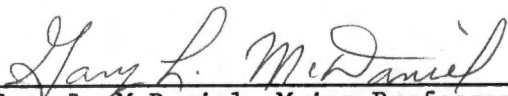


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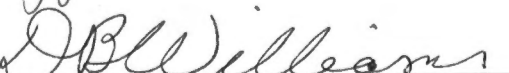
I am submitting herewith a thesis written by Georgia Lea Bresenham entitled "Use of Antitranspirants to Improve Water Relations of Senecio cruentus DC. 'Hansa'." I recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Ornamental Horticulture and Landscape Design.



Gary L. McDaniel, Major Professor

We have read this thesis
and recommend its acceptance:





Accepted for the Council:



Vice Chancellor
Graduate Studies and Research

Thesis

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USE OF ANTITRANSPIRANTS TO IMPROVE WATER RELATIONS
OF SENECIO CRUENTUS DC. 'HANSA'

A Thesis

Presented for the

Master of Science

Degree

The University of Tennessee, Knoxville

Georgia Lea Bresenham

December 1977

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DEDICATION

To my parents, Elton and Mary Bresenham, who have always stood
behind me in all my endeavors.

GILBERT
GILBERT

ABSTRACT

The antitranspirant chemicals Clear Spray and Vapor Gard significantly increased stomatal diffusive resistance in cineraria by reducing transpiration on hot days. Foliar applications of the antitranspirant chemicals to both the upper and lower epidermal surfaces of the leaves were effective in reducing plant water stresses for a period of four weeks, after which time the benefits of the antitranspirant chemicals were greatly reduced. Clear Spray and Vapor Gard did not have a significant effect on stomatal diffusive resistance when no water stresses existed on the plants. Leaf and ambient air temperatures significantly increased stomatal diffusive resistance and transpiration. Phytotoxic damage caused by Vapor Gard was associated with high greenhouse temperatures.

Transpiration losses measured gravimetrically over a four-day period confirmed that the benefits from the antitranspirant chemicals lasted only four weeks. Foliage sprayed with Clear Spray and Vapor Gard was shiny due to the chemical film covering the entire leaf surfaces. As a result of this added benefit, the plants were more attractive than usual when in bloom.

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CHAPTER I

INTRODUCTION

Florists' cineraria, Senecio cruentus DC., have been popular as a potted plant in Europe for many years. They have not been grown on a large scale in the United States for the past forty years, because other crops were less trouble to grow. Today growers in the United States are looking again at the cineraria, primarily because it is a cool season crop. Cineraria offer an alternative to the grower who is currently facing increasing heating costs. The cineraria will remain vegetative at low temperatures (15°C) or will initiate flower buds at 7.2-10°C.

One problem growers face under warm greenhouse environments is severe wilting of cineraria foliage, but under cool conditions this is not a problem. Under warm temperatures a water deficit usually occurs in the cineraria, even though adequate water is available to the roots. Transpiration, which occurs almost entirely from the stomatal pores, occurs more rapidly than the roots can absorb water, resulting in foliar wilting. This condition has made the cineraria less favorable for commercial production.

The purpose of this research was to determine whether transpiration of cineraria could be reduced on warm days by the application of film-forming antitranspirant chemicals, which are designed to reduce transpiration when applied to plant foliage. If wilting on warm days

could be reduced by an economical chemical treatment during the production of cineraria, the quality of cineraria would improve and an inexpensive, relatively low maintenance flowering pot plant would be available the year around to growers, the florist trade, and consumers. Two antitranspirant chemicals were compared for their ability to increase stomatal diffusive resistance of cineraria under different environmental regimes during production of the crop.

CHAPTER II

REVIEW OF LITERATURE

I. ORIGIN OF SENECIO CRUENTUS DC.

Francis Masson was sent out from Kew Gardens, Richmond, Surrey, England (24), during the latter part of the eighteenth century as a plant collector. During his visit to the Canary Islands he collected several species of Senecio. It is from these plants that today's different cultivars of Florists' cineraria, Senecio cruentus, were derived (4).

