again 4 or 5 weeks later. Chemical treatments consisted of spraying the plants weekly with recommended rates of malathion or nicotine sulfate. Other treatments were either an initial biological treatment followed by a chemical treatment (Bio-Chem), or with 2 sprays followed by a biological treatment 2 or 3 weeks later (Chem-Bio). Aphid populations in the control were not suppressed.

The treatment areas where larvae were released were surrounded with a topless, 10 cm-high, Teflon-coated fiberglass cage, as Teflon is too smooth for larvae to escape. Snapdragons were planted in 10-cm clay pots placed in wooden flats so the plants could be moved to be sprayed and then returned. The plants were staked with bamboo canes. Aphid populations were recorded each week. Harvested flowers were rated by 2 flower judges using a 1 to 6 scale, so the highest possible score for 9 plants was 54.

Results and Discussion

Release rate study: First instar lacewing larvae, released at 2, 4, 6, 8, or 10 per plant, significantly reduced aphid populations (Table 1). The aphid population on the check plants appeared to remain relatively stable, because as the aphid populations increased death of some plants occurred. Control percentage was significantly better with 4 larvae per plant than with 2 larvae per plant (Fig. 1). Four to 10 larvae per plant gave similar control. Effective control of aphid populations was evident after 9 days.

Scopes (7) reported that a chrysopid:aphid ratio of 1:50 would effectively control *Myzus persicae* on greenhouse chrysanthemums. This ratio was not exceeded, but aphid control varied 5 to 100% with only 2 lacewing larvae per plant (ratio of 1:36). Pubescence on the lower stem and on flower buds reduced larva mobility. Cannibalism among larvae when first placed in plant cages may have increased the chrysopid:aphid ratio below 1:50. At 4 to 10 larvae/per plant, however, loss of a few larvae would not decrease the ratio below 1:50. Four larvae per plant gave consistent, economic results.

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