The Physiological Aspects of Winter Dormancy, Injury, and Survival

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Winter injury of cool season turfgrasses has been studied by several researchers. The nature and severity of this injury is very complex, difficult to predict, and is not fully understood. Grass species, weather conditions, soil conditions, moisture conditions, etc. all differ and interact with each other to produce highly differing responses.

How Do Plants Reduce Freezing Injury

Turfgrass plants go through a hardening period which reduces their sensitivity to winter injury. The hardening is triggered by shorter days, lower temperatures, and is controlled by the genetic makeup of individual species. The plant responds to the triggering mechanisms by: 1) accumulating carbohydrates, 2) the numbers of molecules in cells increases which reduces free water, 3) protein synthesis increases which helps bind free water, 4) cell membranes become more permeable which can decrease water content and 5) amino acids can increase in crown tissue which is related to freeze tolerance. As temperatures get very cold, metabolism slows and dormancy sets in where the crown eventually remains as the surviving part of the tiller. An overall state of dehydration exists and plants at this point are at their maximum state of hardiness. This usually occurs in temperate zones in late December and early January. As time passes, this maximum state of hardiness gradually decreases and reaches a state of minimum hardiness in late February and early March. Most winter injury occurs during the period of minimum hardiness when day-night temperatures frequently have their widest difference. Day time temperatures induce hydration of the plants but night temperatures can be very cold. When there is a gradual melting of ice cover (melting and refreezing at night) occurring at this time of year, plants are very susceptible to injury.

Types of Winter Injury

Intracellular ice formation

This type of injury is not as common as others. In late winter and early spring as the plants begin to hydrate due to thawing conditions intracellular ice formation has its highest probability of occurrence. The concentration of cellular materials is low and more ice can form than at other times of the year. Ice that forms intracellularly subjects the protoplasm to stresses and strains that can lead to mechanical injury. In addition, external forces resulting from traffic can be very damaging to plants having extracellular ice formation.

Desiccation

This type of injury is most common on semi-dormant turf on sites exposed to wind and where precipitation typically runs off. When conditions favor rapid evapo-transpiration, desiccation injury can occur because root systems are limiting and water is in limited supply (due to drought or being in the form of ice). There are species differences found for desiccation injury with those maintaining metabolic activity at low temperatures being more prone to problems.

Dehydration

Dehydration is desirable to a point and is necessary for hardening, but too much can result in permanent injury. Extracellular freezing gradually removes water from cells and they become more and more dehydrated as the temperature goes down. Plants may become as much as 90% dehydrated at -25F. Those that survive will be at the peak of their hardiness. If cells for a particular species cannot tolerate a given level of dehydration, these cells are killed. Those cells that are killed by severe dehydration may succumb because a toxic concentration of solutes occurs (due to water loss) and/or protein aggregation occurs.

All management factors influence winter survival. Nitrogen fertilization undoubtedly plays an important role. The source of N, species of grass, timing of application all interact and have an impact. As long as plants are not significantly diverted from their natural hardening processes by management, winter survival should not be a serious problem except in in the severest of weather abnormalities.