TEMPERATURE MANIPULATION USING WATER

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Temperature manipulation using water is a major concern of our nursery operation. We are located on the Eastern shore of Maryland and subject to frosts as early as the first part of October.

To explain why temperature manipulation using water is so important to us. I would mention that about 8 years ago we shifted our complete growing operation into wholesale production of broad-leaved evergreens. Our goal was to produce a full, dense, premium quality plant for the discriminating garden center and landscape contractor in the Northeastern United States.

We propagate practically all of our plants and grow them over the first winter in heated fiberglass houses. The transplants are lined out in raised beds the following spring, grown on for two or three years, then dug by hand and shipped in fiber containers.

These plants are vulnerable to frost and freeze damage, particularly the one year old plants. Distressed at severe damage from early fall frosts in 1968, we decided to experiment with water as a method for the prevention of frost and freeze damage.

Over the past 7 years we have developed a system of frost protection using our solid-set irrigation. Although we do not consider it 100% foolproof, we do consider it a vital and necessary part of our operation.

It is the best insurance we have against the extreme hazard of catastrophic damage by early fall and late spring frost or freeze.

For years we have used shade lath over the plant beds, and it offers some protection by holding in the ground heat and moderating the temperature fluctuation. Other nurseries use protective coverings of cloth or burlap. Several nurseries in our area store their finished plants in wooded areas.

All of these measures are helpful, but it is impossible for us to have a protective covering over 500,000 plants when a 25°F temperature and a frost comes as early as October 3rd.

This is made possible due to the release of heat when water turns to ice. As we irrigate, ice forms and heat is given off, some to the plants, some to the ground, and some to the air. Thus the temperature under the ice stays at 32°.

The watering must be continued until the air temperature rises enough to melt the ice completely off the plants. This necessitates a dependable supply of water. We pump from an 11 acre pond.

We have kept soft plants from stem-splitting during extremely heavy freezes, but it requires a lot of water and a heavy build-up of ice. Most of the azaleas and *Ilex* which we grow can withstand a fairly heavy ice load. Some more limber plants such as *Pieris*, *Rhododendron*, and *Ligustrum* sustain more breakdage due to the ice load.

Our solid-set irrigation system consists of 1-1/2" PVC pipe lateral lines with No. 20 TNT Rainbird Sprinklers spaced 40' × 40' offset. We use a small nozzle, 7/64", and try to maintain 40 lbs P.S.I. pressure. These sprinklers apply about 2.2 g.p.m., or about 0.13 inches of water per hour. The sprinklers should rotate 360° at least once per minute.

Our soil is a Matapeake loam with a slow absorption rate. It is often necessary to run the system for 8-10 hours or more which results in too much surface water. This is a distinct disadvantage if you need to get into the block for shipping purposes or other operations.

At any time when there is a chance of a frost or freeze, fall or spring, we have a 2-man team on "Frost Watch". Thermometers are in place at plant level. Temperatures are checked hourly. When the temperature drops to 33°F we turn the system on. During a time when the chance of frost is slight (cloudy or windy) I usually check the top of a vehicle out in the open. A glaze of frost will form there very quickly if frost is imminent.

The "Frost Watch" team checks regularly for any pressure drops indicating leaks or ruptures in the irrigation system. Also, they make sure sprinklers are kicking around. I repeat, the water is not turned off until the ice is completely melted.

Even though we have used this method of temperature manipulation for several seasons, I feel there is much we do not know about frost and freeze control. One example is, "When are the plants hardy enough to withstand a frost or freeze without protection? Is fall foliage color a good indication?" Also, "When unusually warm weather in late November occurs, is the plant, which had become hardy, again subject to frost or freeze damage?"

So far I have dealt entirely with temperature manipulation at the freezing or near freezing levels. There is, of course, a desirable manipulation of temperature by water when the air temperatures reaches high levels near or above the 90°F mark. During May or June, when these temperatures occur, we turn the water on tender transplants for 5-15 minutes. This can prevent

sun scorch and is very beneficial to newly planted material. Temperature manipulation in our propagation houses is done by means of an intermittent mist system.

The use of water to manipulate temperatures is indeed a useful and necessary part of growing broad leaved evergreens.

JOHN MACHEN: Jim Fountain, on this chiseling-in process, how thoroughly does the gypsum have to be plowed in? Also, would you tell us how this reacts with soil that has very fine sand particles in it that tend to compact and therefore does not drain well? You dealt mainly with clay soils. What about sandy soils?

JIM FOUNTAIN: Chiseling is done to make sure that if a plow-pan is present it is broken up. It is not done to get the gypsum down. Harrowing would be as good as turning the soil and probably better. Gypsum is a clay soil conditioner; it does not affect sand because sand has virtually a 0 CEC rating.

