Stress: the Silent Killer©

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INTRODUCTION

Plant stress is a problem that can have immediate or longer-term consequences. While individual stressors, such as hail damage, can be identified as a single cause of plant problems it's more common to have more than one stressor involved. Multiple stressors can result in damage either concurrently or sequentially.

My definition "stress" is the condition where an environmental factor or factors exceed the natural regulatory capacity of a plant and results in decreased growth or performance. Why do growers become frustrated when told that the problem is due to stress? To maximize returns, nurserymen need to control as many production variables as possible and stress is typically unpredictable and not always manageable.

Plants are adapted to their native habitat so a key factor in diagnosing stress-related injury is to understand environmental factors that make up the habitat in which they perform best. Important environmental factors include temperature, moisture (including humidity), light quantity and quality, wind or the lack thereof, soil characteristics, and nutritional needs. Each part of the plant's native environment when compared to a new environment helps identify how well a plant adapts.

While it may be stressful, without being able to grow plants outside their native habitats the nursery industry wouldn't exist. Changes, and especially extreme changes, can result in plant damage. Because of limited environmental niche options and the desire to maximize growth while seeking to control growth characteristics, perhaps one of the most stressful locations for a plant to grow is in the nursery. Some plants, however, are more adaptable than others.

It's important to identify locations in the nursery where plants can maximize growth while developing structural characteristics (straight leaders, appropriate branching, good foliage density, etc.) needed for sales. While there are exceptions to rules, deciduous plants tend to adapt better to exposed sites than evergreens. Broadleaved evergreens generally do better in partial shade than full shade (because they can get leggy) or in full sun (because they can burn). Evergreens that have a heavy leaf cuticle, however, will perform fairly well under warmer conditions and low growing broadleaved evergreens may actually make up a better plant in full sun than in the shade. Root systems are also a factor with shallow and fine-rooted plants generally not performing as well in light soils as coarser-rooted plants. Plant hybrids take on characteristics from each parent and will result in environment adaptability differences. Of course, there are exceptions to every rule.

Nurserymen can generally see a plant going off-color and recognize the gradual decline of an optimally performing plant to a poorly performing plant. The best chance of optimizing growth occurs when one can identify the earliest stages of decline and initiate a remedy quickly. One needs to remember that damage from environmental stressors can cause a range of symptoms on different types of plants so it's critical to be able to see the decline. Ultimately there may be a threshold point when a plant moves from poorly performing to a non-recoverable (dead) status. Recognize that it's much easier to identify poorly performing plants in a crop of good plants than when a group of plants is generally or gradually declining.

EXAMPLE 1: CATCH THE PROBLEM EARLY

Samples of rooted periwinkle cuttings were brought to the office because they weren't growing. They had been transplanted into cells in the late fall but the crop had made little progress in over 2 months. An examination of the roots showed they had not grown. I tested the pH of the medium and it resulted in a reading of 4.3. I recommended application of pelletized dolomitic lime. Figure 1 was taken about 3 weeks after treatment and roots had already started to grow but foliage was still weak.

Fig. 1. Periwinkle (*Vinca*) 3 weeks after pelletized dolomitic lime application.

Fig. 2. Plant growth by early April after pelletized lime application.

My diagnosis was that the *Vinca* had a pH threshold effect that caused cessation of root growth. Because of the fine mesh size of pelletized lime (finer than pulverized lime), it worked quickly and by early April (Fig. 2) the pH was 5.1. By that date, 50% of the crop had been sold, 40% were coming on strong and 10% were un-saleable. The bottom line is to catch the problem early while there is a chance for recovery.

Growers need to anticipate stressors that may arise. Container growers prepare for cold winter temperatures by constructing and covering structures used in container production with white (milky) polyethylene. When covered, low temperatures inside the structure are increased and high temperatures are reduced. Inside air movement is also reduced while humidity is increased and medium moisture (the most important protection against root cold damage) is maintained. The ability to add summer shade to these structures can also reduce summer stress or impacts.

For field production, hedgerows reduce the impact of wind, provide some shade, somewhat increase humidity and help maintain soil moisture. Locating plants sensitive to late-spring and early fall frost higher on slopes helps reduce frost problems. Plants sensitive to excess moisture may also perform better higher on slopes because soils tend to be lighter as finer textured particles are moved down the slope and accumulate in the lower areas due to erosion.

When natural stressors can be anticipated, they can be managed. Sometimes however, stressors, and especially combinations of stressors, such as hail, excessive snowfall, ice, excessively high wind events and very low humidity cannot be avoided or even managed.