During the early and middle nineteenth century, named cultivars of cineraria were propagated by cuttings. Each year new cultivars were raised by seed. By the end of the nineteenth century the custom of maintaining named cultivars by cuttings was dropped, because vegetatively produced cineraria tended to lose their vigor after several propagations (4). Cineraria are currently grown exclusively from seeds. Cineraria are inexpensive to grow and need little heat (3). They require cool night temperatures (7.2-10°C) to initiate flower buds (35). Plants can be kept vegetative during the winter by keeping the minimum temperature above 15.5°C. Cineraria do not require pinching and will naturally form a large mass of flowers which open simultaneously about eight weeks following the lowering of the temperature below 10°C (35).

Cineraria make a beautiful potted plant. Flower colors range from striking white, red, pink, blue, or deep purple, or they may

possess a combination of white and magenta, white and red, or white and purple. These unusual colors are due to the presence of cinerarin, a blue pigment rarely found in the Compositae family. The disk corollas and the rays may be the same color, or the disks may be white, while the rays are colored. Ray corollas are said to be "eyed" when the tips are colored and the inner portion is white (4).

II. THE EFFECT OF WATER DEFICIT ON CINERARIA

One drawback in growing cineraria is that during high temperatures water losses due to transpiration from the leaves often exceed water gains from absorption by the roots. When this occurs a water deficit exists within the plant and the plant wilts (33,39). A water deficit reduces the plant's ability to undergo other physiological processes at a normal rate (26). Wilting is the visible result of the existing water deficit. When a plant wilts, photosynthesis stops (26, 30,45,46) and several growth processes, such as cell enlargement and leaf area expansion are inhibited (26,46).

Zelitch (46) found that many plants wilted when their leaf relative water contents were between 80-85 percent of their fully turgid conditions. Even before wilting is observed, stomata are usually closing. When the wilting point is reached, stomata are generally closed and this results in reduced photosynthetic rates (46).

III. TRANSPIRATION

Plants lose water mainly by transpiration (33). This process involves water loss as vapor from stomata, which are microscopic pores, located primarily on the leaves. Cineraria have numerous stomata on both sides of the leaf, but the number of stomata in the lower epidermis exceeds the number in the upper epidermis, as is the case in many plant species (28,30). In many species the maximum stomatal openings occurring under natural conditions may be in the region of 10 microns (30).

The main function of the stomata is for the exchange of gases needed in photosynthesis (30,45), but while photosynthesis takes place water loss occurs through the stomata. Kramer (26) states that transpiration exceeding water absorption is the main reason why most plants are injured or killed. Some researchers question the necessity of the transpiration process, since water must be constantly available to replace the water plants lose due to transpiration (7,26,28).

IV. DIFFERENT USES OF ANTITRANSPIRANT CHEMICALS

For many years researchers have been looking for ways to reduce water loss in plants during storage, transplanting, shipping, and plant maintenance (6,10,11,22,23,27,29,31,38,40). Antitranspirants, also called antidesiccants, are chemicals which reduce the loss of water in plants (28). Antitranspirant films increase the resistance to diffusion of water vapor from stomata and curtail transpiration by offering resistance to the passage of water vapor (8).

Interest in reducing water loss by plants dates back to Theophrastus, a pupil of Plato, in Athens, Greece, in 300 B.C. (22). In his book, Enquiry into Plants, Theophrastus told of men plastering trees with mud and tying pieces of bark reeds around trees to protect them from the cold and desiccation (41). In the 1930's nurserymen coated small nursery stock with wax to prevent desiccation in storage and painted planted trees with wax for winter and summer protection (31). In the 1940's Goodrich Chemical Company developed a non-toxic moisture-proof plastic called Geon 31X, which upon drying left a transparent film on plants (23). Water loss was reduced significantly in cut branches of Picea excelsa (Norway spruce), Thuja orientalis (Chinese arborvitae), Thuja occidentalis (American arborvitae), Viscum album (mistletoe), and Pinus strobus (white pine) after they were sprayed with Geon 31X (23). Cut Norway spruce used as Christmas trees were also sprayed with Geon 31X. Needle drop was minor during the 10-day trial period (23). Early experiments with Geon 31X on the gardenia flower showed improved cut-flower life due to a reduction in water loss (38).

