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## **Antitranspirants as an aid in the vegetative propagation of *Ilex crenata* "Compacta" and *Rhododendron obtusum* "Coral Bells"**

Mustafa Kamal Bin Mohd Shariff

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I am submitting herewith a thesis written by Mustafa Kamal Bin Mohd Shariff entitled "Antitranspirants as an aid in the vegetative propagation of Ilex crenata "Compacta" and Rhododendron obtusum "Coral Bells"." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Landscape Architecture.

John W. Day, Major Professor

We have read this thesis and recommend its acceptance:

G. Shannon Smith, Effin T. Graham

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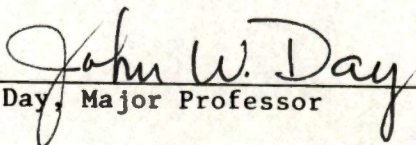
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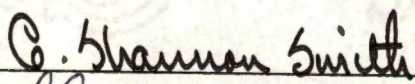
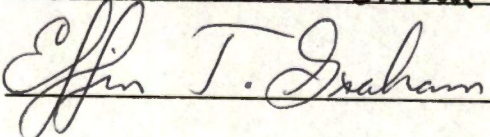
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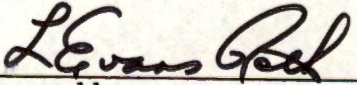
I am submitting herewith a thesis written by Mustafa-Kamal Bin Mohd.-Shariff entitled "Antitranspirants as an Aid in the Vegetative Propagation of Ilex crenata 'Compacta' and Rhododendron obtusum 'Coral Bells.'" I recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Ornamental Horticulture and Landscape Design.

  
\_\_\_\_\_  
John W. Day, Major Professor

We have read this thesis  
and recommend its acceptance:

  
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ANTITRANSPIRANTS AS AN AID IN THE VEGETATIVE PROPAGATION  
OF ILEX CRENATA 'COMPACTA' AND RHODODENDRON  
OBTUSUM 'CORAL BELLS'

A Thesis

Presented for the

Master of Science

Degree

The University of Tennessee, Knoxville

Mustafa-Kamal Bin Mohd.-Shariff

March 1980

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## ABSTRACT

Semi-hardwood cuttings of Ilex crenata 'Compacta' treated with Wilt Pruf NCF (10% v/v), Vapor Gard (2.5% v/v) and B-Nine SP (5000 ppm) lost significantly less water by transpiration than untreated cuttings. Cuttings treated with phenylmercuric acetate (200 ppm) lost significantly more water than untreated cuttings. Leaf damage to cuttings treated with Wilt Pruf NCF and Vapor Gard was low, B-Nine SP caused moderate damage and phenylmercuric acetate caused severe damage.

Cuttings of Rhododendron obtusum 'Coral Bells' treated with Wilt Pruf NCF (10% v/v) and Vapor Gard (2.5% v/v) lost significantly less water than untreated cuttings and showed little damage from anti-transpirants. Cuttings treated with B-Nine SP (5000 ppm) and phenylmercuric acetate (200 ppm) were severely damaged.

For both 'Compacta' holly and 'Coral Bells' azalea, there was no significant difference in the number of roots per cutting and in the mean length of the longest root per cutting between cuttings treated with Wilt Pruf NCF, Vapor Gard and mist.

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## CHAPTER I

### INTRODUCTION

Antitranspirants or antidesiccants are substances which when applied to leaves or other plant parts will help reduce transpiration. Presently, antitranspirants are divided into two major categories: (i) the film type that forms a thin coating over the plant surface and is impervious to water vapor but not to carbon dioxide (9,14,15,16) and (ii) the stomatal type that induces the closure of stomates (42,46). Another category of antitranspirant which has recently been suggested would increase leaf reflectance (7,15,23).

The use of antitranspirants has been rather widely accepted for a number of purposes. They have been used in spraying highway plantings (9), spraying fruit orchards during drought and also for increasing fruit size (12,32), during transplanting to reduce water stress (12) and to protect plants from winter injury (35).

The use of intermittent mist for rooting cuttings has become a widely accepted practice among nurserymen (33). By the use of intermittent mist, the high humidity surrounding the cuttings prevents them from drying out. But the use of intermittent mist has some major disadvantages such as leaching of essential nutrients and other vital compounds from the cuttings which may lower their quality (3,19,20,22, 40) and the increased occurrence of diseases due to the high humidity in the propagating houses. Also, a substantial amount of water is used. Hard or alkaline water may present problems to certain sensitive plants

(43) and production systems utilizing mist require labor consuming steps (44).

The use of antitranspirants in place of intermittent mist has several advantages and has been suggested by several researchers (12, 20,44). The purpose of this study was to investigate the performance of Rhododendron obtusum 'Coral Bells' and Ilex crenata 'Compacta' rooted using available antitranspirants such as Wilt Pruf NCF, Vapor Gard, phenylmercuric acetate and B-Nine SP. Primary objectives of this investigation included:

1. The selection of suitable antitranspirants for use on 'Coral Bells' azalea and 'Compacta' holly cuttings;
2. A comparison of the quality of cuttings rooted under intermittent mist with cuttings rooted using antitranspirants; and
3. A comparison of N, P, K, Ca and Mg contents of the cuttings rooted under the two different methods.

## CHAPTER II

### LITERATURE REVIEW

Less than 1% of the water absorbed by plants is actually retained within the plant and even less is retained in a harvested crop (12,15). Most water is lost to the atmosphere by the process of transpiration which occurs mainly through the stomata. These are elliptically shaped microscopic holes bordered on each side by crescent shaped guard cells which control the opening and the closing of the stomatal aperture. The opening and closing of the stomata is controlled by turgor changes in the guard cells relative to the neighboring epidermal cells. Stomata open when the guard cell turgor increases and close when turgor becomes relatively less than the surrounding cells. The opening and closing of stomata is influenced in some plant species by light, temperature and carbon dioxide. Transpiration is a passive process whereby water in the leaves escapes to the air mainly by vapor diffusion and partly by the action of wind movement surrounding the leaves (23).

Transpiration is not a wasteful process because it has some influence on cooling the plant, the transport of ions within the plant and possibly on the movement of mobile ions in the soil solution towards the root zone. However, no proportionality has been established between the uptake of ions and the transpiration rate.

