

Once a wheat seed is imbibed with water, the seminal roots are the first developmental structure to emerge. After the seminal roots, the coleoptile develops. The coleoptile is a rigid protective structure that covers the emerging shoot to aid it in reaching the soil surface (Figure 1). The coleoptile usually continues to elongate until it breaks the soil surface and reaches sunlight. At this point, it stops growing, and the first true leaf emerges through it.

If the seed is sown deeper than the coleoptile's length, the coleoptile cannot emerge through the soil surface, and consequently, the first true leaf emerges below ground. This causes the first true leaf to take on an accordion-like appearance, and the wheat plant typically becomes yellow and dies (Figure 1). To avoid this situation, wheat should never be sown deeper than the coleoptile length of the chosen variety.

In dryland environments typical of western Kansas and eastern Colorado, wheat is often sown into dry soil and relies on deeper subsoil moisture that accumulated during summer rainfalls. This strategy requires deeper planting depths to reach moisture. This is less of a concern in central Kansas during most years, where growers can achieve good stands by relying on fall precipitation for good topsoil moisture at sowing time.

To achieve good crop establishment on deep-planted seed, long-coleoptile varieties are essential. An additional concern in these regions is that many growers sow their wheat early for grazing, which places sowing time during warmer soil temperatures — which further reduces the length of the coleoptile.

Depending on the variety, this reduction in coleoptile length due to high temperatures may be as much as 60%. For example, a variety that has a 2⅞-inch (75 mm) coleoptile at 60 degrees Fahrenheit could have a 1⅝-inch (40 mm) coleoptile when soil temperature is 80 degrees Fahrenheit. While different varieties have different sensitivities to warm soil conditions, selecting varieties with longer-than-average coleoptiles could help prevent emergence issues under these conditions.

To help guide variety selection for deep sowing, this publication provides growers with an estimate of average coleoptile length of different winter wheat varieties common to Kansas and the Great Plains.

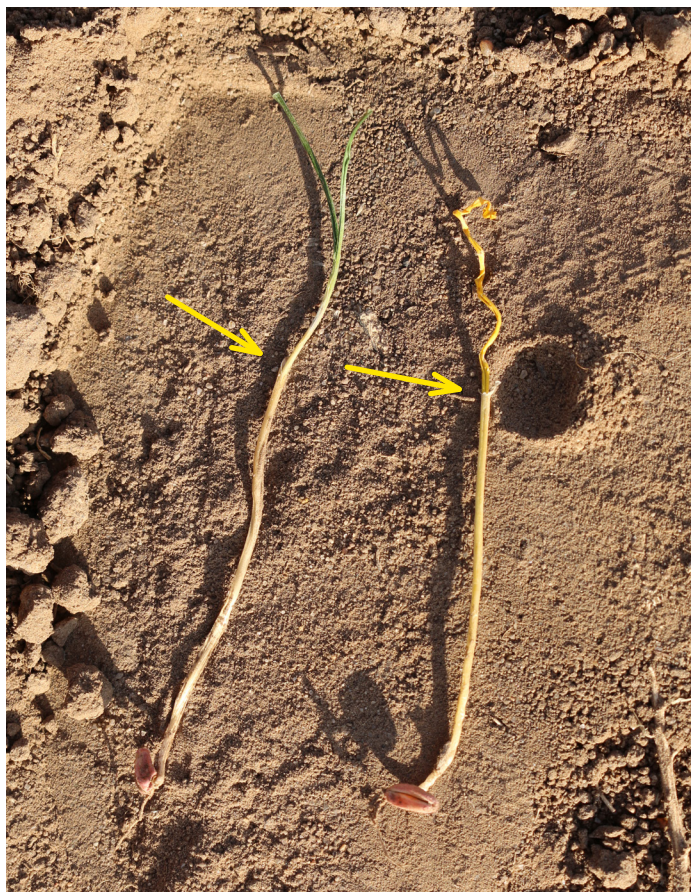


Figure 1. Deep-sown wheat demonstrating the potential for coleoptile elongation (yellow arrows point to the end of the coleoptile). In the left, the coleoptile was able to reach the soil surface and the first true leaf emerged above ground, therefore showing normal early development. In the right, the coleoptile's maximum length was shorter than the sowing depth, resulting in the emergence of the first true leaf below the ground level. As the first true leaf does not have the strength to continue pushing upwards when it emerges below ground, it takes on an accordion-like shape and becomes yellow, leading to plant death.

