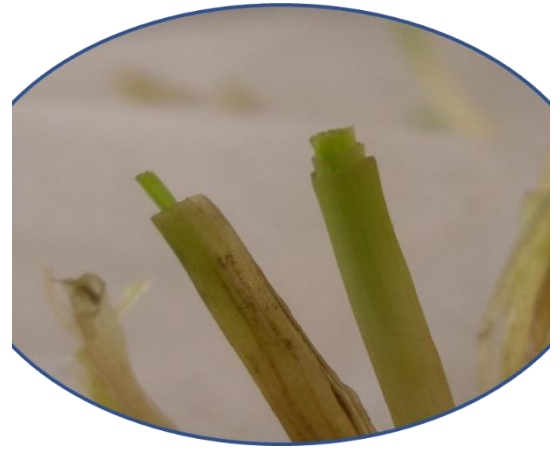


ASSESSING FREEZE DAMAGE TO WINTER AND SPRING WHEAT USING A CROWN VIABILITY TEST



Introduction

The following publication is intended to help producers identify areas of potential winter and spring freeze damage by using a crown viability test. Environmental factors, such as available soil water and soil and air temperature, have a major effect on the growth and development of wheat plants. In the dryland region of eastern Washington, producers look to snow cover during the winter months to (1) provide soil water for the upcoming growing season and (2) serve as a “blanket” to protect the vital crown against rapidly changing or subfreezing temperatures. One to two inches of snow can be enough insulation to trap residual soil heat and help mitigate killing temperatures in the crown zone. The crown is the region of the plant where the main stem, tillers, and crown roots all connect and is the growing point for future nodes and internodes

(Quisenberry and Reitz 1967). It is located just below the soil surface (Figure 1).

Winter wheat can survive temperatures as low as -9°F to -11°F , provided it is a period of short duration and not several hours (Cook and Veseth 1991). However, it is the actual soil temperature at the crown depth that is most critical for plant survival. Even if aboveground plant tissue is killed by extreme, cold temperatures, plants can recover when the crown remains alive. A worst-case scenario is a period of favorable temperatures quickly followed by a rapid onset of temperatures below freezing for an extended period. This can have a devastating effect on survival, especially if there is no snow cover to protect the vital wheat crown (Figure 2).

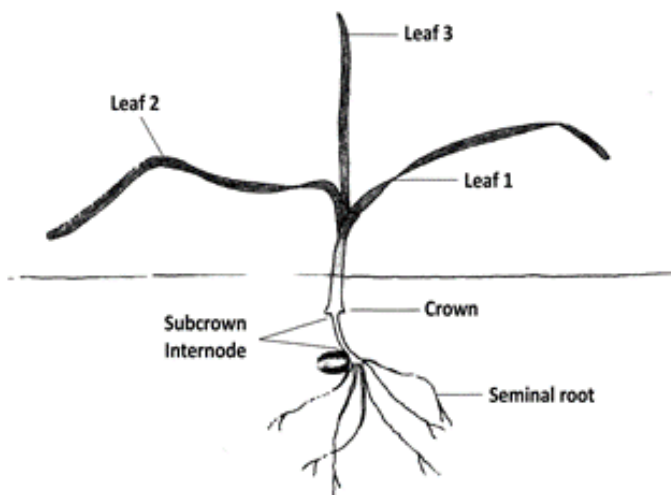


Figure 1. Wheat plant illustration. Image created by David Brian Fowler, University of Saskatchewan Department of Plant Sciences, *Winter Wheat Production Manual*.



Figure 2. Winter injury to wheat. Photo by R.L. Croissant, Bugwood.org.



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Freezing temperatures during the month of April and first week of May after seeding can also have a negative effect on spring wheat survival. Planting dates for spring wheat typically range from the month of April into the first week of May. While this time frame generally is well past the last frost date, abnormalities have been known to occur.

Factors That Influence Degree of Damage

There are several factors that can influence the severity of winter kill. First is planting depth. Ideal planting depth for winter wheat is 1.5 to 2 inches. At this depth, the crown should be well protected by the soil. Fields seeded too deep can result in less vigorous plants. Adversely, fields seeded too shallow or “dusted-in” run the risk of having the crown set near the soil surface where it can become exposed to adverse and greater temperature extremes. Next is the physiological condition of the seedling at the time the cold spell hits. Seedlings that are vigorous and healthy (three-leaf to four-leaf stage) going into the winter months are at the ideal stage of growth and development and have a higher probability of survival against adverse weather. Plants that are too small or weak that may have resulted from a late seeding or from being “dusted-in” to dry soil are subject to winter kill. If a field ends up being seeded late or needs to be reseeded because of poor emergence, it is recommended to seed shallower to hasten emergence to get the plant up and closer to the stage of ideal growth going into winter. One last factor that

can play a major influence on survival is the number of times the plant(s) are subjected to freezing temperatures Table 1 describes the percentage of top growth and plants killed by successive plant freezes at 4°F.