The primary problem associated with transpiration is that when the rate of water loss from the plant exceeds the rate of water absorbed by the roots, wilting occurs. Under prolonged wilting, the plant may suffer irreparable damage or even die. This problem is especially

critical during drought, after transplanting and during cold weather when soil water in the root zone is frozen. Transpiration losses are also important during propagation of cuttings before roots have formed.

Researchers have long been concerned with methods of reducing transpiration but only recently has the use of antitranspirants been investigated. Antitranspirants are chemicals that are applied to the plants to retard transpiration (15). They are broadly categorized into the film-forming types (2,9,10,11,13,16,25,26,29,32,35), the stomata-closing types (5,6,29,34) and the reflective types (15,23).

#### Film-Forming Antitranspirants

Film-forming antitranspirants reduce transpiration by forming a clear film on treated surfaces. In theory, the film formed should be continuous and impervious to water vapor but not to carbon dioxide. However, no materials have been found that have these characteristics. Microscopic inspection of the treated surface shows that the film formed is uneven in thickness and contains gaps and micropores. This partial coverage may be to some advantage in reducing transpiration but not photosynthesis. According to Olofinboba et al. (30), antitranspirants which form effective and persistent leaf coatings are ultimately injurious due to their inhibition of photosynthesis. Suitable materials that are impervious to water vapor while pervious to carbon dioxide have not been identified. Presently available film-forming antitranspirants will reduce carbon dioxide intake more than transpiration. However, because they provide only a partial coverage, carbon dioxide intake and transpiration are reduced to about the same level.

Davenport et al. (10) observed that film-forming antitranspirants (i) reduce leaf expansion, plant height and yield, (ii) increase internode and leaf elongation over a short period of time, (iii) reduce radial expansion of trunks of fruit trees and (iv) increase the size of fruits. They concluded that antitranspirants increase or decrease plant growth depending on whether the current photosynthesis or plant water potential is more important at the time when the treatment is applied.

Several materials such as higher alcohols, silicones, wax, latex and plastic emulsions have been used with some degree of success as film-forming antitranspirants.

#### Stomata-Closing Antitranspirants

Certain herbicides, fungicides, metabolic inhibitors and growth hormones can cause the closure of stomata when applied at very low concentrations (15). The closure of stomata by these chemicals is achieved by two means. In one type, the chemicals used will inhibit certain metabolic reactions that increase turgor of the guard cells. In the other type, the chemicals react with certain components of the cell membrane and alter its permeability. For example, phenylmercuric acetate reacts with the sulfhydryl groups in the guard cell's membrane and affects permeability.

An ideal stomata-closing antitranspirant has low mobility within the plant with activity limited to the stomata thus avoiding toxic effects to other plant systems. However, presently available stomata-closing antitranspirants do not act specifically on the stomata but are antimetabolites in sections of the respiration pathway (46). Their high toxicity and short lasting effects are other disadvantages. Nevertheless,

phenylmercuric acetate and abscissic acid have been used successfully on several plant species (5,29).

#### Reflective Materials as Antitranspirants

These materials increase leaf reflectivity and reduce the energy input received from solar radiation thus lowering the evaporation energy in the leaves. Little research has been done on this aspect of transpiration reduction, but suitable materials that will reflect portions of the light spectrum least used by the plant, such as infra red, may be found. Whitewash and kaolinite have been used with some success for this purpose.

Perhaps the most important problem associated with the use of antitranspirants has been the possibility of detrimental leaf temperatures as a result of transpiration reduction. Gale and Hagan (15) found that reducing transpiration caused leaf temperature to increase by 3°C to 5°C when wind velocity was low. However, lower wind velocities alone reduced transpiration due to the high vapor pressure build up near the leaf surface. They also noted that in hot arid regions the stomata of some plants close at mid-day when cooling is most needed. Kozlowski (23) found that a 40% reduction in transpiration would increase leaf temperature by 3°C. Only in cases of extremely high incident radiation and very low wind velocity would the temperature increase enough to cause leaf damage.

Antitranspirants have been successfully used in several practical and commercial applications to:

- (i) Improve the survival of transplants;
- (ii) Reduce winter desiccation damage of evergreens;



- (iii) Increase shelf life of cut flowers;
- (iv) Reduce smog and salt spray damage;
- (v) Lower certain fungus diseases and insect infestation by means of a physical barrier between the pathogens and the plant surface; and
- (vi) Improve the survival and rooting percentage of cuttings.

Intermittent mist is the most commonly used method of reducing transpiration losses when propagating by cuttings. It is an effective and proven method used by many commercial propagators. However, one disadvantage is the leaching of essential plant substances resulting in slower rooting and subsequent growth and lower liner quality.

Leaching is the removal of materials from a plant by an aqueous solution (38). Substances that may be leached include all major essential nutrients, carbohydrates, a number of amino acids, organic acids, some growth regulating chemicals, vitamins, alkaloids and phenolic compounds.

According to Tukey (38), leaching is a widespread phenomenon in plants. The degree of leaching varies among plant species, plant cultivars and among leaves of the same plant. The degree of leaching depends on several internal and external plant factors. Smooth, waxy leaves which are not easily wetted are less subject to leaching. Young leaves are less subject to losses than mature leaves. Losses are increased by injury to plant parts during removal of cuttings for propagation. Leaching is greater in plants that contain high nutrient content as compared to those that are nutrient deficient. Carbohydrates, phosphorus and sulfur are leached more in the presence of light than in the dark. An increase in temperature appears to cause more leaching

of calcium, potassium and magnesium. Also, salts such as sodium and potassium in the leaching solution increase nutrient loss but calcium apparently inhibits leaching.

Tukey (38) reported that certain elements appear to be more susceptible to leaching than others. Generally, potassium and sodium are leached easily; calcium, magnesium and sulfur with moderate ease; while phosphorus, chlorine, iron and zinc are more difficult to leach. Leaching of nutrients is related to their function and involvement in plant metabolism. Calcium and potassium are more easily leached because they exist in the "free space" areas of the leaves. Phosphorus is not easily leached from actively growing plants because it can be utilized and converted rapidly into an unleachable form.

Leaching of cations from above ground plant parts involves exchange reactions. Cations are mainly leached from cation pools that exist in the so-called "free space" areas within the leaves. Few cations, if any, are leached from within the cell itself or from other components such as the cell wall. Leaching of cations occurs when hydrogen ions in the leaching solution displace cations on the exchange sites of the cuticle. Also, cations may be moved directly from the translocation stream within the leaf into the leaching solution by diffusion and mass flow through areas lacking a cuticle (41).

