SDSU Extension

iGrow Wheat

BEST MANAGEMENT PRACTICES

Chapter 34:
Seasonal Crop Hazards

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Every year Mother Nature presents wheat growers, somewhere in South Dakota, with one or more hazards. The purpose of this chapter is to discuss freeze, hail, and flooding hazards.

General background on spring and winter wheat growth and development

The average seeding and growth stage dates for spring and winter wheat are provided in Table 34.1. The planting window for winter wheat generally ranges from early August to early October or from about August 5 to October 5. Historically, about 10% of the crop is seeded by September 5, 50% by about September 17, and 90% by about October 2. Likewise, the planting window for spring wheat generally ranges from early to late April or from April 1 to April 22. Historically, about 10% of the crop is seeded by April 10, 50% by April 22, and 90% by May 10.

This comparison between winter and spring wheat (Table 34.1) is provided to better understand how crop damage in these two wheat crops differ and how a producer might take advantage of these differences. For example, winter wheat planting starts in September when there is a higher risk of variable sub-soil moisture compared to spring wheat planted in April when moisture in the seeding zone tends to be more uniform. Quick fall establishment of winter wheat is necessary if it is to grow and attain sufficient winter-hardiness to survive the winter. Successful establishment of winter wheat depends on the ability of it to survive the winter.

Winter wheat survival is such a concern for the crop insurance industry in South Dakota that counties in the state have been designated as winter wheat eligible or non-winter wheat eligible counties (Chapter 9). The winter wheat in the eligible counties is insured as regular winter wheat. In the non-winter wheat eligible counties, producers plant the winter wheat at their own risk. In the spring, the winter wheat stand is evaluated by an insurance adjuster and if the stand is rated at 90% of the producer's actual production history (APH), the winter wheat crop then meets the criteria for coverage. For insurance purposes, it is then treated as a spring wheat crop for the remainder of the season.

Generally, the exposure time to hazards is longer for winter than spring wheat. Although spring wheat does not cope with winter survival, it does cope with a delayed planting window. As indicated in Table 34.1, the "Boot" and "Head emergence" dates for spring wheat are about two weeks later than winter wheat. Once winter wheat breaks dormancy and starts spring regrowth and/or once spring wheat emerges following planting, the crops at a given growth stage react similarly to hazards.

Table 34.1. The average date when 50% and 90% of the spring and winter wheat crops are seeded and when 50% of these wheat crops have reached the boot and heading stages, according to reporting district.
Data obtained from the SD Agricultural Statistics Service[1].

Reporting district	*Average date 50% and 90% of a crop condition or stage is reached							
	Winter wheat				Spring wheat			
	Seeded		Growth stage		Seeded		Growth stage	
			Boot	Head emergence			Boot	Head emergence
	50%	90%	50%	50%	50%	90%	50%	50%
NW	Sep 20	Oct 5[a]	May 29	June 11	Apr 22	May 13	June 14	June 24
NC	19	7[b]	27	7	22	9	12	21
NE	15	2	25	7	23	14	11	21
WC	14	Sep 30	24	4	20	16	7	19
C	17	Oct 3	23	3	18	7	8	17
EC	17	4	26	7	17	12	7	15
SW	18	4	23	4	18	11	12	23
SC	14	Sep 29	23	3	15	12	11	19
SE	18	Oct 5	22	2	13	6	2	14

[1]South Dakota Agricultural Statistics Service, 1980-94 average. [a]80% seeded and [b]87% seeded.

General background on freeze and frost injury

Wheat injury occurs at those developmental stages that are most sensitive to frost or freezing temperatures (Table 34.2). Generally, winter wheat is resistant to freezing temperatures in the fall and reach maximum resistance from mid-December through mid-February. Thereafter, from late winter to early May the winter wheat plants gradually lose their resistance. Over wheat's life-cycle, no single temperature causes damage; but rather a range of temperatures that is mitigated by many environmental and cultural factors.

Producers should note that Table 34.2 also indicates (1) the approximate injurious temperatures that, when maintained for two hours, significantly affects wheat at given growth stage; and (2) the primary injury symptoms one might observe when evaluating freeze injury. On average, the yield potential of wheat is affected by freezing temperatures from jointing to the milk stage, with the greatest reduction occurring when frost damaged at heading and flowering.