EXAMPLE 2: TIMING IS EVERYTHING

A grower had an older Quonset-style propagation house that, following a major snowstorm, was piled high with snow. The snow was followed with freezing rain that created heavy wet load on the structure and that resulted in his son's concern about the potential for snow-load damage. The father didn't think it would be an issue but allowed his son to place supports in the structure, reducing the son's concerns. After the snow melted off the structure the supports were short of the ridge by about six-inches. His son, in all probability, saved the structure and the crop.

Timing is everything in nursery operations. Whether irrigating early enough to avoid having wet foliage going into the night to reduce foliar diseases, controlling weeds before they have time to establish and set seed, identifying insect issues before populations get out of control, or selling plants at the time of flowering; all result in reducing operational inputs or maximized returns.

Timing, as related to the stage of growth of a plant, may be the most important factor involved in stress-related damage. Over the years I have seen many instances of the same type of plants growing in essentially the same location where one has damage symptoms and the one next to it does not. For most of these issues, the plant's stage of growth at the time of stress was the only variable option that I could attribute to the problem.

I was called to evaluate damage on young fir trees where new growth had foliar burn. The most severe damage was on the south side of the plant while the eastern and western exposures had partial damage and the north side had none. The cause of the problem was a combination of the plant being in a susceptible stage of growth (the plant had de-hardened and buds had begun to swell) and the exposure to high levels of sunlight. In the early spring, the combination of new growth and heat buildup caused by the angle of incidence of sunlight being more directly focused on the side of the plant will result in this type of damage.

Stage of growth issues not only relate to environmental damage but also to chemical damage. The application of chemical sprays when growth is succulent has a much higher probability of damage than application on mature foliar growth.

The *Hydrangea paniculata* plants pictured below (Fig. 4) had what appeared to be a chemical burn. Plants that were near or at flowering did not exhibit damage while almost all the plants in a vegetative growth stage were damaged. The only variable was related to an application of a pyrethroid that occurred during a susceptible stage of growth.

Fig. 3. Young fir trees where new growth had foliar burn.

Fig. 4. Stage of growth issues relate to chemical damage on *Hydrangea paniculata*.

EXAMPLE 3: A COMBINATION OF STRESSORS ON PLANT GROWTH

Combinations of stressors will typically result in much more damage than individual stressors and those combinations can occur concurrently or sequentially. As a baseline, think about a hemlock (*Tsuga canadensis*) under high sunlight conditions as a single stressor. Add in high temperature that causes additional stress on this understory plant. Combine those with low soil moisture, reducing the ability of the plant to transport enough moisture to the leaves. Next, include low humidity into the equation that creates even more demand for water and follow that with high winds. This scenario creates almost the "perfect storm" for creating stress-related plant damage. The photo of hemlock leaves depicts the resulting damage (Fig. 5).

Plants under stress are more likely to have secondary problems. Those problems can include disease infection, infestation by insects, and increased susceptibility to other environmental plant stressors.

Fig. 5. Illustrates the results of a combination of stressors on hemlock.

We have monitored for exotic bark beetles using traps with various lures as attractants. Lures included ethanol and α-pinene along with some more sophisticated pheromones. Why ethanol and α-pinene? As trees are stressed, one of the biochemical products generated is ethanol while the strong pine tree smell is α-pinene. The strong pine smell of α-pinene is the same smell one senses when sap exudes from trees under stress from cankers, insects, broken branches, or even pruning cuts that weep pitch. Both the ethanol and α-pinene attract insects that will do further damage to trees.

EXAMPLE 4. DIAGNOSING PLANT PROBLEMS REQUIRES EACH OF US TO BECOME DETECTIVES

There are clues that need to be identified and correlated so a solution can be found. There are often times when interviews with those who work closest with the crop will generate very useful information. Tests previously conducted may also help in finding a solution. The key, however, is to proceed in a logical progression toward the solution. Be sure your procedures will not taint the outcome. Review the methods by which information developed by others is determined. Sometimes it's better to start with a clean slate

Top growers in our area consistently look for ways to reduce environmental impact. During one incident, electronic water sensors were used to monitor moisture levels and schedule irrigation cycles. Plants declined during an extended period of high heat with a few short showers. Symptoms were consistent with a soluble salt problem. Media samples taken from the containers were checked for electrical conductivity by a commercial lab and the results were normal.

I performed a sequential pour-through test to identify soluble salt fractions throughout the container. I slowly added water to the medium from the top to avoid channeling (when clear water runs through unabated) and started capturing water as it ran out the bottom, partially filling one beaker or glass after another. Capturing more fractions (samples) works better than fewer. I then tested each fraction for soluble salt content.

The results told a different story from earlier analyses. Low electrical conductivity levels were found at the top and bottom of the container but levels peaked in the middle of the container (Fig. 6).