Kansas Wheat Rx is a prescription for economical and sustainable production of high-quality winter wheat in Kansas.

Wheat Rx is partnership between Kansas Wheat and K-State Research and Extension to disseminate the latest research recommendations for high-yielding and high-quality wheat to Kansas wheat farmers.



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Description of Procedures

This study was performed under controlled conditions, which differ from field conditions but provide a comparison among the different wheat varieties' potential coleoptile lengths.

Seeds were retrieved from all varieties entered in the 2025 Kansas State University winter wheat variety performance tests, as well as from other seed sources used for agronomic studies during the same crop year. Sixty seeds of each variety were tested (Figure 2). Variety randomization ensured that the experiment was conducted in a randomized complete block design and each variety occurred one time, and that the coleoptile length was measured in 40 plants per variety. Temperature during the experiment was stable, ranging from 69 to 72 degrees Fahrenheit.

Coleoptile Length of Winter Wheat Varieties

Results from this controlled-environment experiment are shown on Table 1. The longest coleoptile varieties ranged from $2\frac{3}{4}$ to $3\frac{1}{2}$ inches (71 to 90 mm) and included Rockstar, AR Iron Eagle 22AX, KS Silverado, KS Dallas, WB4445CLP, Sheridan, Bob Dole, WB2606 Brand, Whistler, High Cotton, LCS Steel AX, KS Providence, LCS Cowie AX, Strad CL Plus, OK198417C, and Doublestop CL Plus. A number of variety options were also included in the second and third longest coleoptile groups and could potentially be good options for deep sowing in western Kansas environments, as their coleoptile length was greater than $2\frac{1}{2}$ inches (65 mm).

Alternatively, many varieties had relatively short coleoptiles, falling in the three lowest groups. Few varieties had coleoptiles shorter than 2 inches (50 mm), which is an improvement from past years. The only varieties that had 2-inch (50 mm) or shorter coleoptiles were KS Hatchett, KS Mako, and AP Bigfoot, with a few others in the 2 to $2\frac{1}{4}$ (50-55 mm) range (Larry, AM 553, LCS Atomic AX, and Paradox). Caution should be exerted when sowing these varieties in deeper than average conditions.

