Bulletin No. 724

Spring Freeze Injury to Idaho Cereals

Larry D. Robertson
Extension Crop Management Specialist

Cooperative Extension System

University of Idaho

College of Agriculture

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Every year, small grains in Idaho face potential injury from cold temperatures. Injury to spring and winter cereals from low spring and summer temperatures has occurred in all parts of Idaho but is most prevalent in the higher-elevation southeast. Some producers may suffer significant losses to spring freezes each year. Low temperatures during the boot, heading and early seed filling periods can be particularly destructive.

The types of injury described here occur to both spring-seeded crops and to fall-seeded crops after they break dormancy in early spring. Winter barley, winter oats and winter wheat respond similarly to cold springtime temperatures.

Susceptibility to spring freeze injury

In fall, fall-seeded, winter cereal crops go through cold hardening — a complex biochemical process that increases their resistance to winter cold. In spring, when they break dormancy and resume growth, the crops quickly lose their acquired cold hardiness and resistance to freezing (Fig. 1). Many factors influence spring freeze injury. Plant growth stage, plant moisture content, freeze type, duration of exposure and lowest temperature reached are most important.

Plant growth stage

Spring freeze injury occurs whenever freezing temperatures coincide with susceptible plant growth stages. Susceptibility to freezing temperatures in spring steadily increases as maturity progresses through the flowering stage then decreases slightly as seed develops (Fig. 1). All cereals are most sensitive to freeze injury during reproductive growth, beginning at jointing and continuing through the boot, heading and pollination stages (Zadoks stages 31-69). A light freeze (28°-32°F) can severely injure cereals at these stages and greatly reduce grain yields.

Spring and winter crops behave similarly to springtime subfreezing temperatures. They differ mainly in being at different stages of growth when the freeze occurs.

Cover: Random head sterility on spring wheat due to spring freeze damage at flowering. Thin parts of the heads are sterile, and seed is not developing.