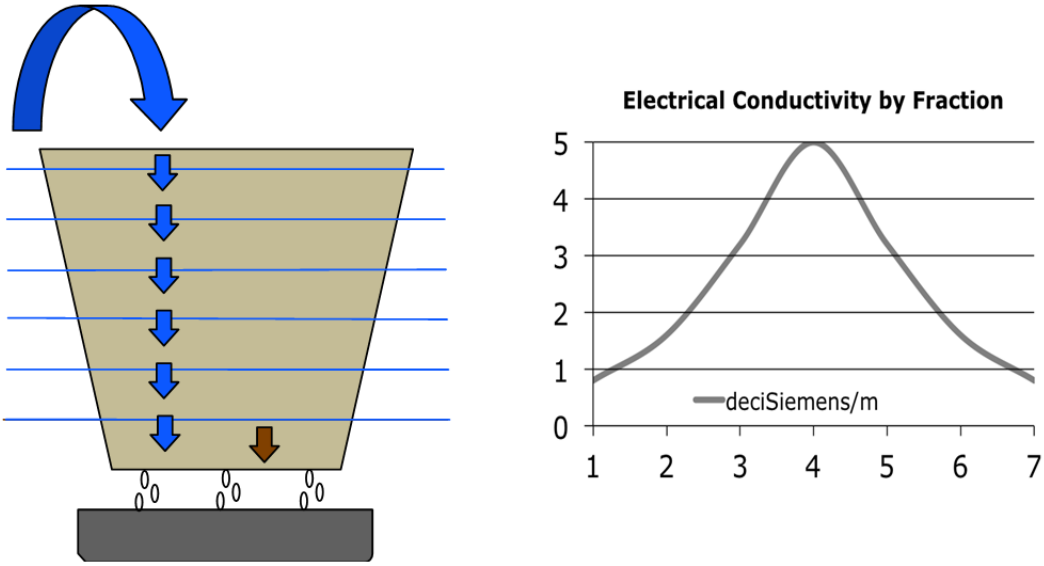

Fig. 6. Sequential pour through (left) and electrical conductivity by fraction (right).

In all probability, limited rain and irrigation had pushed salts deeper into the medium but there wasn't adequate liquid to leach soluble salts out. The lack of salts at the bottom was probably caused by capillary action from the water moving across the floor covering. Peak soluble salt levels were easily high enough to damage plant roots and those were found in the middle of the container where roots were concentrated. Plants less damaged were located near the outside of the house and that was attributed to additional irrigation water from an adjacent house. My recommendation was to include regular leaching cycles during irrigation.

The best way to start toward diagnosing plant problems is to keep a journal of historical plant problems and diagnoses. The journal should include when problems occurred, where problems occurred, weather conditions at the time of the problem, and weather conditions during the period leading up to the problem. Weather information needs to include temperatures, temperature extremes, light conditions, humidity, the amount of rainfall, and wind conditions. Note any stresses the plant may have sustained: soil moisture levels that include water deficiencies or excesses, fertility issues, chemical applications and mechanical damage. Note if the damage appeared suddenly or was progressive and if on random or grouped plants. Always check for biotic (living) organisms such as insects, mites and diseases and try to determine if they are primary or secondary problems.

Symptoms of the same type damage can vary from plant to plant and especially between various types of plants. Don't assume all plants in a location are exhibiting damage from the same stressor. I refer back to the fir tree that had damage due to the southern exposure. The series of three photos below (Fig. 7) were taken on the same day in the same field with various symptoms. From left to right, they were diagnosed as foliar scorch on the southern exposure, *Phytophthora* root rot, and frost damage that occurred when new spring growth was exposed to freezing temperatures.

Fig. 7. Same field but three different symptoms and three different causes.

Fig. 8. Different causes but same symptoms.

The photo above (Fig. 8) shows two Canaan fir trees with similar symptoms at the base, a clear browning of the leaves. A stem canker caused damage to the tree on the right while damage to the one on the left was caused by mechanical damage.

To verify a diagnosis, determine if a nearby plant of the same type has the same or similar symptoms and check for other nearby plants that might have similar or related symptoms, even if they are not of the same type. Have another set of eyes evaluate those situations in question. There are always others with more information on a specific type of plant. Finally, especially when an answer is not readily forthcoming, sleep on it. It's amazing what comes to mind while relaxing and not focusing on the problem.

SUMMARY

In closing there are a few points to remember:

- If journals are not kept that include detailed notes of incidents, solutions will be lost.
- It's important to understand why a problem occurred. (If an answer can't be found it will probably come back to haunt you.)
- Experience is the best teacher and experience of others is far more cost effective than personally experiencing it.