Good and Tukey (17), in their experiments to determine the effect of cutting maturity on leaching of metabolites from cuttings rooted under mist, made the following conclusions. Softwood and herbaceous cuttings are more difficult to leach because a large portion of the nutrients are bound within the growing tissues. Hardwood cuttings are more easily leached because they have less growing tissues. Nutrient

deficiency symptoms observed in cuttings rooted under mist may be due to the leaching of nutrients from the cuttings or to the insufficient existing nutrients in the cuttings that would be used for new growth.

Leaching and the cost of installing and maintaining mist systems have led some researchers to suggest the use of antitranspirants to replace mist in rooting cuttings (12,44). Only a few experiments using antitranspirants have been conducted and results have been variable (3,20). More research is needed in this aspect of plant propagation.

## CHAPTER III

### MATERIALS AND METHODS

#### Experiment I

The purpose of this experiment was to select the most suitable antitranspirants to be used on 'Coral Bells' azalea and 'Compacta' holly cuttings.

Fifty Japanese Holly (Ilex crenata 'Compacta') cuttings were taken on June 15, 1979, and trimmed to 5 inches (12.7 cm) in length. Some of the leaves were removed to reduce variation in the leaf surface area among the cuttings. Fifty 50 ml glass test-tubes and one-holed rubber stoppers were used for the experiment. Each stopper was punctured by a hypodermic needle to ensure an equilibrium between atmospheric pressure and the pressure inside the tube. Each cutting was then inserted into the one-holed stopper with the top 2 inches of the cutting remaining above the stopper. Cuttings were held in place using Scotch Super Strength Adhesive.<sup>1</sup> Stem cuttings were wrapped using drafting tape to prevent possible injury from the adhesive. After cuttings were well secured, the stoppers were fitted into the test-tubes filled with water. Care was taken to ensure that part of the cutting was submerged in the water. The test-tubes were then allowed to stand in metal test-tube racks for 24 hours in the greenhouse to ensure proper transpiration flow.

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<sup>1</sup>3M Co., St. Paul, Minnesota.

At the end of the 24 hour period, water was again added to each of the test-tubes so that each test-tube had an equal volume of water. Four antitranspirants were then sprayed onto the cuttings until runoff. Control cuttings were sprayed with distilled water (Table 1). After the antitranspirants had dried, the test-tubes were weighed and the initial weights recorded. Weights of the test-tubes were then recorded daily and these minus the initial weights gave the weight of the water lost to transpiration. The experiment was terminated after 15 days on June 30, 1979. At the end of the experiment, a visual rating based on the number of leaves damaged was made of each cutting. Damage ranged from small chlorotic or necrotic spots to those that affected the entire leaf. The total leaf surface area of each cutting was then measured using an Automatic Area Meter (Model AAM).<sup>2</sup>

The experimental design chosen was a completely randomized arrangement of 5 treatments with 10 replications per treatment. Greenhouse temperature ranged from 64°F (17.7°C) to 100°F (37.8°C) during the entire experiment.

The procedure previously described was repeated with 'Coral Bells' azalea. These cuttings were taken on June 23, 1979, and the experiment was terminated on July 9, 1979.

#### Experiment II

This experiment compared 'Coral Bells' azalea and 'Compacta' holly cuttings propagated under mist with those treated only with the selected antitranspirants. Primary objectives were: (1) to measure

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<sup>2</sup>Hayashi Denko Co., Ltd., Tokyo, Japan.

Table 1. Treatments used in selecting suitable antitranspirants for Rhododendron obtusum 'Coral Bells' and Ilex crenata 'Compacta' cuttings.

Treatment	Concentration
Distilled water	-
Phenylmercuric acetate <sup>1</sup>	200 ppm
Succinic acid 2,2 dimethylhydrazide <sup>2</sup>	5000 ppm
Wilt Pruf NCF <sup>3</sup>	10% v/v
Vapor Gard <sup>4</sup>	2.5% v/v

<sup>1</sup>Eastman Kodak Co., Rochester, New York.

<sup>2</sup>Available as B-Nine SP, Uniroyal Inc., Naugatuck, Connecticut.

<sup>3</sup>Nursery Specialty Products, Greenwich, Connecticut.

<sup>4</sup>Miller Chemical and Fertilizer Corp., Hanover, Pennsylvania.

treatment effects on rooting and quality of cuttings including leaf damage ratings and (ii) to determine effects of mist versus antitranspirants on leaching of nitrogen (N), phosphorus (P), potassium (K), calcium (Ca) and magnesium (Mg) from the cuttings.

Fine river sand treated in the following manner was used as the rooting medium for the cuttings. First, approximately 1 gallon of sand was washed and agitated with high pressure tap water in a metal container until the water in the can was reasonably clear. Much of the silt, clay, organic matter and very fine sand was removed by this process. The remaining sand was then transferred to a 2 gallon crock. One-half gallon of 10% solution of hydrochloric acid was then poured over the sand and allowed to drain for 24 hours. The sand was then washed with tap water and later with distilled water to remove any excess acid. Washing was continued until a pH of 6.2 was attained. The sand was allowed to air dry and later stored in square plastic containers until used in the experiment.

Cuttings of 'Coral Bells' azalea and 'Compacta' holly were taken on September 21, 1979, and trimmed to 4 inches (10.1 cm). The number of leaves for all cuttings was maintained as uniformly as possible. Prepared cuttings of each cultivar were then randomly selected and put into groups of 10 cuttings. One group (10 cuttings) of each plant was taken to the laboratory for analysis of N, P, K, Ca and Mg. The remaining cuttings were treated with IBA powder<sup>3</sup> (3000 ppm) and stuck into the prepared medium. Two groups (10 cuttings per group) of cuttings of each cultivar were placed under automatic mist; 2 groups

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<sup>3</sup>Hormodin No. 2. Merck and Co., Rahway, New Jersey.

were sprayed with Vapor Gard and 2 groups sprayed with Wilt Pruf NCF (Table 2). Groups of cuttings were arranged in a randomized complete block with 3 treatments, 2 replications, with 10 cuttings per treatment.

The growing medium of all cuttings treated with antitranspirants was watered daily to maintain moisture. A Green Thumb Moisture Meter<sup>4</sup> was used to ensure that the medium in all the containers was uniformly moist. The temperature and humidity in the greenhouse were also recorded daily using a hygrothermograph.<sup>5</sup> A second application of Wilt Pruf NCF and Vapor Gard was made on October 26, 1979, 30 days after the initial application. The greenhouse temperature ranged from 53°F (11.7°C) to 89°F (31.7°C) and the relative humidities were from 43% to 100% during the entire experiment.