Varietal differences in winter hardiness can also play a factor as not all varieties are created equal. Wheat varieties such as ‘M-Idas’ and ‘VI Voodoo CL+’ have Winter Survival Index ratings of 8 or 9 (on a 1–10 rating scale, with 1 being the most winter hardy and 10 being the least winter hardy), meaning they are “susceptible” to winter kill. Others winter wheat varieties, such as ‘LCS Artdeco’ or ‘Rosalyn’, have a rating of 7, meaning they fall into a category “moderately susceptible” to winter kill. On the opposite end of the spectrum, varieties such as ‘Devote’ or ‘Curiosity CL+’ have a Winter Survival Index rating of 1, which means they fall into a category which are “resistant” to winter kill. Winter Survival Index information for other winter wheat varieties can be found at the [WSU Wheat and Small Grains](#) website and in the “[Small Grains Variety Selection Tool](#).”

Winter kill is more severe under drought conditions because moist soil has a slower rate of temperature change than dry soil, which protects the crown from damage caused by rapid temperature changes. The last factor that can influence winter wheat survival is the amount of snow cover present during adverse swings in cold temperatures. As little as one or two inches of snow cover can provide enough protection against cold weather to ensure crown survival. Plants will recover if the leaves succumb to low temperatures; however, the crown must remain unharmed, as a dead crown equals a dead wheat plant.

Table 1. Percentage of top growth and plants killed by successive plant freezes at 4°F.

Number times frozen	Top growth killed, cumulative %	Plants killed, cumulative %
0	6.8	0.50
1	33.5	19.00
2	59.8	52.60
3	83.9	82.00
4	96.7	97.90
5	100.00	100.00
Least Significant Difference (LSD) 0.05	3.5	6.30

Source: Taken from Pauli (1960).

Crown Viability Test

One way to determine if winter wheat plants have survived a spell of cold weather is to perform a crown viability test. The following nine steps outline how to verify if a wheat crown is viable, unhealthy, or dead:

1. Dig 20 to 50 plants for testing from each site of concern, keeping crowns intact. Select plants from representative areas of the field, especially if you suspect damage in certain areas.
2. Using cool water, gently rinse soil from plants.
3. Clip all the roots off within 1/8 inch of the crown.
4. Clip stems about 1 to 1½ inches from the crown (approximately where the greenish and whitish areas meet [Figure 3]).
5. Wrap the sample in dampened paper towels.
6. Place sample in plastic bag and seal (sealed to prevent dehydration).
7. Place sample into refrigerator for 24 hours (prevents plant shock resulting from temperature differential).
8. Remove sample from refrigerator and leave at room temperature for up to ten days. (Growth activity should be visible as soon as 24 hours.)
9. Examine samples for shoot growth.
 - a. No regrowth indicates a dead crown (Figure 4).
 - b. Wheat crown regrowth (Figure 5).
 - c. Limited regrowth can indicate an unhealthy crown (Figure 6).
 - d. Regrowth of 1 to 1½ inches indicates a healthy crown (may take up to seven to ten days) (Figure 7).



Figure 3. Arrow indicates where to clip the stems. Photo by Aaron Esser, Washington State University Extension.



Figure 4. Dead wheat crown. Photo by Timothy Smith, Washington State University Lind Dryland Research Station.

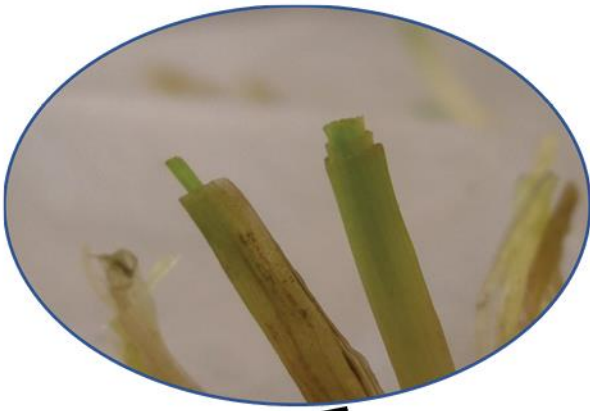


Figure 5. Beginning stages of wheat crown regrowth. Photos by Aaron Esser, Washington State University Extension.



Figure 6. Unhealthy wheat crown. Photo by Timothy Smith, Washington State University Lind Dryland Research Station.



Figure 7. Healthy wheat crown with uniform regrowth. Photo by Timothy Smith, Washington State University Lind Dryland Research Station.

Acknowledgements

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