Modern antitranspirant chemicals can be divided into three groups, each with a unique method for reducing transpiration of plants. These types are: film-forming, stomata-regulating, and reflecting (9,28). All are normally applied as foliar sprays (28). The majority of antitranspirant chemicals marketed today are of the film-forming type (28).

Film-forming antitranspirants have been manufactured from latex, various plastics, silicones, polyterpenes, and high molecular weight

solid alcohols (9,28). Following a foliar application of an antitranspirant material, the water used to mix the compound evaporates, leaving a transparent film which inhibits the escape of water vapor from the stomata (9,28). Plastic film-forming antitranspirant chemicals are more permeable to water vapor than to carbon dioxide (21,37). Photosynthesis of plants treated with antitranspirant chemicals is reduced to the same or greater extent than transpiration, except under conditions of stress, when photosynthesis in treated plants is greater than in non-treated plants (21).

Researchers recommend that antitranspirant chemicals be applied during the stage of growth when the plant is more dependent on maintaining turgid cells than photosynthesis, to guarantee that growth is not stunted (15,16). Reduced growth and yields have been reported (15, 16), but in some situations reduced growth may be an advantage (28). With pre-sale and post-harvest applications of antitranspirant chemicals, growth is not as important a factor as reduction in water loss (28,29).

Davenport, Fisher, and Hagen (8) found that the stomata have a greater aperture under antitranspirant films even though transpiration is curtailed, because leaf water potential is increased. This increases the turgidity of the guard cells and results in wider stomatal apertures (8).

The stomata-regulating antitranspirant chemicals act on plant processes by affecting the cells around the stomatal pores (9,28). This prevents the stomata from opening fully and decreases the loss of water vapor from the leaf. Stomata-regulating antitranspirant chemicals are

of little value commercially, because many of them are phytotoxic or grossly affect plant processes (28).

The reflecting materials reduce the absorption of radiant energy and thereby aid in reducing leaf temperatures and transpiration rates (9). Unfortunately these materials are of no value to the grower, because they are manufactured from white spray materials such as kaolinite or lime, which form an unattractive white coating of high reflectivity upon drying (28).

Antitranspirant chemicals have not been used to a great extent in the floriculture industry, but they do offer possibilities for the growing and selling of floricultural products (28). Davenport and associates have conducted research with antitranspirant chemicals and have consistently found that water loss can be reduced significantly in plants with the use of these chemicals, especially when the plants were treated soon after watering (8,9,10,11,15,16).

At the University of Maryland, antitranspirant research has been conducted with potted chrysanthemums. This research suggests that antitranspirant chemicals may be able to reduce water use in pot plant production (29). In other tests involving foliar applications of phenylmercuric acetate to chrysanthemums, water loss due to transpiration was reduced by 30 percent without causing tissue damage (6). The transpiration rate of potted oleanders in a greenhouse was reduced 25-35 percent after being sprayed with a film-forming antitranspirant, CS-6432 (Chevron Chemical Company) (11). Coatings of latex and silicone were applied to sweet orange seedlings. Measurements of growth and

moisture usage over a 20-day period indicated that latex reduced water loss considerably. Malcolm and Stolzy suggested that transpiration can be reduced by covering the stomatal pore (27).

Antitranspirant chemicals have been used to reduce the wilting of turf (5,28), to prevent woody and herbaceous plants from drying out in shipment or in retail outlets (11,29), and to aid plants, shrubs, and trees planted in the warmer months of the year to reduce "transplant shock" (2,10). The nursery industry can also benefit from the use of antitranspirant chemicals in protecting trees and shrubs from winter burn injury (2,28,31,34). Antitranspirant chemicals are used to prevent needle drop on Christmas trees by the Christmas tree industry and homeowners (2,18,19,20,23).

Pre-harvest applications of antitranspirant chemicals were made to the leaves of cherry trees (12,42), mature 'Valencia' orange trees (1), peach trees (14,44), and olive trees (13,15), when fruit growth was more dependent on turgor than on photosynthesis (16). The antitranspirant chemicals reduce water stress by decreasing transpiration and resulted in both size and weight increases in various fruits (1,12,13,14,15,16,42,44). Post-harvest fruit water loss and shriveling were reduced and keeping quality was improved (15,32).