The experiment was terminated on November 14, 1979, after the cuttings were reasonably well rooted. Length of the longest root, number of roots formed and leaf damage rating as percent leaves damaged of each cutting were recorded. Roots were then removed and the cuttings taken to the laboratory for the analysis of N, P, K, Ca and Mg.

Cuttings were oven dried at 70°C for 48 hours and dry weight recorded. Two cuttings were selected at random, finely ground and analyzed for selected elements as follows:

#### Nitrogen Digestion Procedure

Finely ground plant tissue (0.2 g) was put into a 125 ml Erlenmeyer flask. Concentrated hydrosulfuric acid (10 ml) was added

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<sup>4</sup>Green Thumb Products, Apopka, Florida.

<sup>5</sup>Belfort Instrument Company, Baltimore, Maryland.



Table 2. Treatments used in the rooting of Rhododendron obtusum 'Coral Bells' and Ilex crenata 'Compacta' cuttings.

Treatment	Concentration
Mist	-
Wilt Pruf NCF	10% v/v
Vapor Gard	2.5% v/v

and the flask was allowed to predigest overnight. Then the solution was heated to about 200°C for 2.5 hours or until the volume was reduced by 50%. It was then allowed to cool. When it had sufficiently cooled, 20 ml of 35% hydrogen peroxide was added to the flask. The solution was again heated to more than 200°C until about 45 minutes after clearing was completed. Water was then added to facilitate cooling. The solution was transferred to a 250 ml volumetric flask and the volume made up to 250 ml with distilled water. The flask was then shaken thoroughly and set aside to allow for it to stabilize. The solution was then run on a Technicon Autoanalyzer.

#### Procedure for Ashing of K, P, Ca and Mg by the Aluminum Heating

##### Block Method

Finely ground plant tissue (0.5 g) was placed into a 50 ml tube. Two small glass beads and 3.0 ml of concentrated nitric acid were then added. A small funnel was placed in the mouth of the tube to act as a condenser. The digestion of the sample was done overnight at room temperature by placing the tube into the aluminum heating block. The block was then placed on a hot plate and it was heated at 150°C for 1 hour. Perchloric acid (2.0 ml) was added to the tube and the block was again heated at 235°C for 2 hours until the liquid was clear. The tube was allowed to cool to room temperature and 1.0 ml of hydrochloric acid was added. The solution was again digested at 150°C for 20 minutes. The sample was allowed to cool and then transferred into a 100 ml volumetric flask. Distilled water was added to make up to 100 ml. The flask was thoroughly shaken and was allowed to stand overnight. The sample was then run on a Technicon Autoanalyzer.

## CHAPTER IV

### RESULTS AND DISCUSSION

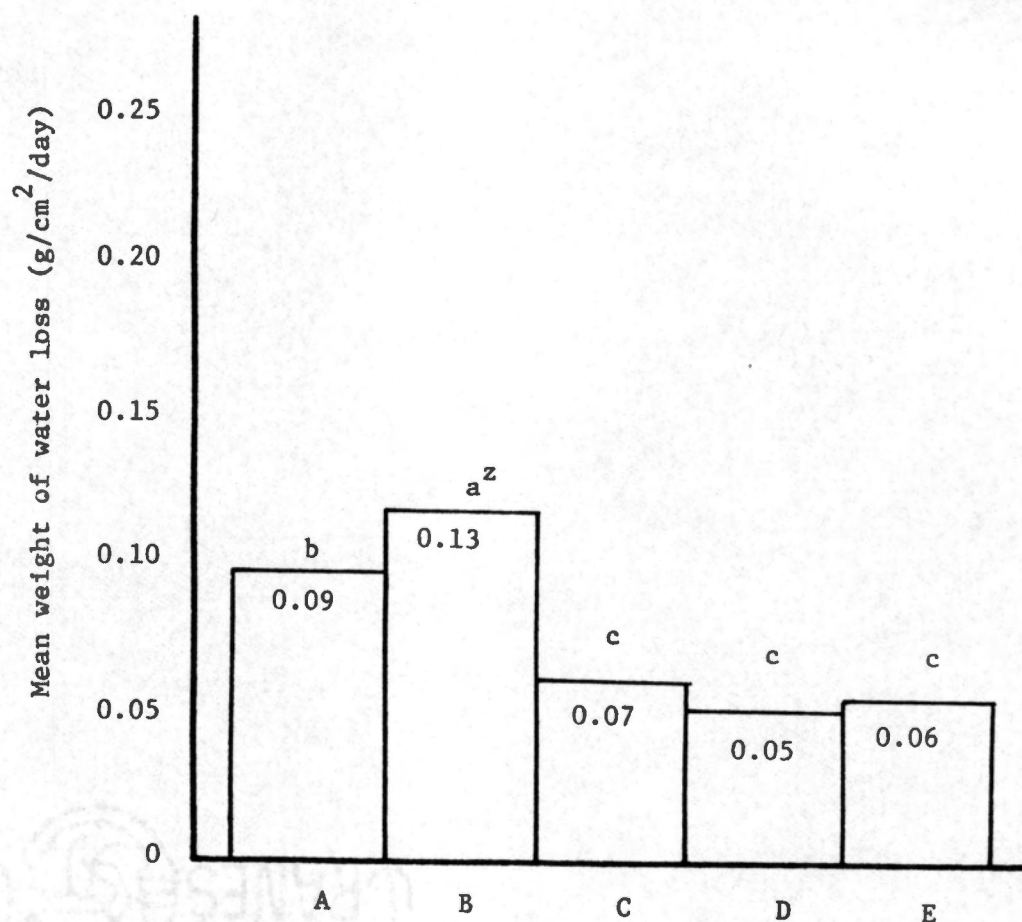
#### Experiment I

An analysis of variance and a mean separation using a planned F-test at the 5% level was performed on the weight of water lost from 'Compacta' holly cuttings. There was a significant difference in water lost among treatments. Control and phenylmercuric acetate were different from each other and all other chemicals; however, no significant difference was observed between the weights of water lost from cuttings treated with Wilt Pruf NCF, Vapor Gard and B-Nine SP (Figure 1).

Cuttings treated with phenylmercuric acetate lost the greatest amount of water. This is contrary to the findings of other researchers who showed phenylmercuric acetate to be an effective stomata-closing antitranspirant when used at a low concentration. However, phenylmercuric acetate has not been used before on 'Compacta' holly. Also, it is likely that the high leaf damage rating of the chemical contributed to its low effectiveness (Table 3).

