

Identifying Wheat Growth Stages

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Identifying growth stages of any crop is important to enable timely crop management decisions that maximize yields and profitability. In wheat there are two growth stage systems: Feekes and Zadoks (Figure 1 and Table 2). The Feekes scale is more common than Zadoks for producers because it is used by most pesticides labels. The Zadoks scale is much more detailed than the Feekes scale and is commonly used in scientific papers. The Feekes scale ranges from 1-11.4 and provides enough detail to capture key development stages that are associated with management practices. Despite very detailed definitions of wheat growth stages, once you get to a field these “simple” definitions become anything but simple.

In the field you are growth staging an entire field and not individual plants. For wheat, and all other grain crops, a field is a specific growth stage once 50 percent or more of the plants in the field reach that growth stage. When growth staging any crop, you must get out into the field. Typically you want to walk into the field at least 40 to 50 feet before you start growth staging. The edges of a field receive more sunlight and in some cases more water and nutrients and can



Figure 2. Wheat plants at Feekes 3/green-up growth stage.

therefore be larger and at a later growth stage than the field as a whole.

There are several wheat growth stages that are important for Kentucky producers to recognize for optimal crop management and to maximize grain

yield and profitability. These growth stages, approximate time of year, and importance are listed in Table 1.

Photographs illustrating key wheat growth stages are presented in figures 2 to 17.

Figure 1. Feekes growth stage for wheat (excerpt from ID-125, *A Comprehensive Guide to Wheat Management in Kentucky*).

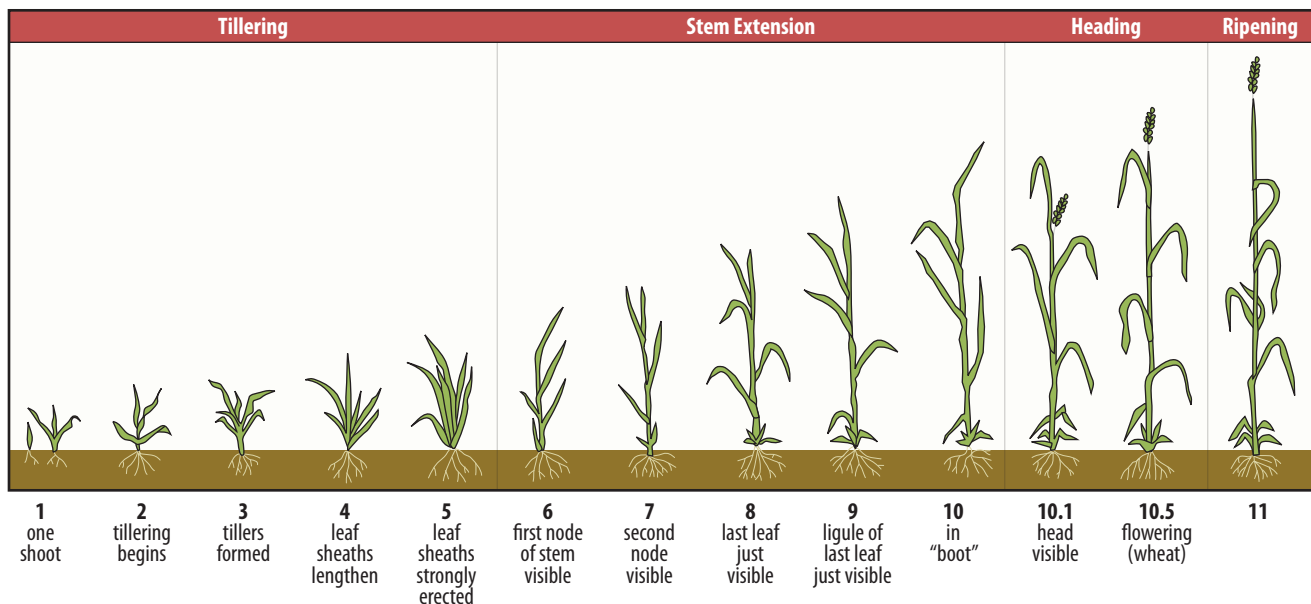


Table 1. Key wheat growth stages, approximate timing, and importance in Kentucky wheat production.

