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## PRODUCTION TECHNIQUES TO MINIMIZE STRESS

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This paper summarizes the production techniques used at Greenleaf Nursery Company's Oklahoma Division to reduce plant stress from both high and low temperatures. The nursery is located in hardiness zone 6, based on average minimum temperature, and zone 4, based on extreme minimum temperature. We have had temperatures from −18°F to 112°F. We are constantly forced to deal with a wide range of temperatures. It is from this experience that we have developed these techniques.

### COLD WEATHER STRESS REDUCTION

Many of our ideas regarding cold weather changed after the winter of 1983–84. The effects of those observations are included in this current list.

**Proper hardening of plant material prior to the onset of cold weather.** This factor is quite possibly the single most important factor in reducing plant stress and subsequent damage or death due to cold weather. We establish dates for different broad groups of plant materials, at which time we reduce the nitrogen level in the container and the amount of water applied to the plant. We also never wash off frost that accumulates on the plants in the fall in order to help harden the growth.

**Structures.** We currently use several types of poly houses for winter production.

1. Portable wooden 'A' frame structures.
2. Permanent welded pipe frame houses.
3. Commercial gutter-connected greenhouses.
4. Quonset-type structures.

We currently have about 400,000 ft.$^2$ under poly in the propagation area in both quonset-type and gutter-connected greenhouses. We will have over 1½ million ft.$^2$ under poly in our container growing area. Most of that area is supported by wooden 'A' frame structures; however, some of the space is now in both welded pipe and commercial structures. Each type structure has its advantages and limitations. The structure we are currently trying to build is the welded pipe structure, since the maintenance and handling on the 'A' frames is so expensive, as is the initial cost on the commercial house.

**Windbreaks.** Windbreaks constructed from either taller, hardier, plants or from inert materials, such as plastic, have varying degrees of success in reducing stress. Generally speaking, we have not had good success using wind breaks where we only erected vertical barriers.

**Mulching** (or other types of insulation barriers). We continue to use a large amount of wheat straw to mulch our containerized 1 gal. and 5 gal. trees. This can be a problem-solver or problem-maker depending on the severity of the winter. The straw does provide good insulation and protection to the roots in moderate to hard winters, but in severe winters the medium in the containers can freeze solid under the straw. Once that happens, it is next to impossible to thaw the medium, due to the insulation the straw provides.

**Bunching the containers.** Grouping container material as tight as possible is one of the best methods of protection. Where young plants are still sitting can-tight, we will also fill the aisles between the beds, in order to create one solid block of plant material. When bunching containers, we also stagger the rows to create a tighter group. Depending on the cultivar, we may use hardier plants, straw, or microfoam around the perimeter of the bunched plants as a barrier.

**Other factors.**

1. Adjusting planting times so that you expose the crop to less winter, give it more time to harden off before winter, or change to spring planting.
2. Using square containers so that you create a tighter seal across the top of the bed of bunched plant material.
3. Use of metal cans. If it fits your scheme and your market, containerized plants have a greater survivability in metal cans than in plastic.
4. Not moving a container any more than is necessary right before the onset of cold winter. If the container has formed a seal with the ground and you break that seal and move it, the plant will have less chance of surviving a severe winter. (Honest, its true!)

**Planting time.** Be sure the plant is well established by the onset of hot weather. This allows the plant to develop a good root system and a natural shade canopy over those roots before it gets hot. This will make a tremendous difference in avoiding heat stress.

**Shade cloth.** We use both temporary shade and permanent pipe and cable shade structures with a number of cultivars. During the hottest summers, we have some cultivars that may require temporary shade over a two- or three-week period to cope with the temperature extremes. We use 47% shade over American arbor-vitae and 'Crimson King' maple, for example. We have disease developing if we use heavier shade.

**Spacing.** We always try to wait to space out a plant until it has a full canopy over the container and try not to space it out immediately after it has been sheared

During periods of extreme heat we have also filled the aisles with plants and put microfoam on the south and west edges of the block. This drastically reduces the exposure to high soil temperatures along edges of the bed that have a strong sun exposure. We have experienced soil temperatures of near 130°F on the edges of our beds in black poly containers.

**Shearing.** Not shearing at all on some cultivars when it gets very hot is one way to reduce stress. Some cultivars will appear to be growing quite lushly and apparently require shearing but will, in turn, stress very badly if sheared when the temperature is high.

**Water application.** We use a water tank mounted on a trailer to water the edges of the blocks when they dry out in the extreme heat. That way we do not have to apply the water to a whole block of containerized plant material when only the edges are stressed. We will also use a short period of overhead water during the day on some of our broadleaf and tree blocks to reduce stress and wilt. Then we can come back later in the day with a longer watering to wet the medium thoroughly.

This has been a quick overview of the subject of preventing cold and heat stress in containerized plant material. Our views on the subject tend to be in a constant state of revision with the experience we gain after each period of extreme stress.