Cuttings treated with Wilt Pruf NCF lost the least amount of water and exhibited low phytotoxicity. Vapor Gard effectively reduced water loss and was the least phytotoxic of all chemicals used.

For 'Coral Bells' azalea, only data for the control, Wilt Pruf NCF and Vapor Gard treated cuttings were available for analysis because those treated with phenylmercuric acetate and B-Nine SP were killed by treatments.



A = Control, B = Phenylmercuric acetate,

C = B-Nine SP, D = Wilt Pruf NCF, E = Vapor Gard.

<sup>z</sup>Mean separation using a planned F-test at 5 percent level.

Figure 1. Mean weight of water loss per cm<sup>2</sup> per day from Ilex crenata 'Compacta' cuttings.

Table 3. Leaf damage rating for Ilex crenata 'Compacta' and Rhododendron obtusum 'Coral Bells' given as percent leaves damaged\* by treatments.

Treatments	'Compacta' holly	'Coral Bells' azalea
Control	0.8	27.2
Phenylmercuric acetate	75.9	100.0
B-Nine SP	25.4	100.0
Wilt Pruf NCF	1.8	22.7
Vapor Gard	0.7	10.6

\*Damage ranged from small chlorotic or necrotic spots to those affecting the whole leaf.

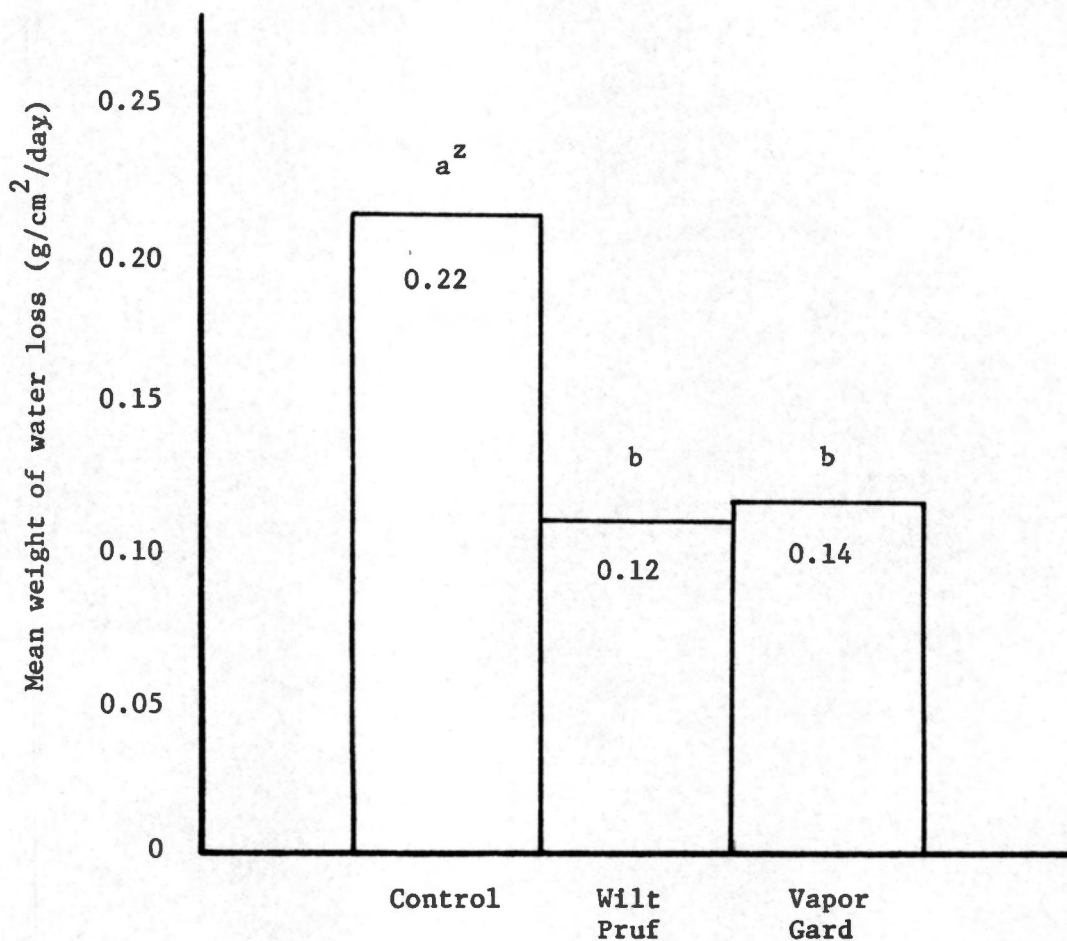
An analysis of variance on weight of water lost from cuttings showed a significant effect due to treatments. Both antitranspirants reduced water loss below the control but were not different from each other (Figure 2). Cuttings treated with Wilt Pruf NCF lost the least amount of water. The leaf damage ratings for Wilt Pruf NCF and Vapor Gard were low (Table 3).

Phenylmercuric acetate was less effective in reducing water loss for both 'Compacta' holly and 'Coral Bells' azalea at the selected concentration. The severe leaf damage may account for its ineffectiveness and is attributed to the uneven distribution of the chemical on the leaf surfaces. A wetting agent was not used because it may have caused more damage (34). A lower concentration of the chemical may have been more effective.

B-Nine SP was not suitable at the selected concentration for use on either plant due to its high phytotoxicity. Also, B-Nine was found to be unsuitable by others (31) for use as an antitranspirant because of its mechanism of action in closing the stomata.

Leaves of 'Coral Bells' azalea were more susceptible to chemical damage as compared to 'Compacta' holly. The greater pubescence and external morphology of azalea leaves may account for the damage. All leaves sprayed with Wilt Pruf NCF and Vapor Gard were shiny in appearance which may have increased reflectivity.

Based on their performance as described above, Wilt Pruf NCF and Vapor Gard were selected as suitable for use on 'Compacta' holly and 'Coral Bells' azalea.



<sup>z</sup>Mean separation using a planned F-test at 5 percent level.

Figure 2. Mean weight of water loss per cm<sup>2</sup> per day from Rhododendron obtusum 'Coral Bells' cuttings.