Evaluating crop injury

There are two factors to consider when evaluating wheat frost damage. First, growers should generally wait for at least 3 days of warmer temperatures before assessing damage. Three days of warmer temperatures generally increase the chance the plant will resume growth while cool temperatures will not. Damaged plants must have time to resume growth in order to give any indication they have the potential to recover. If you assess damage before the plant has time to recover, the damage can be either under- or over-estimated.

Assessments conducted three or more days after frost are common if the severity of the frost is variable or light and one wants to get the best estimate of potential crop recovery. There are cases where crop damage can be evaluated shortly after frost. For instance, the frost is very severe (mid 20s or lower) and the growing point is near or above the soil surface. In such cases, frost may result in blackened plants or water-soaked main stem growing points—indicating there is little if any chance for new tillers and any compensation for early yield losses.

Table 34.2. Approximate temperatures that cause freeze injury to wheat at spring growth stages and symptoms and yield effect of spring freeze injury.

Growth Stage	Injurious temperature (Two hours)	Primary symptoms	Yield effect
Tillering	12°F or -11°C	Leaf chlorosis; burnt leaf tips, silage odor; blue cast to field	Slight to moderate
Joint	24°F or -4°C	Death of growing point; leaf yellowing or burning; lesions, splitting, or bending of lower stem; odor	Moderate to severe
Boot	28°F or -2°C	Floret sterility; spike trapped in boot; damage to lower stem; leaf discoloration; odor	Moderate to severe
Heading	30°F or -1°C	Floret sterility; white awns or white spikes; damage to lower stem; leaf discoloration	Severe
Flowering	30°F or -1°C	Same as heading stage (above)	Severe
Milk	28°F or -2°C	White awns or white spikes; damage to lower stems; leaf discoloration; shrunken, roughened, or discolored kernels	Moderate to severe
Dough	28°F or -2°C	Shriveled, discolored kernels, poor germination	Slight to moderate

Shroyer et al. 1995. Kansas State University.

A second factor in evaluating spring wheat frost damage is to dissect and inspect the growing points of the lower main stems. The growing point is a region of actively dividing cells located on the main stem and is enclosed by leaf tissue. The growing point is located immediately above the topmost node on the main shoot. This growing point is critical because it initiates the development of all of the shoot, including leaves, tillers, and terminates in the wheat inflorescence (flower head) or spike. Damage to the growing point will either kill the seedling or severely inhibit or slow its growth.

As the seedling emerges, the growing point is located at the crown or about ¾-inch above or below the soil surface. Later, at stem internode elongation (jointing stage), the growing point is eventually elevated above ground. An analogy would be the elevation of a radio antenna (stem), upward in sections (internodes), until the antenna tip (spike or head) is fully elevated.

At jointing, wheat generally tolerates temperatures from the lower to upper 20s for some time; however, if temperatures fall to the lower 20s for two hours or longer, significant damage can occur. Once temperatures approach the lower 20s, damage is directly related to length of time. If the exposure is two hours or less, the damage will likely be less than if exposure is more than two hours. If frost occurs as the elongating plant reaches the boot stage, damage to the flag leaf, stems, and the developing head can occur if the temperature drops to the upper 20s.

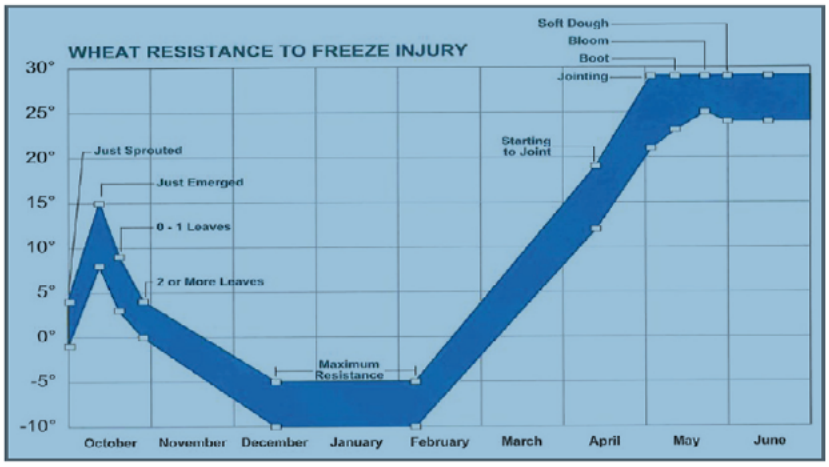

Figure 34.1. Temperatures that cause freeze injury in winter wheat at different growth stages. Winter wheat rapidly loses hardiness during spring growth and is easily injured by late freezes. (Adapted from A.W. Pauli)

Assess damage to the growing point by splitting the stem down the middle and looking for the growing point region immediately above the topmost node. The growing point looks like an elongated and immature spike sitting atop the topmost node. Tissue in this region should be *firm* and *yellowish* to *white* in color. Mushy tissue or discolored tissue (brown and/or black) are typical signs of freeze injury. Generally, the amount of damage is dependent on the temperature and duration.

