

## MNLA Certification Training Magic from the Manual: Plant Cold Hardiness

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You may think that winter is a long ways away, but do you know that your plants started getting ready for winter three months ago: June 21 to be exact. Since that day, the days have been getting shorter and that is one of the processes used in developing winter hardiness in plants. Are you ready to help them prepare for this critical biological process?

### Types of Winter Injury

Some common types of winter injury associated with above ground portions of plants include sunscald, frost cracks, foliar browning, blackheart, die-back, flower bud damage, dehydration damage, heaving damage, and late spring and early fall frost damage. Winter injury to nursery and landscape plants may also result from breakage caused by the weight of snow and ice accumulation. Ice storms can result in tremendous losses. Landscape plants may also be damaged by snow removal equipment and deicing salts.

**Root cold hardiness** is critically important. Roots are always less cold hardy than top growth and root cold hardiness may be the critical factor which determines plant survival under certain conditions. Increased container production and use of above ground landscape planters makes root cold hardiness an even more important consideration because plant roots are exposed to lower temperatures than they would be if grown under natural conditions. Roots are also exposed to greater temperature fluctuations under container growing conditions. During years with very severe winters or when winter protection from snow is lacking, root cold hardiness also becomes an important factor in landscape survival. Poor growth of trees and shrubs following a severe winter is often attributed to other causes such as drought or disease, since symptoms of the injury do not become apparent until midsummer when the previous winter and its conditions have been forgotten. Trees and shrubs exhibiting root injury may resume growth normally in the spring, sending out vegetative shoots and blossoms and they may even set fruit. Later, when the tree is stressed by warmer, drier conditions, the effects of previous winter's root injury become apparent. Portions of the crown, and in severe cases the entire plant, may wilt and die.

The temperatures to which roots are subjected are determined by soil temperature which in turn are influenced by many factors including soil texture, specific heat, heat conductivity, radiation, water content, organic matter content, evaporation, soil solution concentration, topographic position, surface condition, air temperature, sunshine, wind velocity, barometric pressure, precipitation, and soil or media composition. A difference of only a degree or two can make a significant difference in root survival.

Frost damage may not result in the direct loss of the plant. Many plants are vegetatively hardy while flower buds are subject to injury, such as Forsythia. These plants may exhibit reduced flowering and fruiting following severe winters. Although plants may not be killed, winter injury often results in subsequent infection by wood decay fungi. Frost injured tissue can also provide an entrance for insects and pathogenic fungi and bacteria.

### Cold Acclimation

The development and maintenance of cold hardiness is a dynamic process called cold acclimation. The degree of cold hardiness developed during acclimation varies considerably between species, between members of the same species adapted to different geographical locations, and according to environmental conditions. Cold hardiness results from a delicate balancing act between a plant's genetic capacity to harden and a wide variety of environmental factors. **Any environmental factor which slows the growth rate of plants will generally increase freezing tolerance.** Such factors include: low temperature, reduced soil

moisture, shortened photoperiod, and reduced nitrogen availability. The opposite is also true wherein relatively high levels of nitrogen and/or moisture lead to reduced acclimation during the fall. Prolonged warm weather in the fall can also delay the development of cold hardiness resulting in increased winter injury. **Slight** stress from drought, fertility and heat will often increase plant cold hardiness, however, severe levels of moisture, nutrient or environmental stress interfere with hardiness development and result in increased injury.

**Decreasing photoperiod or shortening days, and low temperatures are the two main factors involved in the initiation and development of plant cold hardiness.** The cessation of growth and induction of dormancy or rest caused by shortened photoperiods account for the central role of light in the initial phase of plant cold hardiness development. Temperature is the most critical factor involved in the second developmental phase of plant cold hardiness. If environmental, cultural and physiological factors have been, and continue to be favorable, cold acclimation progresses further in response to decreasing temperatures in late fall and early winter. The end results of cold acclimation are changes in plant morphology, physiology, and metabolism which enable plants to either **avoid** or **tolerate** the formation of ice within plant tissues.

The first line of defense against the formation of ice is called **freezing point depression**. The freezing point of cellular water is determined by the soluble solute content of sugars, organic acids, amino acids, and proteins in the cell sap. Freezing of plant tissue can also be avoided through the process of **supercooling**. Supercooled water is water whose temperature has been lowered below 32°F (0°C) without the formation of ice crystals. Supercooled water does not freeze because of compartmentalization of cellular water and the absence of either external or internal ice nucleators. Under the right conditions, a plant's water can be supercooled until the homogeneous nucleation point of water is reached, which is -38°F (-38°C). Supercooling can often be detrimental rather than beneficial since when nucleation does occur, ice formation is rapid and can cause extensive mechanical damage caused by intracellular, or inside the cell, ice formation.

Plants which are able to tolerate very low temperatures must be able to accommodate ice within the plant without disruption of their tissues. They must also be capable of surviving severe desiccation of the cytoplasm or cell contents, and subsequent mechanical and biochemical stresses on cellular constituents. Hardening results in an increase in cytoplasmic viscosity making the cytoplasm more resistant to mechanical disruption. Hardening may also involve increased binding of water to macromolecules and membranes. Thus, frost resistance is essentially the ability to tolerate intercellular or outside the cell ice and cell dehydration without injury.

### **Sample Test Questions:**

1. Which of the following is not directly involved in winter injury to plants?
  - A. Sunscald
  - B. Blackheart
  - C. Pruning wounds
  - D. Dehydration
  - E. Heaving damage
2. A factor that will increase cold hardiness in plants is:
  - A. Increased temperatures
  - B. Increased moisture
  - C. Increased fertility
  - D. Shorter photoperiod
  - E. Longer photoperiod

3. T F        Roots harden off to a greater extent than branches.
4. T F        Trees and shrubs that have sustained root injury may resume growth normally in the spring.
5. T F        Decreasing photoperiod or shorting days, and low temperatures are the two main factors involved in the initiation and development of plant cold hardiness.

**Answers:**

1. C; 2. D, 2. F; 3. T; 5. T.

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*Certification Training Magic from the Manual is a monthly article written by the MNLA Certification Committee as a study tool for the MNLA Certification Exam. Information from these articles is taken directly from the chapter in the MNLA Certification Manual. It is an outline and does not replace studying the entire chapter in the manual.*