JAKE TINGA: I have a pin oak that I'm putting in a clay in a 2 × 2 × 1 foot hole and I'm going to put some plant food pills down in the bottom of it. Would you recommend I put 3 or 4 cups of gypsum in the bottom of the hole too?

JIM FOUNTAIN: No, not in the bottom of the hole. Spread it around on the surface uniformly and water it in. You want the clay to break up all the way from the top to the bottom.

JAKE TINGA: But the poor drainage is in the bottom of the whole.

JIM FOUNTAIN: Well, put it in the bottom then.

JOHN ROLLER: In a loose soil with a 4.5 pH, can gypsum furnish calcium to the plants?

JIM FOUNTAIN: Yes, and this also holds true for Florida sandy soils.

DICK AMMON: We have a clay loam soil and the way I understand it, our soil is like toothpaste and this gypsum is going to make it like popcorn? How often and about what rates should we apply gypsum and should it be plowed under or disked in the top and can we surface broadcast it in shade tree rows?

JIM FOUNTAIN: I tried to point out that gypsum is not a "cure-all." No, we're not going to make popcorn out of your toothpaste, but we can improve your soil structure. The normal rate is from 2-5 tons per acre. Gypsum does alter soil pH to some degree. For every ton you apply the pH will drop by 0.1 pH unit. Frequency depends on rainfall patterns; the more rain, the sooner it leaches out of the soil profile. We recommend early fall and a late spring application. Even though gypsum is

water soluble, for best results it should be incorporated to prevent surface runoff from carrying it off. We have found that if 5 lbs/yd^3 gypsum is mixed with sterile potting soil it will help in suppressing *Pythium* attacks at times when the soil might be overwatered, as for instance in freeze protection. We have also found that when you use gypsum in azaleas and camellias, you get a better growth in the spring.

DICK AMMON: When gypsum leaches down does the soil become like it was?

JIM FOUNTAIN: Yes. Organic matter helps to overcome the leaching, though.

JUDD GERMANY: Dick Marshall, you were talking about near freezing temperatures. Have you successfully used water protection in really cold weather, say 10°F and below?

DICK MARSHALL: No, we have not. We feel from all the information we have, though, that this would not work at such low temperatures; 22°F should be about as low as this will work.

JOHN ROLLER: Dick, is this technique effective under low humidity and high winds at 24-30°F temperatures?

DICK MARSHALL: Yes, in that range we certainly can get protection with this system. Even water distribution is harder in a wind, though, and this is essential for good protection. I might point out that we are talking about plants in the field; container growing is a different proposition.

CHARLIE PARKERSON: Gerald, you mentioned root growth in relation to top growth. We can stimulate top growth by pruning at the right time of year. Is what you say based on research?

GERALD SMITH: No, this is not based on any research to my knowledge at all. I've knocked thousands of plants out and root growth is one of the things I was interested in. If that root system is "sitting still", I just don't see any top growth occurring. Does anybody disagree with me on that?

BRYSON JAMES: Gerald, not in containers, but certainly in field grown stock we quite often see top growth start in early spring before there is much root activity — and likewise, you get root activity in the fall for much longer than you get top growth — this may be different from what you are talking about, but it is something to consider. I follow what you are saying although I'm not sure of the relationship between field conditions and containers. I believe you could get air temperatures permissive of top growth before the soil warms up enough to promote root growth.

GERALD SMITH: Roots begin growth about 10°F cooler than the shoots, generally.

BRYSON JAMES: Yes, but the air warms up very rapidly in spring compared to the soil.

CHARLIE PARKERSON: Our plants seem to make better roots in the fall and growth begins in spring with the roots already to the bottoms of the containers. By August we're losing roots.

BOB WRIGHT: If you come back next year we may have the answer to this. We are investigating root growth of hollies and rotundifolia hollies which grow in flushes and we want to see if root growth is related to shoot flushing. Early indications point to root growth followed by shoot growth.

LANNY NEEL: Dick Marshall, you asked a question as to how you can tell if a plant is winter hardy. In experiments, the last several inches of stem sections were frozen at lower and lower temperatures, then thawed. Electrodes hooked up to the stems to measure electrical resistance across the stem can detect when the cells rupture (due to freezing) which allows the cell sap to escape into the woody tissues of the stem. One can be precise with this method and can use it to accurately predict winter hardiness. This would become even more useful if records and observations were kept over several years.

GERALD SMITH: Ed Brown, would you tell us whether your results in Florida have been similar to Dick's?