Previous research suggests that as a supplement to good care, antitranspirant chemicals have a potential value in floriculture production. This is especially true for certain potted crops such as cineraria and hydrangea which are very vulnerable to water stress and frequent wilting (28).

CHAPTER III

MATERIALS AND METHODS

I. EXPERIMENT 1

In preliminary investigations of the potential for using anti-transpirant chemicals on cineraria during production, chemicals were tested for their effectiveness in reducing transpiration. These chemicals were: Clear Spray (latex of pure acrylic polymer; W. A. Cleary Corporation), Vapor Gard (di-l-p-menthene; Miller Chemical and Fertilizer Corporation), Wilt Pruf NCF (di-l-p-menthene; Nursery Specialty Products, Div., J. A. Hartman Corp.), Folicote (hydrocarbon wax; Crystal Soap and Chemical Co., Inc.), and All-Safe (di-l-p-menthene; Certified Laboratories).

On December 19, 1976, treatments consisting of five antitranspirant chemicals at two concentrations each, plus a control group treated with distilled water, were made to the cineraria plants. Concentrations were: Clear Spray (100 ml/liter and 200 ml/liter), Vapor Gard (12.5 ml/liter and 50 ml/liter), Wilt Pruf NCF (100 ml/liter and 200 ml/liter), Folicote (25 ml/liter and 100 ml/liter), and All-Safe (330 ml/liter and 500 ml/liter). Tween 20 (polyoxyethylene sorbitan monolaurate) (0.01 ml/liter), a surfactant was added to each solution, including the control group. The antitranspirant chemicals were applied as foliar sprays to individual plants using a Super Polyspray, all-purpose hand sprayer with a fine mist nozzle. The 72 cineraria cv.

Hansa plants used in this experiment were purchased from Chase Greenhouse Inc., Knoxville, Tennessee. The plants were approximately four and one-half months old and were in 8-cm plastic pots. Plants were arranged in a completely randomized design on raised benches in a glass greenhouse.

II. EXPERIMENT 2

Since no phytotoxicity to the foliage was found at the concentration levels used in Experiment 1, except with Wilt Pruf NCF, the concentrations were increased, except Wilt Pruf NCF, which was reduced, to determine the highest rate which could be used without causing plant damage. On February 3, 1977, the same 72 plants used in Experiment 1 were again treated with the five antitranspirant chemicals. Concentrations were: Clear Spray (333 ml/liter and 400 ml/liter), Vapor Gard (100 ml/liter and 200 ml/liter), Wilt Pruf NCF (111 ml/liter and 142 ml/liter), Folicote (150 ml/liter and 200 ml/liter), and All-Safe (750 ml/liter and 1000 ml/liter). The control plants were once again treated with distilled water. Tween 20 (0.01 ml/liter) was added to all solutions, including the control group.

III. EXPERIMENT 3

Vapor Gard and Clear Spray

Cineraria cv. Hansa seeds were sown on Pro-Mix B, on October 31, 1976, and were treated with a Banrot drench to control damping-off organisms. The seed flats were placed under Sylvania Gro-Lux lights

(approximately 706 lux) at an average temperature of 26.6°C. The seeds germinated in three to five days. When the seedlings were two weeks old, they were moved to a glass greenhouse. One month following germination, seedlings were transplanted into 5-cm plastic pots, using a soil mixture of one part soil:one part peat moss:and one part perlite. Seedlings were treated with another Banrot drench to control damping-off organisms and fertilized two times a week with a soluble Peters 20-20-20 (oxide form) (200 mg/liter) fertilizer delivered through a Hozon proportioner with hand watering. On February 15, 1977, the plants were transplanted into 8-cm pots. Fertilization frequency was increased to each time the plants were watered with a Peters 20-20-20 (oxide form) (200 mg/liter) fertilizer.