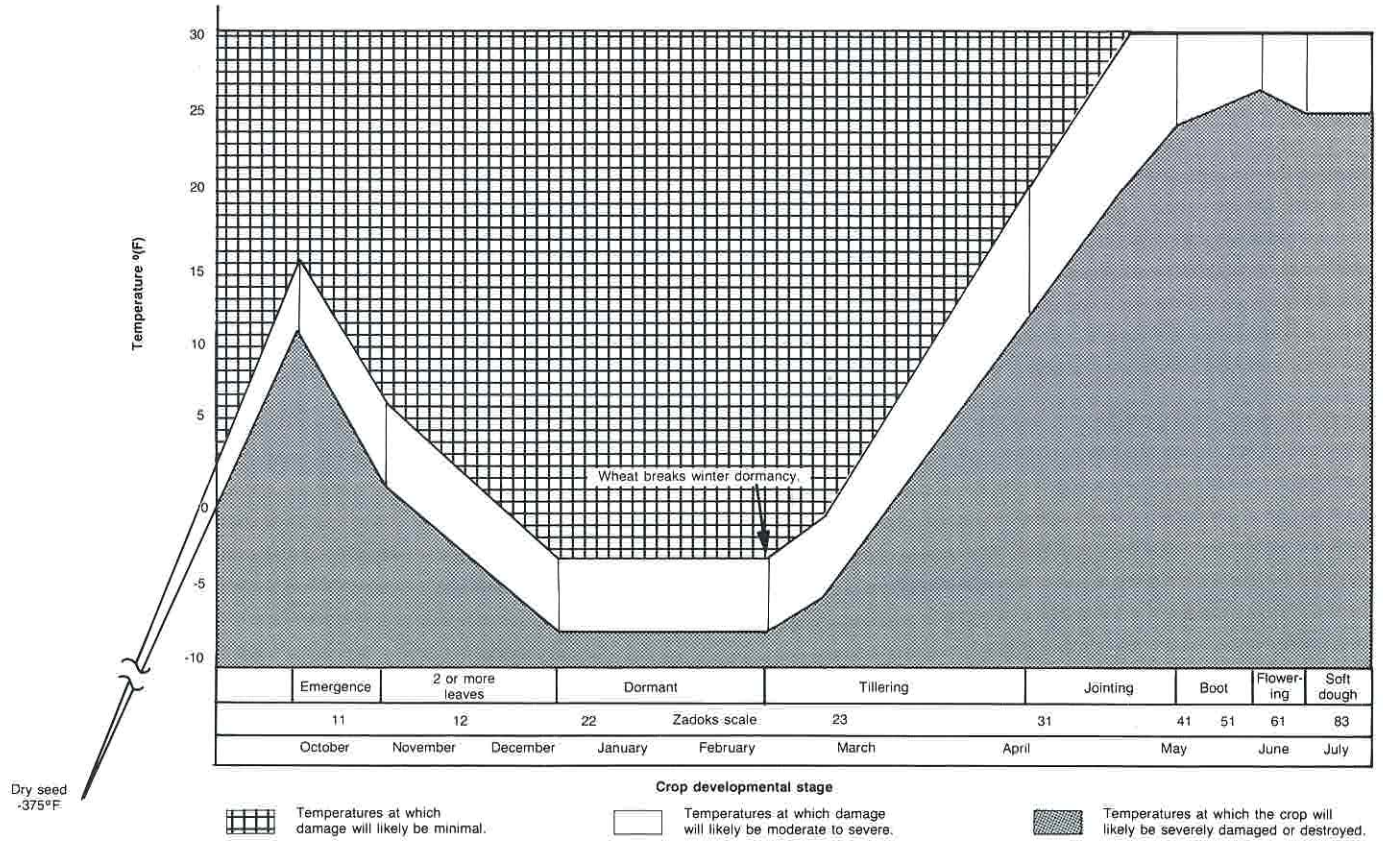

Fig. 1. Temperatures that cause freeze injury to winter wheat when exposure duration is 2 or more hours. (Adapted from Paulsen, G. M., E. G. Heyne and H. D. Wilkins. 1982. Spring freeze injury to Kansas wheat. Kansas State University Cooperative Extension Service C-646.)

Early plantings and early-maturing varieties are more likely to be injured by spring freezes than are later plantings and late-maturing varieties. However, in areas where early fall freezes are likely, late-spring plantings and late-maturing varieties may be injured by freezes that occur late in crop maturation.

Minor varietal differences in susceptibility to spring freeze injury have been reported, but they result primarily from differences in plant growth stage when the freeze occurs. Spring freeze resistance among cereal varieties at the same growth stage is similar. Therefore, little opportunity exists to increase freeze resistance through varietal selection.

Plant moisture content

Damage results from mechanical disruption of cells by ice crystals that enlarge both within and between cells. Cereals grown under good growing conditions and high soil-test nitrogen levels are more susceptible to freeze injury because of their lush growth and high moisture content. Drought and other stresses tend to harden plants to cold by decreasing plant water content, thereby reducing the severity of freeze injury at a given temperature.

It is also possible that ample soil moisture, cool temperatures and high soil-test nitrogen levels may result in less-severe injury. This could occur if the favorable conditions slow plant maturity, resulting in plants at an earlier, less-susceptible growth stage when the freeze occurs.

Temperature

Degree of injury is influenced by the duration of low temperatures as well as by the lowest temperature reached. Prolonged exposure to a given temperature can cause much more severe damage than brief exposures.

The extent of injury from a given temperature report is difficult to predict. Predicting is complicated by differences in elevation and topography among and within fields and between fields and official weather reporting stations. Growers' fields may have temperatures several degrees higher or lower than that recorded at the nearest official weather station. Field pockets may have temperatures several degrees lower than occur at higher elevations or on open slopes. Also, temperature reports fail to provide duration of critical temperatures.

Types of freezes

A freeze is defined as an occurrence of a temperature of 32°F or lower in a thermometer shelter at about the 5-foot level. It may or may not be accompanied by frost. The National Weather Service has described three classes of freeze:

Light freeze — the air temperature in a standard instrument shelter ranges between 28° and 32°F.

Moderate freeze — the air temperature in a standard instrument shelter ranges between 24° and 28°F.

Severe freeze — the air temperature in a standard instrument shelter is less than 24°F.

Radiation freezes occur when the air mass over an area is cool, the winds are light and the sky is clear or nearly so. Under these conditions, the soil surface cools rapidly as heat radiates outward. Air in contact with the soil surface gives up its heat to the cooler surface. As this cooling process continues, the temperature of the layer of air next to the soil surface decreases. If heat loss by outward radiation continues throughout the night, the minimum temperature will occur near sunrise. Under these conditions, the temperature near the soil surface can be 1 or more degrees lower than that recorded in the temperature shelter. If a layer of clouds interrupts the outward flow of heat, the temperature will often be prevented from falling below the freezing point. The lowest temperatures in a field will generally occur in low areas.

Advection freezes occur when a mass of air whose temperature is below freezing moves over an area. Under this condition, the temperature steadily decreases with increasing height above ground — the reverse of radiation freezes. Advection freezes usually are accompanied by winds. They are not associated with the low-level temperature inversion found in radiation freezes. Lowest temperatures during advection freezes generally occur on slopes or near the tops of ridges and hills.

A combination **radiation-advection freeze** occurs occasionally when a cold air mass and strong winds move in during the day and the winds subside at night. If nighttime skies are clear, radiational cooling further decreases the temperature and may result in a severe freeze.

See University of Idaho bulletin 494, *Spring and Fall Freezing Temperatures and Growing Seasons in Idaho,* for tables of probability of spring and fall freezing temperatures for many locations in Idaho.

Spring freeze injury symptoms

Knowing the symptoms of freeze injury may enable early assessment of damage, giving you a greater selection of uses for the damaged crop and of alternative crops to plant. Waiting until harvest to assess damage may decrease the value of the damaged crop for some uses and limits management alternatives.