## Experiment II

An analysis of variance was performed on data collected from the rooting experiment. There were no significant treatment differences in the mean number of roots per cutting (Figures 3 and 4) and the mean length of the longest root per cutting (Figures 5 and 6) between Wilt Pruf NCF, Vapor Gard and mist control for 'Compacta' holly and 'Coral Bells' azalea.

The leaf damage rating was low for 'Compacta' holly cuttings treated with Wilt Pruf NCF. No leaf damage was observed on cuttings treated with Vapor Gard and mist (Table 4).

However, 'Coral Bells' azalea leaves exhibited leaf damage when treated with Wilt Pruf NCF, Vapor Gard and mist. The leaf damage rating for Wilt Pruf NCF was the highest followed by Vapor Gard and mist.

The quantitative analysis of nutrient elements performed on cuttings to determine the effects of Wilt Pruf NCF, Vapor Gard and mist on N, P, K, Ca and Mg content after rooting was inconclusive (Tables 5 and 6). Apparent differences occurred between treatments. However, there was a highly significant treatment x block interaction. This precluded discussion of individual treatment effects on nutrient content of cuttings. Apparently too few replications were utilized or environmental conditions were so different that major variation occurred in blocks.

P and K content of 'Compacta' holly cuttings was consistently lower in treated cuttings than untreated cuttings except for K content of cuttings under mist. Ca content was consistently higher in treated cuttings than control cuttings. There were inconsistencies in the



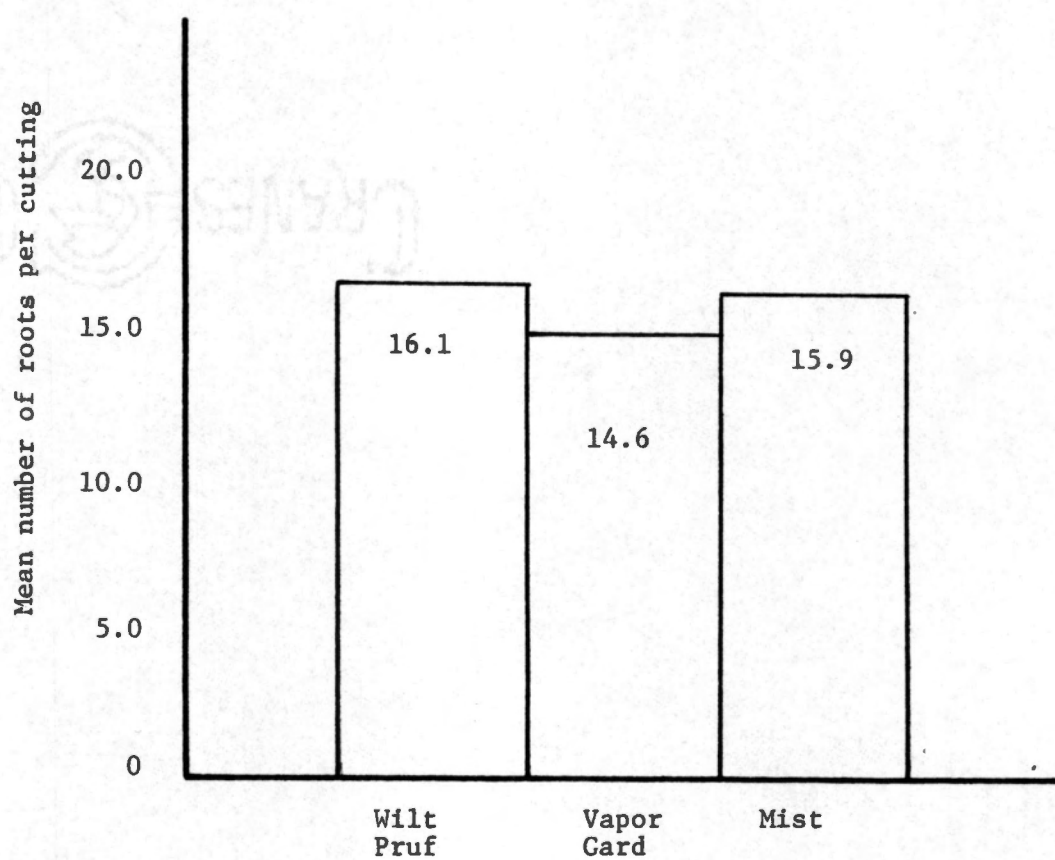


Figure 3. The mean number of roots per cutting of Ilex crenata 'Compacta' under three treatments.

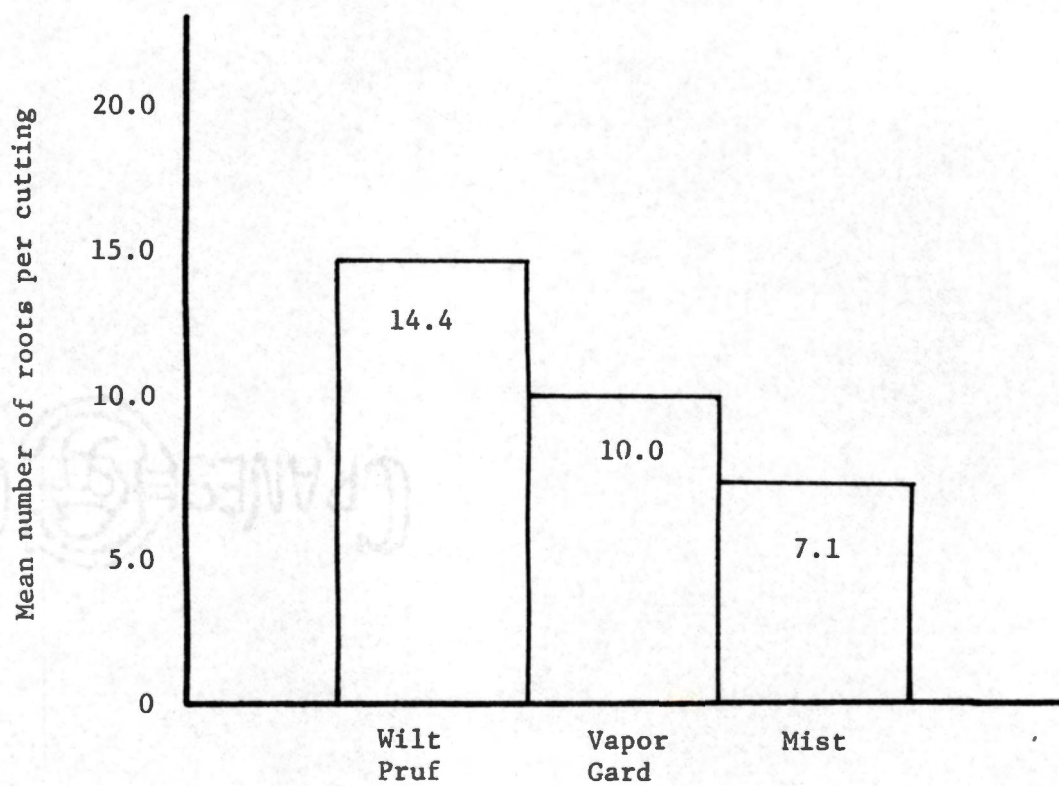


Figure 4. The mean number of roots per cutting of Rhododendron obtusum 'Coral Bells' under three treatments.

