# Coleoptile Length of Winter Wheat Varieties 2024



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 is not able to 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 rainfall events. 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 coleoptile length.

Depending on 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.

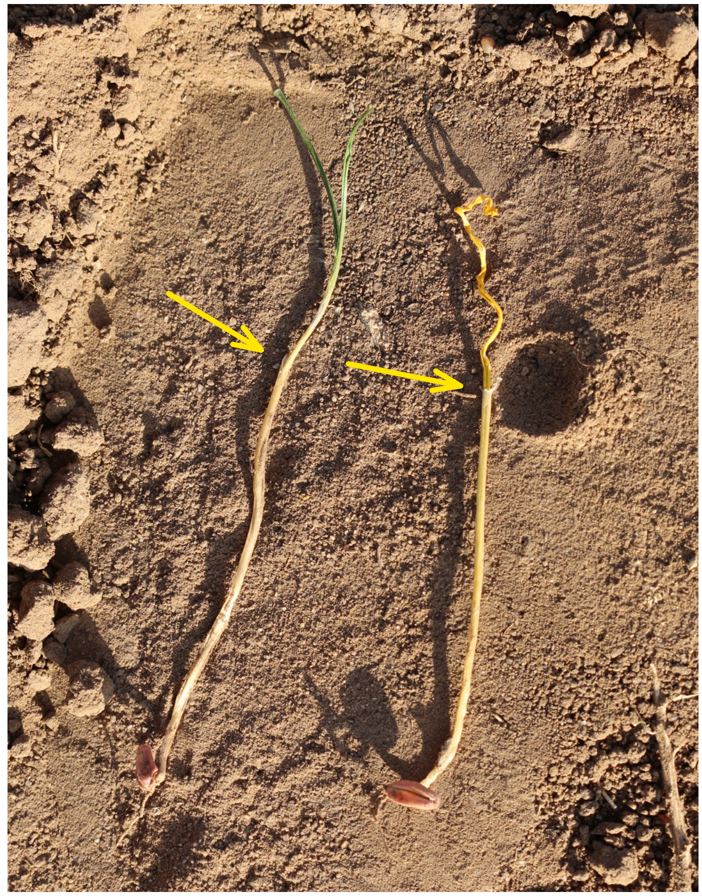

**Figure 1.** *Deep-sown wheat demonstrating the potential for coleoptile elongation (yellow arrows point to the end of the coleoptile). In the left, the coleoptile was able to reach the soil surface and the first true leaf emerged above ground, therefore showing normal early development. In the right, 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.

KANSAS WHEAT Rx

kswheat.com/kansas-wheat-rx

## 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 2024 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 2¾ to 3 inches (69 to 75 mm) and included KS Providence 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 environments, as their coleoptile length ranged from 2¼ to 2¾ inches (57 to 69 mm). Alternatively, many varieties had relatively short coleoptiles, falling in the three lowest groups less than 2 inches (51 mm). These varieties included: Breakthrough, WB4523, WB4699, Paradox, LCS Radar, Paradise, P25R76, EXP 2405, KS Bill Snyder, P25R74, WB4347, KS Big Bow, KS Mako, AR Iron Eagle 22AX, WB4792, LSC Runner, WB4422, and P25R65. Caution should be exerted when sowing these varieties in deeper than average conditions.

