Factors Affecting Wheat Germination and Emergence in Hot Soils

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One of the most cost-effective ways to increase fall forage production by winter wheat is early sowing. Sowing prior to September 20 generally provides enough time for wheat to establish canopy, produce some forage and develop sufficient roots to anchor the plant in the soil. Therefore, dual-purpose wheat in the southern Great Plains is typically sown from late August through late September. Factors such as seed dormancy, high temperature germination sensitivity and coleoptile length may delay germination or prevent wheat seedling emergence when sown early into hot soils. Delayed germination reduces the amount of time for wheat growth prior to winter dormancy, resulting in less forage production. It is important for dual-purpose wheat producers to understand factors that might delay wheat germination or reduce emergence.

Post Harvest Dormancy

A wheat seed is dormant when it will not germinate, even when favorable conditions for germination are present. Some degree of seed dormancy is a favorable trait for a wheat variety. Seed dormancy is highest just before harvest, therefore, dormancy prevents premature sprouting of wheat and is essential to preventing pre-harvest sprouting. Seed dormancy is gradually lost with time, but the rate of seed dormancy loss is affected by several factors. Inhibitory substances found in the seed coat of hard red winter wheat varieties, for example, can strengthen post-harvest dormancy. Wheat stored under extremely hot or cold conditions after harvest will generally germinate more readily than seed stored at ambient air temperatures. This is why it is advisable to place seed samples in the refrigerator for a day or two prior to running germination tests. The strength of dormancy also increases with decreasing temperatures during grain fill. So, seed of the same variety harvested from different areas of the state or region might behave differently when sown early. Post-harvest dormancy of most hard red winter wheat varieties will sufficiently dissipate by October. Early-sowing provides less time between harvest maturity and wheat sowing, and seed dormancy may not have dissipated enough to allow germination.

High Temperature Germination Sensitivity

In addition to post-harvest dormancy, some varieties have seed dormancy accentuated by high soil temperature, which is commonly referred to as high temperature germination sensitivity. (Table 1). Wheat can germinate in soil temperatures from 40 F to 99 F, but temperatures from 54 F to 77 F are considered optimal. Soil temperatures in western Oklahoma frequently exceed 80 F well into the fall. Soil temperatures at Altus, for example, typically exceed 90 F until mid-September and frequently do not fall below 80 F until October (Figure 1). These temperatures are sufficient to prolong dormancy in sensitive varieties such as 2174, WB-Grainfield, Ruby Lee, Overley, SY Southwind and LCS Mint. Varieties with high temperature germination sensitivity are generally not the best choice for sowing prior to September 15. A good rule-of-thumb is to plant less sensitive varieties, such as Duster, Winterhawk or Gallagher first and wait to sow sensitive varieties until after soil temperature has cooled. In most years, the combination of time after harvest and cooler soil temperatures is sufficient to allow germination for most hard winter wheat varieties by September 15.

Coleoptile Length

Hot soil conditions at sowing also reduce coleoptile length. The coleoptile is a rigid, protective structure that covers the emerging shoot to aid it in reaching the soil surface. Once the coleoptile breaks the soil surface, it stops growing and the first true leaf emerges. If the coleoptile does not emerge through the soil surface, the first true leaf emerges below ground,

Table 1. High temperature germination sensitivity and earliest recommended planting dates for hard red winter wheat varieties.

No sensitivity September 1	*Moderate sensitivity September 10*	*Sensitive September 20*
Brawl CL Plus	Byrd	2174
Duster	Deliver	Centerfield
Endurance	Doans	CJ
Gallagher	Doublestop CL Plus	LCS Mint
OK Bullet	Fuller	LCS Wizard
T154	Iba	Overley
TAM 111	T153	Ruby Lee
TAM 112	T158	SY Llano
TAM 113	WB-Cedar	SY Southwind
Winterhawk		WB-Grainfield
		WB-Redhawk
		WB4458