On March 12, 1977, 180 plants were moved into a coldframe outside of the greenhouse to initiate flower buds. The coldframe was covered every night with fiberglass sheets to protect the plants from rain and seasonal frost. The plants remained outside for five weeks, until April 15, 1977. Temperature readings were taken daily with a Taylor maximum-minimum thermometer. The average night temperature was 9.5°C. This temperature is within the 7-10°C range that Potter (36) suggests for producing compact, well-formed cineraria which will flower at approximately the same time.

On April 15, 1977, the 180 plants were returned to a heated greenhouse and were transplanted into 15-cm plastic pots. Due to a limited amount of greenhouse space, it was impossible to conduct a study involving all five antitranspirant chemicals tested in Experiments 1

and 2. Two antitranspirant chemicals, Clear Spray and Vapor Gard, were selected based on their ease of application and appearance on the cineraria foliage. The plants were treated on April 28, 1977, with Clear Spray (200 ml/liter), Vapor Gard (50 ml/liter), or distilled water. All three solutions contained Tween 20 (0.01 ml/liter). Each plant was sprayed to run-off, taking care that the underside of the leaves were well covered, since the majority of the stomata are located in this region. Plants were sprayed with a 6220 Hudson Bugwiser sprayer with an adjustable spray nozzle and roto valve which can turn in any direction, thus making it easy and practical to thoroughly spray the underside of the leaves.

Data was gathered on May 11 and 27, and June 2, 1977, to determine the differences in stomatal diffusive resistances and leaf temperatures on cloudy and sunny days at different periods and light intensities during each of the days. Light intensities were recorded with a Model LI-185 Lambda Photometer* and a Model LI-210SN Lambda Photometric Sensor.* Stomatal diffusive resistances and leaf temperatures were measured with a Model LI-60 Lambda Diffusive Resistance Meter* and a Model LI-20 Lambda Diffusive Resistance Sensor* (25,43).

All plants flowered at about the same time, an average of 175-180 days after the seeds were sown. The plants were compact, well-formed, and the flowers were beautifully colored.

*Lambda Instruments Co., Inc., Lincoln, Nebraska 68504

IV. EXPERIMENT 4

Transpiration Measurement by the Gravimetric Method

Gravimetric measurements provide a reliable method for determining water loss due to transpiration (33). A subset of 15 plants was selected from the original 180 plants which had been sprayed with Clear Spray (200 ml/liter), Vapor Gard (50 ml/liter), and distilled water. The plants were watered to soil capacity at 1900 hour, on June 9, 1977. The pots were placed in polyethylene bags and were sealed at the soil line, leaving the foliage exposed, at 0800 hour, on June 10, 1977, to determine transpiration losses by the plants. The plants were weighed at two-hour intervals from 0800 hour to 2000 hour during a four-day period (June 9-12, 1977). The loss in weight represented the amount of water transpired. After the last reading each day, approximately the same amount of water lost due to transpiration that day was added to the soil.

Leaf area was measured for the 15 plants with a Model LI-3100 Lambda Automatic Area Meter.* Fresh and dry weights were also recorded. Dry weights were obtained after placing plants in individual bags in a drying oven for 20 hours at 65°C. Relative humidity was determined using a Taylor Instrument Company Sling Psychrometer. Because of the great variation in the size of cineraria, transpiration was calculated by the following method.

$$\text{TRANSPIRATION} = \frac{\text{GRAMS WATER TRANSPIRED}}{\text{DRY WEIGHT OF THE PLANT}}$$

*Lambda Instruments Co., Inc., Lincoln, Nebraska 68504

CHAPTER IV

RESULTS AND DISCUSSION

I. EXPERIMENT 1

Experiments 1 and 2 were trial experiments designed to find satisfactory concentrations at which five antitranspirant chemicals could be applied to the foliage of cineraria without being phytotoxic. Visual observations were made to determine whether phytotoxicity occurred. No damage was observed with Clear Spray, Vapor Gard, Folicote, and All-Safe. Significant damage was caused by Wilt Pruf NCF. Tween 20 was added to each solution, including the control group. Since Tween 20 was not phytotoxic, any damage was attributed to the effect of the antitranspirant chemical.

