OVERWINTERING STRUCTURES IN CONNECTICUT FOR NURSERY STOCK

Part I: The Plant Response

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Winter damage from cold temperatures is the most important limiting factor in the culture of some nursery stock in New England, especially container grown nursery stock. Plants in containers are more vulnerable to cold weather damage than plants in the field because the roots in containers are above ground.

The objective of these papers is to first consider the environmental factors affecting plant response to winter injury and then to survey some of the past and current methods of overwintering plants.

Plant Hardiness

Generally container plants are placed in protective storage as late in the fall as is considered safe, allowing the plant to develop cold hardiness under natural conditions. Plant growth must stop before it can develop. The termination of growth does not in itself result in cold hardiness.

Recent research has shown that many plants pass through two distinct phases (Havis, 1972). The first phase is the result of exposure to long nights and has two interesting features.. First the "stimulus" is very much like a plant hormone in that it can be translocated in the plant and, second, the response produces a relatively small degree of hardiness compared to the ultimate hardiness that the plant is capable of developing (Havis, 1972).

The second phase of hardening is the response to actually being frozen. Without the first phase, freezing would kill the plant. After the first phase, freezing induces the cells to carry on certain changes that result in its ultimate hardiness.

Root Hardiness

Field grown nursery stock left in the field over winter presents little problem to root hardiness. The surrounding soil provides protection so that roots aren't exposed to extremes in temperature. Container grown plants provide a different situation. Variations in temperature are more extreme.

Root growth and hardiness appear to be completely independent of top dormancy and hardiness (Havis, 1972). Roots do not seem to have a winter dormancy as do the tops of many plants. It is certain that throughout the fall and winter, the roots are the most cold-sensitive part of the plant and winter protection must be based on the tolerance of the roots, not the tops (Havis, 1972).

In winter storage of container grown or balled plants, the conditions chosen for storage are sometimes based on the cold tolerance of the tops of the plants. This can be a mixtake because roots of most plants will be killed at a much higher temperature than that required to damage the tops (Havis, 1972). Consideration of minimum storage temperature should be based on root hardiness. Table 1 lists data on small plants comparable to the size of first year container plants that have been studied for safe root storage temperature and killing temperature. These killing temperatures are based on the roots found along the outer edge of the container (Havis, 1974).

Table 1. Safe root temperatures and killing temperatures

Species	Safe Temp.	Killing Temp.
Acer palmatum 'Atropurpureum'	17°F	14°F
Cornus florida	24	20
Cotoneaster horizontalis	22	18
Cryptomeria japonica	20	17
Daphne cneorum	24	20
Ilex crenata 'Convexa'	24	20
Ilex opaca	24	20
Juniperus horizontalis 'Douglassi'	10	0
Juniperus horizontalis 'Plumosa'	10	0
Kalmia latifolia	15	-
Magnolia soulangeana	24	20
Magnolia stellata	24	20
Pieris floribunda	15	-
Pieris japonica	15	-
Pyracantha coccinea	22	18
Rhododendron carolinanum	15	-
Rhododendron catawbiense	15	-
Taxus media 'Nigra'	15	10
Viburnum carlesii	22	18

Adapted from Havis (1972)

Effects of Nutrients on Hardiness

The degree of hardiness of a plant can be altered by growing conditions and by cultural practices such as pruning, transplanting, watering and fertilizing (McGuire, 1972). According to Dickey and Poole (1962) cold injury to azalea foliage decreases when the rate of fertilization is increased from 1 1/2 tons to 2-3 tons/acre of 6-6-6-2 (N-P-K-Mg) per year. Matkin (1957) reports that plants which were well fertilized through the fall and winter came out of dormancy with more vigorous growth than those that were not fertilized.

Cold hardiness of roots cannot significantly be increased for prolonged periods of time above their normal hardiness by either fertilizers or growth regulators (Gouin, 1974). Plants that suffer losses of roots are generally late in initiating spring growth and produce less total top growth than plants that have not suffered any root damage. Keeping up the fertilizer rates through the summer into the fall has not caused the plants to be less hardy than withholding fertilizer in the fall (Havis, 1972). According to Havis (1972) and his work with Pieris japonica, no decrease in hardiness resulted from withholding nitrogen in the summer and giving heavy applications in either August or September. However, plants given a heavy application in mid-October had severe winter kill, but not from late growth.

Tests conducted with rhododendrons showed that the late growth produced from ammonium-nitrogen was frost tender, whereas the same amount of late growth from nitrate-nitrogen was hardy (Havis, 1972). The remainder of the plants other than the late flush, appeared to be equally hardy. Healthy vigorous plants are produced by keeping all nutrients in balance and this appears to be the condition favorable for hardiness.

Winter Injury in Storage--Desiccation

Desiccation is caused by the foliage becoming so dehydrated that the leaf tissue dies. If the soil around the roots becomes dry and conditions are favorable for evaporation, the leafy plants will dry out in storage just the same as they do in the summer (Havis, 1972). Desiccation in storage usually occurs while the soil is frozen. It doesn't matter how moist the soil is. If it is frozen, the plant cannot use it.

Allowing the soil to freeze and reach a temperature of as low as 25^{o}F should do no harm to well hardened container plants in storage (Havis, 1972). While the soil is frozen, it is extremely important to maintain a high humidity in storage, especially for evergreen plants. Containers may be stored in barns lined with polyethylene to help maintain high humidity. According to Havis (1972) a serious mistake is to ventilate the storage area with outside air while the soil is frozen. This is almost certain to cause more damage than the high temperature that was being corrected. The best way to reduce the buildup of high temperatures in polyethylene houses is to apply spray paint for shading, for ventilation is the wrong approach (Havis, 1972).

Effects on Plant Tops from Having the Roots Killed by Low Temperatures

The following from Havis (1972) provides observations of what to expect from low temperature damage and an aid in diagnosing these plant troubles:

Cryptomeria, Daphne, Ilex--foliage appears healthy while cool and moist. When exposed to warm, drying conditions, the leaves shrivel and die.

Cornus, Magnolia, Viburnum--may begin to leaf out and even flush new growth, then suddenly wilt and die.

Cotoneaster, Pyracantha--look perfectly normal for a few weeks, even in warm weather and suddenly die when new growth starts.

Juniperus, Taxus--remain healthy looking but do not grow.

Literature Cited

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