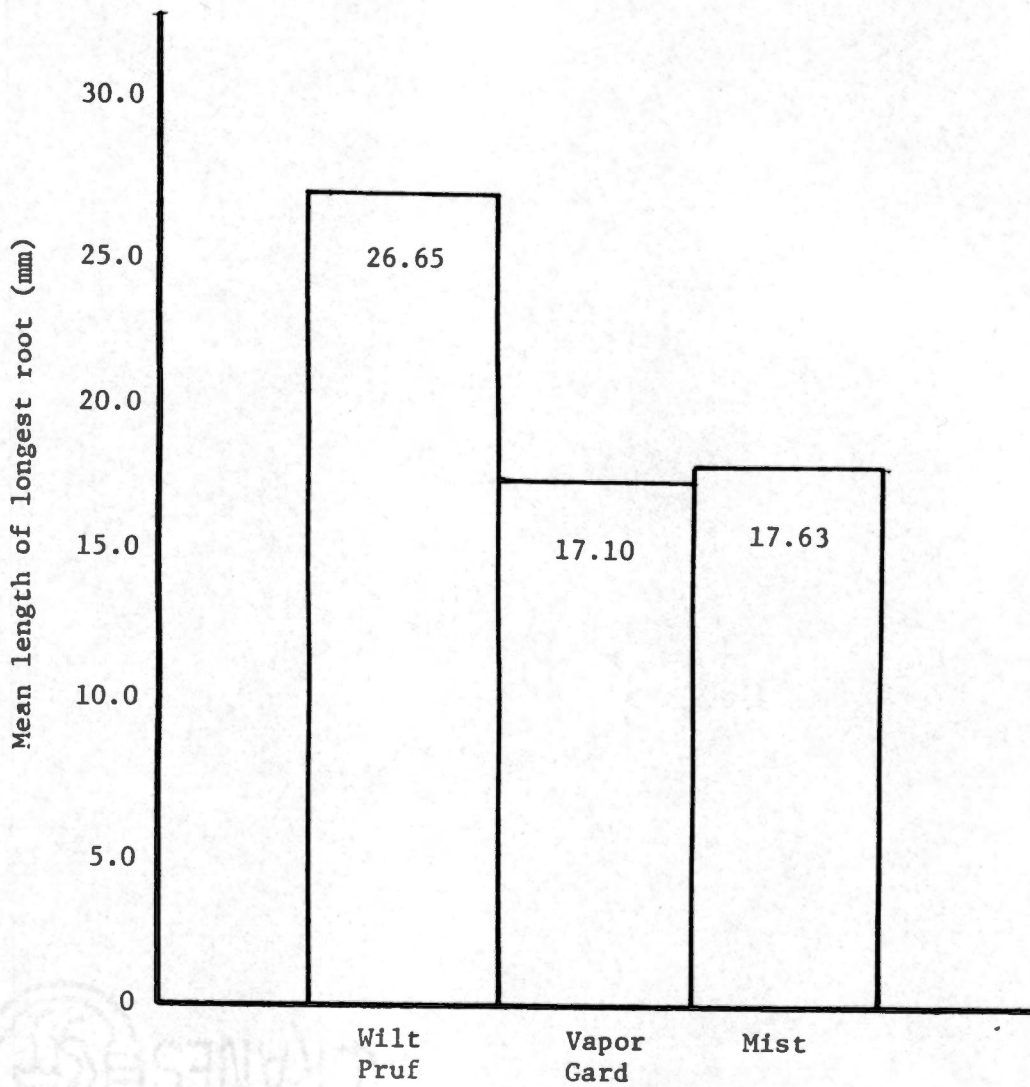


Figure 5. The mean length of the longest root of Ilex crenata 'Compacta' cuttings under three treatments.

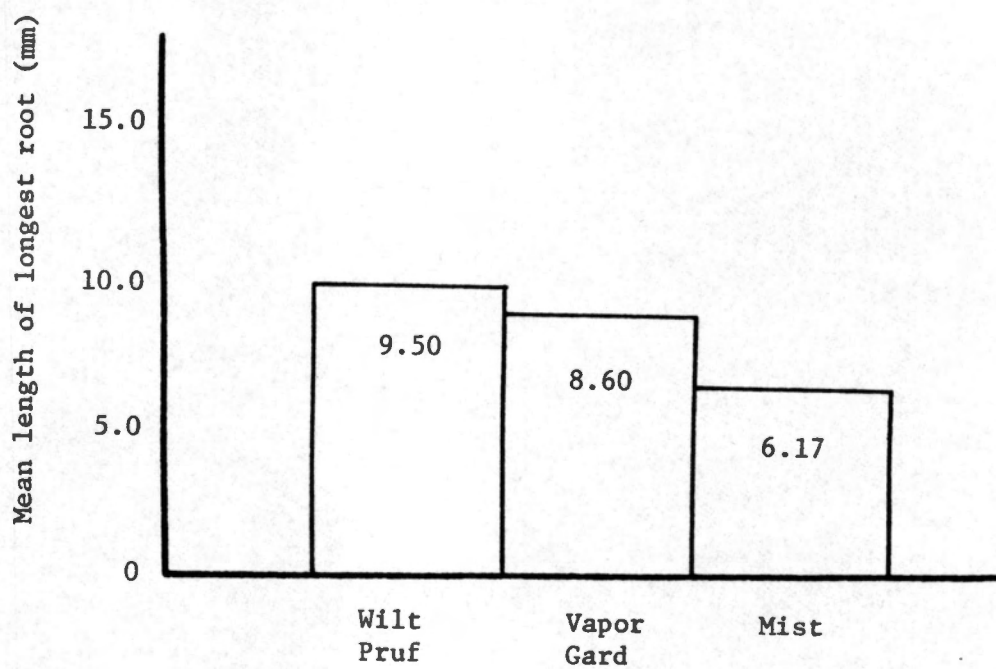


Figure 6. The mean length of the longest root of Rhododendron obtusum 'Coral Bells' cuttings under three treatments.