At temperatures above 28° F, the amount of damage to the growing point is generally low to moderate because the growing point is protected by the surrounding tissue, and/or location of the growing point is below the soil surface. At 28° F or lower, the amount of damage to the growing point increases—depending on how low and fast the temperature drops, and the health of the plant as frost occurred. Moreover, the risk of freeze injury increases significantly the farther the temperature drops below 28° F, even if the growing point is below the soil surface.

All crop producers agree that assessing freeze injury is an emotional experience. Again, remember that to accurately assess the damage, you need to wait a few days. Often the most vivid symptoms of freeze injury is the appearance of the leaves immediately following the frost. Generally, water-soaked areas will appear on the leaves and in turn will turn brown in a few days if the frost event was moderate.

In cases of severe freeze, the leaves may appear black and/or may be disintegrating. Even though a spring frost may result in leaf defoliation, defoliation itself is not always the most important factor. A major factor in the assessment of spring freeze damage in wheat is determining the ability of the damaged stand to produce additional tillers that will potentially produce a harvestable head that compensates for any yield loss as the result of frost damage.

Generally, following a moderate freeze, new growth including leaves or tillers will start to appear in about 3 to 10 days if temperatures recover enough to spur growth. In contrast, with a severe freeze, there is less chance for regrowth recovery that compensates for yield losses. If the damage occurs before jointing, there is a greater chance of the crop recovering to produce an economic yield than if the frost is severe and occurs following jointing or later. Two excellent sources of information regarding frost or hail damage to wheat can be found in Shroyer et al. (1995) and Klein and Lyon (2006).

Hail injury

Hail, like frost, is a weather event that often defoliates the wheat crop. The ability of the hailed wheat to recover is very similar to its ability to recover following frost. However, following hail, the plant must cope with breakage or bruising that may occur to the stem. Again, when assessing damage, use the same general guidelines listed under frost damage. In many cases, the leaves may be stripped from the plant and recovery is generally possible if the hail occurs at early growth stages.

Should hail occur later, recovery is possible as long as the stem is not damaged or broken below the spike. Leaf defoliation may result in a significant loss in photosynthetic surface that contributes to yield. Leaves split lengthwise by hail can still contribute to yield since much of the yield produced in the leaves can still move to the ear. The monetary assessment of hail damage in wheat is very complex and should only be determined by a trained crop adjuster.

Often damage claims in wheat are deferred to the end of the season in order to account for (1) additional tillers that might develop and contribute to yield, and (2) and for additional yield losses that might occur before the damaged crop is finally harvested.

In summary, generally wait for at least 3 days of warm weather before making a management decision. If frost damage is light and variable, there is a chance that regrowth in the form of new tillers will help compensate for early yield losses. If however, damage is severe and/or at a sensitive stage, there is less chance for recovery and compensation for early yield losses. In frost damaged or hailed wheat fields, it is common to defer the evaluation of any losses until harvest is complete. Therefore, it is strongly suggested in the event of a frost or hail event that producers contact their crop insurance agent as early as possible.

Flood damage

Crop damage as the result of flooding is generally the result of oxygen (O_2) deprivation to the growing plant. In some cases, plants can tolerate flooding as long as the plants are not totally submerged. Generally, as the amount of plant tissue submerged increases, the risk of oxygen deprivation increases to levels that are lethal to the plant.

In cases where wheat is totally submersed in warm water in the mid-70s F°, death may occur within 24 hours, while totally submerged plants in water temperatures of 50s F° or below may survive a few hours longer. It is not uncommon for partially submerged wheat plants to survive flooding three to four days if the water temperatures are relatively cool. In many cases, yield losses ranging from 20 to 50% have been reported in the literature where waterlogging of the soil occurred for 10 days or more.

Additional information and references

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Acknowledgements

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