II. EXPERIMENT 2

The concentrations of the antitranspirant chemicals used in Experiment 1 were increased, except Wilt Pruf NCF, which was reduced, since it had previously caused foliar burning, to determine the maximum concentrations which could be used without causing phytotoxic effects to the plants. Foliar damage was observed at all concentrations and on all plants, except the control plants. Tween 20 was added to all solutions and was not phytotoxic.

III. EXPERIMENT 3

Sunny Day

Past research (6,10,11,12,29,42) has shown that antitranspirant chemicals are effective when applied from one to fourteen days prior to the recording of data. The purpose of this experiment was to test the persistence of the antitranspirant chemicals on the cineraria during production. Only two of the five available antitranspirant chemicals could be tested due to limited greenhouse space and equipment for taking data. Clear Spray and Vapor Gard were selected on the basis of their ease of application and least detracting from the natural appearance of the foliage. A single application of Clear Spray (200 ml/liter) and Vapor Gard (50 ml/liter) was made during the last six weeks of the production phase when wilting is a constant problem.

Data was recorded on May 11, 1977, from 180 plants, to study the effects of light intensity, leaf temperature, and ambient air temperature on stomatal diffusive resistance during a sunny day. The plants had been sprayed with Clear Spray, Vapor Gard, or distilled water two weeks before the data was taken. Some damage resulted to the plants treated with Vapor Gard. This could be explained by the higher average ambient air temperatures in the greenhouse during May than in December, that contributed to the chemical burning the edges of the leaves.

Orthogonal comparisons were analyzed using Clear Spray, Vapor Gard, and distilled water as the treatments and stomatal diffusive resistance as the dependent variable with the interactions of leaf and

ambient air temperatures. No significant differences were shown between the ability of the two antitranspirant chemicals to increase stomatal diffusive resistance. However, both antitranspirant chemicals significantly increased stomatal diffusive resistance, compared with the control, thus reducing transpiration (Table 1). Leaf and ambient air temperatures were highly significant factors in influencing stomatal diffusive resistance. As the ambient air temperature increased the leaf temperature and stomatal diffusive resistance also increased. Decreasing ambient air temperature had a reciprocal effect on leaf temperature and stomatal diffusive resistance. Light intensity did not significantly influence stomatal diffusive resistance of cineraria.

It has been speculated that antitranspirant chemicals would raise the leaf temperature of the plants, because transpiration would be reduced (22). The results of this study show that Clear Spray and Vapor Gard did not significantly raise leaf temperatures (Table 1).

Cloudy Day

On May 26, 1977, four weeks after the application of the antitranspirant chemicals, readings were taken during a cloudy day at mid-morning (0930 to 1130 hour), light intensity 3,869 lux, mid-day (1330 to 1530 hour), light intensity 21,875 lux, and late afternoon (1730 to 1930 hour), light intensity 7,825 lux, to determine the stomatal diffusive resistances and leaf temperatures. Since it was not possible to take resistance readings on 180 plants in a two-hour period, 20 plants were randomly selected from each chemically treated group. All data was taken from these 60 plants.

TABLE 1

MEAN STOMATAL DIFFUSIVE RESISTANCES AND LEAF TEMPERATURES
OF ANTITRANSPIRANT TREATED CINERARIA ON A SUNNY
DAY, MAY 11, 1977, 1500-1900 HOUR, AT 28.3°C

Chemical	Stomatal Diffusive Resistance (sec. cm ⁻¹)	Leaf Temperature (°C)
Clear Spray	6.87* ^a	29.7
Vapor Gard	6.78*	30.5
Control (distilled water)	5.01	30.4

^aMean separation within columns by LSD, 5 percent level.

*significant

At mid-day on a cloudy day (21,875 lux) the two antitranspirant chemicals performed similarly in relation to stomatal diffusive resistance and both were more effective than the control (Table 2). By late-afternoon on a cloudy day (7,825 lux) there was no significant difference between Clear Spray, Vapor Gard, or distilled water (Table 3). This was due to the cooler greenhouse temperatures and lack of water stress on the plants. The antitranspirant chemicals aided in the reduction of transpiration when the plants were under stress, but when there was no stress due to cool greenhouse air temperatures the chemicals had little effect on the plant water relations.