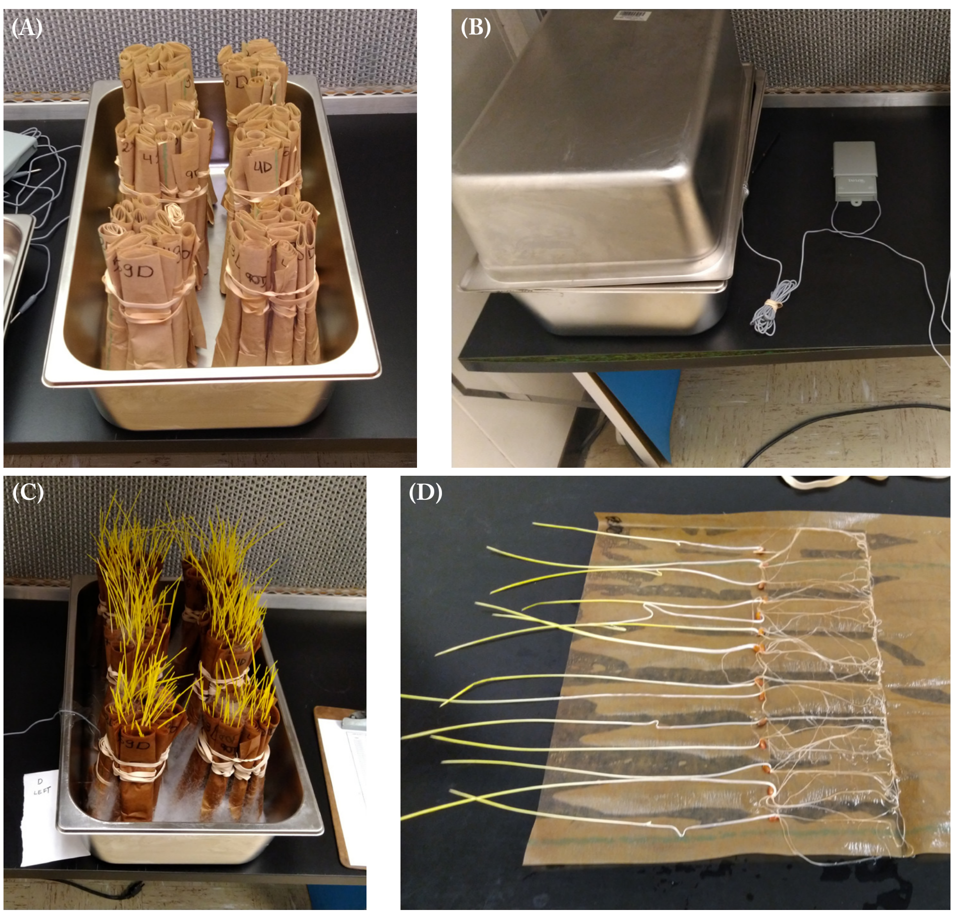


**Figure 2.** *Methodology used for coleoptile length estimation in this study, including (A) adding the rolled up germination papers and water to stainless steel pans, (B) measuring daily temperatures within pans for 12 days, (C) opening the pans at the study termination date, and (D) measuring the 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 2023-24 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 | | | | | | |
|---|---|---|---|---|---|---|
| **Very Short** | **Short** | **Medium short** | | **Medium long** | **Long** | **Very long** |
| **1 – 1¾" (39 – 45 mm)** | **1¾– 2" (45 – 51 mm)** | **2 – 2¼" (51 – 57 mm)** | | **2¼– 2½" (57 – 63 mm)** | **2½– 2¾" (63 – 69 mm)** | **2¾– 3" (69 – 75 mm)** |
| P25R65 | Breakthrough | CP7869 | AG Icon | AP Sunbird | CO18D297R | KS Providence |
| | WB4523 | Zenda | AG Golden | LCS Warbird AX | LCS Helix AX | Doublestop CL+ |
| | 535 | LCS Galloway AX | WB4401 | KS Western Star | Strad CL+ | |
| | WB4699 | 505 | CP7017AX | WB2545 | LCS Steel AX | |
| | Paradox | KS Hatchett | Joe | Green Hammer | | |
| | LCS Radar | XP 24-11 | KS Ahearn | OK Corral | | |
| | Paradise | CP7266AX | High Country | Canvas | | |
| | P25R76 | SY Wolverine | LCS White Light-ning | AP24 AX | | |
| | EXP 2405 | Smith's Gold | AP Prolific | Crescent AX | | |
| | KS Bill Snyder | Showdown | AP Bigfoot | Guardian | | |
| | P25R74 | AG Radical | Uncharted | Langin | | |
| | WB4347 | Everest | 503 | WB2606 | | |
| | KS Big Bow | LCS Atomic AX | AP Roadrunner | WB4595 | | |
| | KS Mako | KS Territory | CP7909 | Rock Star | | |
| | AR Iron Eagle 22AX | KS Hamilton | 513 | Whistler | | |
| | WB4792 | | | CO18035RA | | |
| | 514 | | | LCH16ACC403-158 | | |
| | LSC Runner | | | Kivari AX | | |
| | WB4422 | | | LCS Julep | | |
| | | | | High Cotton | | |
| | | | | WB4445CLP | | |
| | | | | KS Dallas | | |

## For More Information

Dual-purpose Wheat: Management for Forage and Grain Production. K-State Research and Extension publication MF3375

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

Wheat Seedling Emergence from Deep Planting Depths and Its Relationship with Coleoptile Length. PLoS One 2013; 8(9): e73314 doi: 10.1371/journal.pone.0073314

Wheat Grain Yield Response to Seed Cleaning and Seed Treatment as Affected by Seeding Rate During the 2018–2019 Growing Season in Kansas. Kansas Agric. Exp. Stat. Res. Report 6(5). 2020.

Wheat Grain Yield Response to Seed Cleaning and Seed Treatment as Affected by Seeding Rate During the 2019-2020 Growing Season in Kansas. Kansas Agric. Exp. Stat. Res. Report 7(5). 2021.

Wheat Grain Yield Response to Seed Cleaning and Seed Treatment as Affected by Seeding Rate During the 2020-2021 Growing Season in Kansas. Kansas Agric. Exp. Stat. Res. Report 8(4). 2022

## Authors

**Romulo Pisa Lollato,** *Extension Wheat and Forage Specialist*

**Luiz Otavio Pradella,** *Masters Student*

**Jorge Andres Cuellar Montano,** *Visiting Scientist*

**Mariana de Oliveira Mota,** *Masters Student*

**Benhur Sari Severo**, *Visiting Scientist*

**Maximo Nores Allende,** *Visiting Scientist*

**Jane Lingenfelser,** *Assistant Agronomist*

**Erick DeWolf,** *Wheat Pathologist*

**Kelsey Andersen Onofre**, *Plant Pathologist*



**Kansas State University Agricultural Experiment Station and Cooperative Extension Service**

K-State Research and Extension is an equal opportunity provider and employer. Issued in furtherance of Cooperative Extension Work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, Director of K-State Research and Extension, Kansas State University, County Extension Councils, Extension Districts.

**MF3612 July 2024**