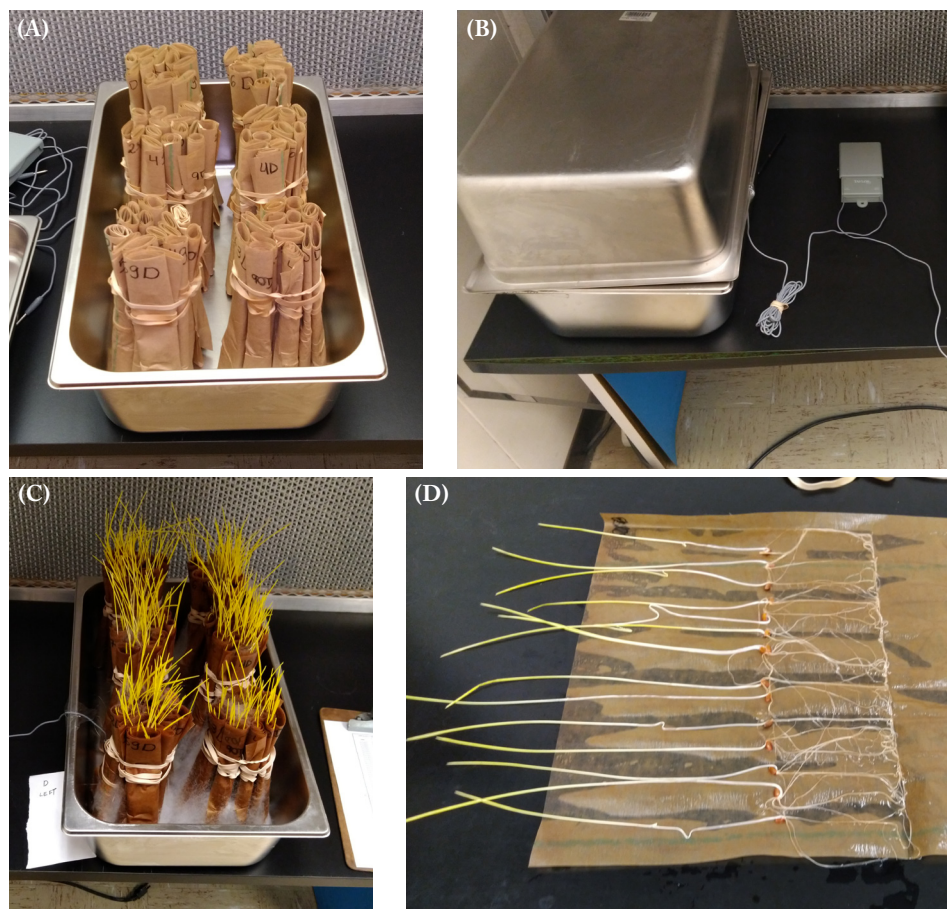


Figure 2. Methodology used for coleoptile length estimation in this study, including (A) adding the rolled-up germination papers and water to stainless steel pans, (B) measuring daily temperatures within pans for 12 days, (C) opening the pans at the study termination date, and (D) measuring the coleoptile length of 10 plants within each paper.

Table 1. *Wheat variety grouping based on coleoptile length measured in a controlled environment experiment during the 2024–25 winter wheat season in Kansas. A total of 40 coleoptiles were measured per variety. Within groups, varieties are ordered from shortest to longest coleoptile.*

Coleoptile Length ¹							
1 ¹⁵ / ₁₆ – 2 ³ / ₁₆ in (49 - 55 mm)	2 ³ / ₁₆ – 2 ¹ / ₂ in (55 - 62 mm)		2 ¹ / ₂ – 2 ³ / ₄ in (62 - 69 mm)		2 ³ / ₄ – 3 in (69 – 76 mm)	3 - 3 ¹ / ₄ in (76 – 83 mm)	3 ¹ / ₄ – 3 ¹ / ₂ in (83 – 89 mm)
KS Hatchett	PS 1986	WB4422	(W) Joe	KS Homesteader CL+	Kivari AX	KS Providence	OK198417C
KS Mako	KS Territory	AM 514	WB-Grainfield	TAM 204	OK 20056 CF- 10 C24	LCS Cowie AX	Doublestop CL Plus
AP Bigfoot	WB4523	WB4595	KS Bill Snyder	Crescent AX	LCS Julep	Strad CL Plus	
Larry	Breakthrough	AM 513	KS12D03-1 (Durum)	LCS Aries	OK Corral		
AM 553	CO20037R	Zenda	WB4269	LCS Chrome	AP24 AX		
LCS Atomic AX	WB2452	KS Big Bow	Guardian	LCS Galloway AX	Rockstar		
Paradox	Everest	WB4401	AM 545	TAM 112	AR Iron Eagle 22AX		
	AM 555	AP18 AX	AP Prolific	CP7017AX	KS Silverado		
	WB2545	Showdown	High Country	LCS Helix AX	KS Dallas		
	WB4699	CP7869	Canvas	AgriMaxx EXP 2405	WB4445CLP		
	AG Radical	SY Monument	LCS Warbird AX	LCS Runner	Sheridan		
	AM 543	WB4792	CO19DOBR	CO19410R	Bob Dole		
	KS Hamilton	AP Sunbird	Beachners KI202	AG Golden	WB2606 Brand		
	LCS Radar		TAM 115	LCS Valiant	Whistler		
			SY Wolverine	AR Turret 25	High Cotton		
			KS Western Star	KS Ahearn	LCS Steel AX		
			T158	Paradise			

¹ Varieties are separated based on fixed coleoptile length intervals. Coleoptile length of a variety may change from year to year, so varieties may move between length categories in different seasons. The minimum and maximum values measured are also season-specific, so the exact length range of each category may change slightly.

For More Information

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Factors Affecting Wheat Germination and Stand Establishment in Hot Soils, Oklahoma State University Extension Publication PSS-2256.

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