Comparison of a Sunny Day and a Cloudy Day

Leaf temperatures were significantly different on a sunny day and a cloudy day. Leaf temperatures were approximately 1°C above ambient air temperatures on the cloudy day, while on a sunny day leaf temperatures were approximately 2°C above ambient air temperatures. Stomatal diffusive resistances were significantly greater on a sunny day than on a cloudy day (Table 4). The average light intensity on the sunny day was 44,100 lux and on the cloudy day was 11,188 lux.

On June 2, 1977, five weeks after the application of Clear Spray and Vapor Gard, there was no significant difference between the ability of Clear Spray, Vapor Gard, or distilled water to increase stomatal diffusive resistance on a sunny afternoon (light intensity 35,000 lux) (Table 5). There was stress on the plants due to high greenhouse temperatures (32.7°C) on a sunny afternoon, but the antitranspirant

TABLE 2

MEAN STOMATAL DIFFUSIVE RESISTANCES AND LEAF TEMPERATURES
OF ANTITRANSPIRANT TREATED CINERARIA ON A CLOUDY DAY,
MAY 26, 1977, 1330-1530 HOUR, AT 25.0°C

Chemical	Stomatal Diffusive Resistance (sec. cm ⁻¹)	Leaf Temperature (°C)
Clear Spray	8.14* ^a	25.4
Vapor Gard	7.93*	25.9
Control (distilled water)	6.55	25.9

^aMean separation within columns by LSD, 5 percent level.

*significant

TABLE 3

MEAN COMPARISON OF TWO ANTITRANSPIRANT CHEMICALS ON A
LATE-AFTERNOON OF A CLOUDY DAY, MAY 26, 1977,
AT 24.1°C

Chemical	Stomatal Diffusive Resistance (sec. cm ⁻¹)	Leaf Temperature (°C)
Clear Spray	7.90 ^a NS	24.2
Vapor Gard	7.75 NS	25.8
Control (distilled water)	7.60 NS	25.0

^aMean separation within columns by LSD, 5 percent level.

TABLE 4

MEAN COMPARISON OF ANTITRANSPIRANT TREATED CINERARIA
 STOMATAL DIFFUSIVE RESISTANCES ON A SUNNY DAY,
 MAY 11, 1977, 1500-1900 HOUR, AT 28.3°C, AND
 A CLOUDY DAY, MAY 26, 1977, 1330-1530
 HOUR, AT 25.0°C

Chemical	Sunny Day Stomatal Diffusive Resistance (sec. cm ⁻¹)	Cloudy Day Stomatal Diffusive Resistance (sec. cm ⁻¹)
Clear Spray	6.87* ^a	8.14*
Vapor Gard	6.78*	7.93*
Control (distilled water)	5.01	6.55

^aMean separation within columns by LSD, 5 percent level.

*significant

TABLE 5

MEAN STOMATAL DIFFUSIVE RESISTANCES AND LEAF TEMPERATURES
OF ANTITRANSPIRANT TREATED CINERARIA ON A SUNNY
AFTERNOON, JUNE 2, 1977, 1300-1500 HOUR,
AT 32.7°C

Chemical	Stomatal Diffusive Resistance (sec. cm ⁻¹)	Leaf Temperature (°C)
Clear Spray	13.62 ^a NS	34.4
Vapor Gard	13.25 NS	33.5
Control (distilled water)	14.31 NS	35.7

^aMean separation within columns by LSD, 5 percent level.

chemicals did not increase stomatal diffusive resistance significantly better than the distilled water on the control plants. Apparently, after five weeks the antitranspirant chemicals were no longer effective. However, stomatal diffusive resistances for a sunny day (light intensity 35,000 lux) on June 2 (Table 5), were higher than they were for a sunny day (light intensity 44,100 lux) on May 11 (Table 1, page 18). The data in Table 1 reflects turgid plants, thus the relatively low resistance values, and the data in Table 5 reflects a majority of wilted plants where the stomata were closing or were already closed, thus the higher resistance values.