Table 4. Leaf damage rating for Ilex crenata 'Compacta' and Rhododendron obtusum 'Coral Bells' given as percent leaves damaged\* by treatments.

Treatments	'Compacta' holly	'Coral Bells' azalea
Wilt Pruf NCF	5.0	50.5
Vapor Gard	0	24.0
Mist	0	11.0

\*Damage ranged from small chlorotic or necrotic spots to those affecting the whole leaf.

Table 5. Mineral content (mg per sample) of *Ilex crenata* 'Compacta' cuttings before and after rooting using intermittent mist, Wilt Pruf NCF and Vapor Gard.

Block	Treatment	D.W. (g per sample)	Nutrient (mg per sample)				
			N	P	K	Ca	Mg
	Before	0.25	4.60	0.60	2.28	1.80	0.93
I	Mist	0.36	4.50	0.54	2.41	4.93	1.19
	Wilt Pruf	0.32	4.61	0.48	1.92	2.91	0.86
	Vapor Gard	0.29	4.03	0.52	2.00	2.70	0.84
II	Mist	0.39	5.11	0.55	2.15	4.68	1.13
	Wilt Pruf	0.36	4.68	0.58	2.05	3.71	4.75
	Vapor Gard	0.33	4.95	0.56	2.01	3.96	1.12

Table 6. Mineral Content (mg per Sample) of Rhododendron obtusum 'Coral Bells' Cuttings Before and After Rooting Under Intermittent Mist, Wilt Pruf and Vapor Guard

Block	Treatment	D.W. (g per sample)	Nutrient (mg per sample)				
			N	P	K	Ca	Mg
	Before	0.35	5.36	0.67	2.73	3.50	0.81
I	Mist	0.44	3.56	0.48	2.11	4.93	1.36
	Wilt Pruf	0.36	2.81	0.40	2.09	3.35	0.79
	Vapor Gard	0.41	3.32	0.45	2.17	3.73	0.82
II	Mist	0.49	4.51	0.59	2.55	6.62	0.12
	Wilt Pruf	0.34	3.88	0.54	2.41	3.47	0.99
	Vapor Gard	0.26	2.65	0.31	0.18	2.89	0.55

amount of N and Mg. The average nutrient content of rooted cuttings in percent dry weight were as follows: N = 1.37%, P = 0.16%; K = 0.62%; Ca = 1.11%; and Mg = 0.47%.

In 'Coral Bells' azalea rooted using mist and both antitranspirants, N, P and K content was lower than control cuttings. However, Ca and Mg content was inconsistent. The average nutrient content of rooted cuttings in percent dry weight were as follows: N = 0.91%; P = 0.12%; K = 0.58%; Ca = 1.07%; and Mg = 0.25%.

Nutrient content expressed as percent dry weight was lower in azalea than holly cuttings.



## CHAPTER V

### SUMMARY AND CONCLUSIONS

#### Experiment I

Untreated cuttings of Ilex crenata 'Compacta' lost significantly more water to transpiration than cuttings treated with the antitranspirants B-Nine SP (5000 ppm), Wilt Pruf (10% v/v) and Vapor Gard (2.5% v/v). Cuttings treated with phenylmercuric acetate (200 ppm) lost significantly more water than untreated cuttings. There was no significant difference in the amount of water loss between cuttings treated with B-Nine SP, Wilt Pruf NCF and Vapor Gard. Leaf damage to cuttings treated with Wilt Pruf NCF and Vapor Gard was low. Although B-Nine SP significantly reduced transpiration, it caused moderate leaf damage. Phenylmercuric acetate was ineffective in reducing transpiration and caused severe leaf damage.

Untreated cuttings of Rhododendron obtusum 'Coral Bells' lost significantly more water to transpiration than cuttings treated with Wilt Pruf NCF (10% v/v) and Vapor Gard (2.5% v/v). There was no significant difference in water loss between cuttings treated with Wilt Pruf NCF and those treated with Vapor Gard. Leaf damage to cuttings treated with Wilt Pruf NCF and Vapor Gard was low. However, Vapor Gard was less toxic than Wilt Pruf NCF.

No data was available for cuttings treated with phenylmercuric acetate and B-Nine SP because they were severely damaged by the treatments.

It is concluded that Wilt Pruf NCF and Vapor Gard at the concentrations used in this study were effective in reducing transpiration and were low in toxicity to 'Compacta' holly and 'Coral Bells' azalea. Phenylmercuric acetate and B-Nine SP were not suitable for use on these cultivars because of their high toxicity.

### Experiment II

There was no significant difference in the mean number of roots per cutting and the mean length of the longest root per cutting for 'Compacta' holly and 'Coral Bells' azalea rooted under mist and rooted using Wilt Pruf NCF and Vapor Gard.

Cuttings treated with Wilt Pruf NCF had more leaf damage than those treated with Vapor Gard or those rooted under mist. Greater leaf damage occurred on 'Coral Bells' azalea than on 'Compacta' holly. It is suggested that the azalea leaves are more subject to damage because of their pubescence.

The effect of leaching on N, P, K, Ca and Mg in cuttings was not determined statistically because of a highly significant treatment x block interaction. The reasons for the interaction are unknown but environmental conditions in the greenhouse were more variable than suspected or insufficient replications were employed.

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## VITA

The author, Mustafa-Kamal Bin Mohd.-Shariff, was born in Taiping, Perak, Malaysia on December 11, 1953. He attended Sekolah Kebangsaan Assam Kumbang, Taiping and later continued his studies at the King Edward VII Secondary School, Taiping.

He entered the Universiti Pertanian Malaysia, Serdang, Selangor in 1972 and obtained his Diploma in Agriculture three years later in June of 1975. On graduating he became an Agriculture Assistant with the Malaysian Department of Agriculture at the Agriculture Training Center, Selama, Perak until December of 1975.

In January of 1976, the author came to the United States of America and enrolled in the undergraduate program at Louisiana State University, Baton Rouge where he received his Bachelor of Science degree in Horticulture in December of 1977.

The author joined the graduate school at The University of Tennessee, Knoxville in March of 1978 and received his Master of Science degree, with a major in Ornamental Horticulture and Landscape Design in March of 1980.