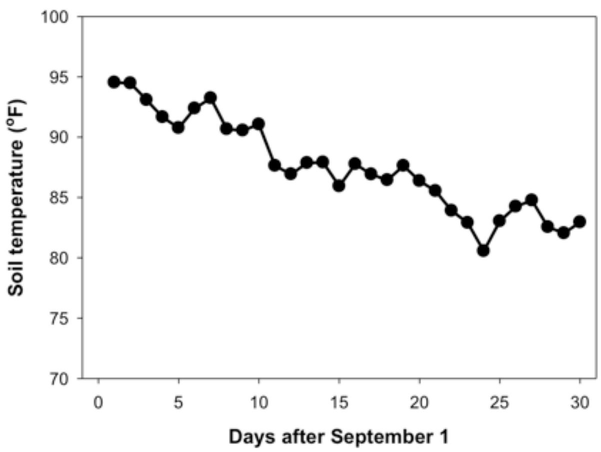

Figure 1. Average maximum observed temperature at a two-inch depth under bare soil at Altus, OK from 1997 to 2007.

takes on an accordion-like appearance and the wheat plant typically dies (Figures 2A and 2B). For this reason, wheat should never be sown deeper than the coleoptile length. Wheat coleoptile length is related to mature plant height, and most modern, semi-dwarf varieties have shorter coleoptiles than old, tall varieties. Most modern wheat varieties can safely be sown up to 1.5 inches deep, but most will not emerge when sown deeper than 1.5 inches into hot soils. For this reason, "dusting in" early-sown wheat and waiting on a cool rain to reduce high-temperature germination sensitivity and increase coleoptile length frequently results in more uniform emergence than planting deeper to reach moisture.

When sowing early, producers should carefully choose varieties and avoid those with varietal characteristics that can reduce germination. Reduced or erratic wheat germination will result in less fall forage production and reduced stocking rates. Soil temperatures generally cool enough to allow full germination of most hard red winter wheat varieties by October 1.

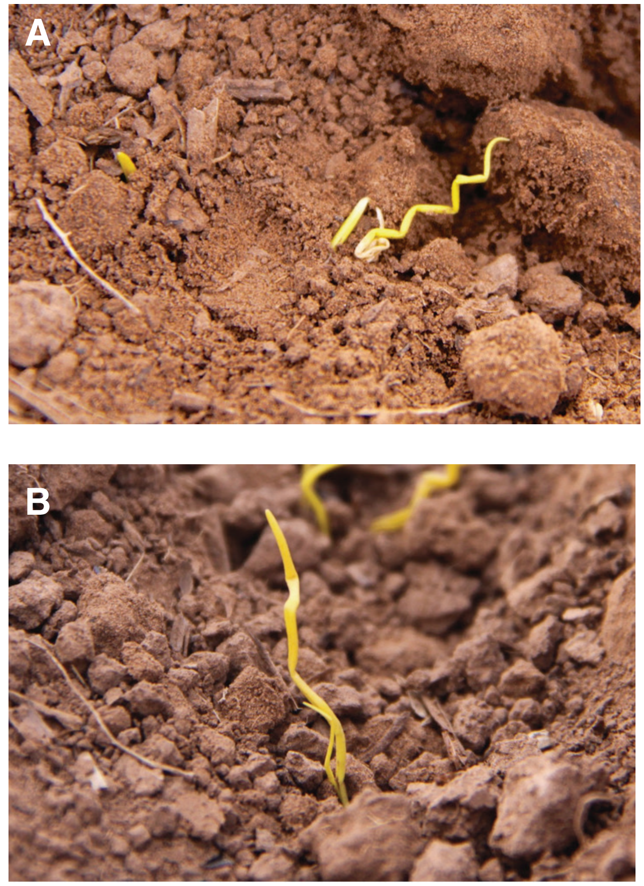

Figure 2A and 2B. If the wheat coleoptile fails to break the soil surface, the first true leaves will emerge below the soil surface. If this happens the leaves, as shown in the picture, will have an accordion-like appearance and the plants will die.

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