IV. EXPERIMENT 4

Transpiration Measurement by the Gravimetric Method

On June 9, 1977, approximately six weeks after the plants were treated, 15 plants were observed carefully for four consecutive days. The antitranspirant chemicals did not reduce transpiration any more than the distilled water control treatment (Table 6). This confirms the results found on June 2, showing the antitranspirant chemicals were no longer effective after five weeks.

Relative humidity was a highly significant factor in influencing transpiration. The plants within the chemical treatments showed significantly different transpiration rates. This can be attributed to the variability of cineraria in plant stature, leaf size, and leaf count per plant (Table 7). Statistically light intensity was not a significant factor in influencing transpiration.

TABLE 6
 MEAN TRANSPIRATION LOSS OF ANTITRANSPIRANT TREATED
 CINERARIA OVER A FOUR-DAY PERIOD, SIX WEEKS
 AFTER THE APPLICATION OF TWO
 ANTITRANSPIRANT CHEMICALS

Chemical	Transpiration ^a Loss (ml)	Mean Leaf Area (cm ²)
Clear Spray	1.85 ^b NS	29.0
Vapor Gard	1.80 NS	28.4
Control (distilled water)	1.65 NS	28.9

$$^a \text{Transpiration} = \frac{\text{Grams water transpired}}{\text{Dry weight of plant}}$$

^bMean separation within columns by LSD, 5 percent level.

TABLE 7
DIFFERENCES IN CINERARIA LEAF AREA AND
LEAF COUNT ON JUNE 14, 1977

Chemical	Plant	Number of Leaves	Mean Leaf Area (cm ²)
Clear Spray	1	26	26.2
	2	18	31.2
	3	16	39.7
	4	25	28.9
	5	<u>52</u>	<u>19.6</u>
Average		27.4	29.2
Vapor Gard	1	25	20.3
	2	10	48.7
	3	28	19.0
	4	35	23.7
	5	<u>23</u>	<u>30.2</u>
Average		24.2	28.4
Control (distilled water)	1	27	20.2
	2	15	29.7
	3	22	30.3
	4	12	34.2
	5	<u>20</u>	<u>30.3</u>
Average		19.2	28.9

CHAPTER V

SUMMARY AND CONCLUSION

The two antitranspirant chemicals Clear Spray and Vapor Gard did successfully reduce transpiration for four weeks after they were sprayed on cineraria. There was no significant difference in the ability of either of the two antitranspirant chemicals to reduce transpiration. If antitranspirant chemicals are to be useful to a grower of cineraria, more than one application of the chemicals will most likely be necessary during the production cycle to get continuous benefit from the chemicals. Then it may be possible to successfully grow a crop of cineraria during the summer months without the plants being severely damaged by wilting. Caution should be used when applying antitranspirant chemicals during the hot summer months, because some of the antitranspirant chemicals may be phytotoxic at higher temperatures. More research needs to be done in this area, including other floricultural crops that have water relations problems.

Clear Spray added to the attractiveness of the cineraria by leaving a smooth shiny film on the leaves. A pre-sale application of Clear Spray to a spectacular cineraria in bloom would aid the grower and retailer in reaping larger profits per plant, since they would have a more attractive pot plant to sell. The plants would also be somewhat protected from desiccation during shipping and have an increased shelf-life in a store or a customer's home as a result of reduced water loss.

No foliar damage was ever associated with Clear Spray and plants treated with this chemical displayed excellent quality. Some foliar burning resulted from Vapor Gard, thereby detracting from the appearance and saleability of the plants. Clear Spray and Vapor Gard did not appear to have retarded the growth of the cineraria plants. As a supplement to good care and culture, antitranspirant chemicals could prove to be a valuable tool to the grower by assisting in more efficient utilization of labor for watering, while reducing the amount of fresh water needed for production.

Cineraria were moved outside into a cold frame for a five week period to set flower buds. This period of production in the coldframe would reduce the time devoted to a cineraria crop in the greenhouse space and allow the grower more time for production of other crops.

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1958

ANGSTER HOND

100% COTTON FIBRE

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