ED BROWN: The only real experience we ever had was on December 13, 1962, when the temperature dropped about 50°F in about 45 minutes around noon. We decided to turn on the sprinklers that night when the temperatures got down to 34°F and we left them on all night and straight through the second day and night. We did not melt the ice off the plants, but we did turn the water off when the temperatures got up to about 38° and warmer weather was predicted. A neighbor of ours used Rainbird #20 sprinklers on his groves and they froze because not enough water was put out fast enough. We have #40 heads and we had no damage.

DICK MARSHALL: We have a neighbor who used to grow about 40,000 outdoor azaleas about three years ago. He turned on his irrigation system about 3 AM to try to protect against a frost and by 6:30 he ran out of water in his small supply pond. He lost all of his plants. That same day we ran ours until the ice was completely melted off and we had no damage.

ED BROWN: I would say that the reason why his plants froze was because the temperatures were still below freezing when his water ran out and not because he did not wash the ice off. You should turn the water on and off when the temperature reaches 36°F because of the chill factor.

GRADY WADSWORTH: There's an excellent publication

available about frost protection put out by the University of Washington in 1974, and it says to leave the water on until ice stops forming and free water is on the surface of the ice, or else freeze injury can occur.

DICK STADTHERR: As far as electrical conductivity tests go, I've conducted quite a lot of them and I would like to caution you that there is quite a bit of difference between cultivars. We tested roses and found as much as 10° difference between cultivars. The University of Minnesota is doing quite a bit of work on the onset of hardiness and I think there are some newer tests out than the electrical resistance method.

ROBERT WRIGHT: Measuring electrical conductivity requires special instruments which a nurseryman might not have. On the other hand, you can determine when the tissue is damaged by freezing; you can take leaves and put them in distilled water and shake them. If there has been injury the soluble salts will escape from the damaged cells and cause the conductivity of the water to increase markedly.

HUNTER BOULO: Robert, what kind of reading would you expect on the solubridge to know if you had damage?

ROBERT WRIGHT: This is a relative thing; you'd have to compare uninjured leaf wash water to injured leaf wash water to determine this. We hope to have a paper out soon in *HortScience* on the effect of the nutritional status of the plant and freeze damage.

CHARLIE PARKERSON: Charlie Johnson, water is getting more and more scarce and we're hearing about salt water intrusion. I feel that we've got to conserve every drop of water we can and recycle it. How do you feel about the use of persistent insecticides and herbicides which might accumulate in the water?

CHARLES JOHNSON: Changing pesticide use patterns and the installation of filters can reduce the hazard.

JAKE TINGA: Grady, what do you do in Texas when the wind blows the water away?

GRADY WADSWORTH: We block plants adjacent and make wider beds and use portable sprinkler heads strategically located on corners.

PHIL BEAUMONT: Grady, I heard you say you used lime to solidify mushy areas under your plastic. How did you do that?

GRADY WADSWORTH: We got this from the Texas Highway Department. We lime stabilize the ground with 10 lbs of commercial powdered lime per square yard. Check with your state road department; they'll know more about stabilizing land than anyone else.

GERALD SMITH: Has anyone had any experience with irrometers?

CHARLIE PARKERSON: I was reading what Mr. Flemmer at Princeton nursery had said. He puts them around selected indicator plant material and calibrates them that way. Mr. Hill of the D. Hill Nursery had tried them in 1952 and he didn't like them at all. Fred has used the bake-o-lite blocks on field stock and had very good results with them.

EARL ROBINSON: Were you referring to these electronic probes? I've had experience with a hand probe in New Jersey where I've stuck it in a glass of pure water and it read about 10% wet. After putting some table salt in the water it read 100% wet. Apparently it is based on conductivity and you might have to use relative comparisons under similar watering procedures to get any value from them.

BOB WRIGHT: Tensiometers and blocks were developed for use in field soils. The large pore spaces of container media interfere with their proper function.

BRYSON JAMES: Jake Tinga suggested a long time ago, and Charlie mentioned it again, use an indicator plant. A bean is a good one; it wilts quickly and can be easily removed.

QUESTION BOX

Bryson L. James, Moderator

1. What effect does the use of systemics have on the rooting of cuttings? — (systemic insecticides, fungicides)

CHARLIE PARKERSON: We use Meta Systox-R and Benlate with success on Japanese holly and Junipers.

BRYSON JAMES: As far as effects on rooting of cuttings, has anyone experience with this? I know that work done at N.C. State a number of years ago showed no effect of materials sprayed on the foliage on rooting of cuttings; I've done some work on this and had similar results.

VOICE: Does this hold true with Benlate and Truban used on soils to prevent fungus diseases? I've heard some greenhouse operators say that these will affect rooting when used in soils.

BOB WRIGHT: With herbicides, we found no effect on cuttings unless the stock plants were damaged.

MIKE McCALL: We use Banrot on all our cuttings and don't see any bad effects from it.