Feekes Growth Stage	Typical Timing in Kentucky	Importance
3	Nov	Wheat plants with adequate tillers are needed prior to winter dormancy to ensure maximum yield potential.
3 Green-Up	mid Feb early March	Wheat begins actively growing, "breaking" dormancy, at green-up in the spring.
		The first nitrogen application, of a split nitrogen application, is recommended at this stage.
		Often leaves appear to be twisting spirally and the plants will be prostrate: growing along the soil surface.
5	mid to late March	Wheat has elongated and become erect.
		The second nitrogen application, of a split nitrogen application, is recommended.
		If applying nitrogen as single application, apply at this stage.
		Herbicides and insecticides commonly applied at this stage.
		The growing point is still below the soil surface.
6 Jointing	late March early April	The leaf closest to the soil surface on the pseudostem is about 1-inch from the soil surface.
		The growing point is above the soil surface. Risk of injury (cold, freeze, herbicide, mechanical, etc.) negatively affecting yield increases.
		The first node is detectable. At early stages, the node will not be visible without carefully peeling the first couple of leaves from the stem. In later stages, the node becomes visible.
9 Flag Leaf	April	The ligule and collar of the final leaf (flag leaf) is visible.
10.5 Heading	May	Almost all (75%-80%) of a wheat plants' photosynthesis (energy to fuel grain fill) occurs in the flag leaf.
10.5.1 Beginning Flowering	May	The wheat head has completely emerged.
		The first anthers become visible.
		Newly emerged anthers are bright yellow. The longer the anthers have been emerged the paler they become until they are white.
10.5.2 Flowering	May	Flowering begins in the middle of the head and progresses up and down the head.
		This is the optimal stage to apply fungicides to protect against head diseases. If fungicide cannot be applied at this stage it is best to apply up to 10 days after this date. Applications earlier than this stage are not as effective as applications after this stage.
10.5.3 Full Flower	May	Anthers are visible to the top of the head.
11.3 Physiological Maturity	late May early June	All anthers are visible along the entire head.
		Kernels are forming in the head.
		All kernel dry matter has accumulated.
		Kernels contain approximately 40% moisture.
		Kernels can be split with a fingernail.
11.4 Harvest Maturity	June	Moisture is not detected when kernel is split open.
		Kernels, head, and stem are turning yellow.
		Straw and leaves are beginning to turn yellow, but considerable green tissue remains.
11.4 Harvest Maturity	June	Kernel cannot be split with fingernail.
		Kernels approximately 13% moisture.
		All plant material is golden and can be easily harvested.



Figure 3. Wheat field at Feekes 3/green-up growth stage.

Table 2. Feekes and Zadoks wheat growth stage scales.

Stage	General Description	Scale		Additional Comments
		Feekes	Zadoks	
Germination	Dry seed		00	
	Start of imbibition		01	
	Imbibition complete		03	Seed typically at 35 to 40% moisture.
	Radicle emerged from seed (caryopsis)		05	
	Coleoptile emerged from seed (caryopsis)		07	
	Leaf just at coleoptile tip		09	
Seedling Growth	First leaf through coleoptile	1	10	
	First leaf unfolded		11	
	2 leaves unfolded		12	
	3 leaves unfolded		13	
	4 leaves unfolded		14	
	5 leaves unfolded		15	
	6 leaves unfolded		16	
	7 leaves unfolded		17	
	8 leaves unfolded		18	
9 or more leaves unfolded		19		
Tillering	Main shoot only		20	
	Main shoot and 1 tiller	2	21	
	Main shoot and 2 tillers		22	
	Main shoot and 3 tillers		23	Many plants will only have 2 or 3 tillers per plant at recommended populations.
	Main shoot and 4 tillers		24	
	Main shoot and 5 tillers		25	
	Main shoot and 6 tillers	3	26	Leaves often twisting spirally.
	Main shoot and 7 tillers		27	
	Main shoot and 8 tillers		28	
Main shoot and 9 tillers		29		
Stem Elongation	Pseudostem erection	4-5	30	
	1st detectable node	6	31	Jointing stage
	2nd detectable node	7	32	
	3rd detectable node		33	
	4th detectable node		34	Only 4 nodes may develop in modern varieties.
	5th detectable node		35	
	6th detectable node		36	
	Flag leaf visible	8	37	
	Flag leaf ligule and collar visible	9	39	
Booting	Flag leaf sheath extending		41	Early boot stage.
	Boot swollen	10	45	
	Flag leaf sheath opening		47	
	First visible awns		49	In awned varieties only.
Head (Inflorescence) Emergence	First spikelet of head visible	10.1	50	
	¼ of head visible	10.2	52	
	½ of head visible	10.3	54	
	¾ of head visible	10.4	56	
	Head completely emerged	10.5	58	
Pollination (Anthesis)	Beginning of flowering	10.51	60	Flowering usually begins in middle of head.
		10.52		Flowering completed at top of head.
		10.53		Flowering completed at bottom of head.
	½ of flowering complete		64	
	Flowering completed		68	
Milk Development	Kernel (caryopsis) watery ripe	10.54	71	
	Early milk		73	
	Medium milk	11.1	75	Milky ripe.
	Late milk		77	Noticeable increase in solids of liquid endosperm when crushing the kernel between fingers
Dough Development	Early dough		83	
	Soft dough	11.2	85	Mealy ripe: kernels soft but dry.
	Hard dough		87	
Ripening	Kernel hard (hard to split by thumbnail)	11.3	91	Physiological maturity. No more dry matter accumulation.
	Kernel hard (cannot split by thumbnail)	11.4	92	Ripe for harvest. Straw dead.
	Kernel loosening in daytime		93	
	Overripe		94	
	Seed dormant		95	
	Viable seed has 50% germination		96	
	Seed not dormant		97	
	Secondary dormancy		98	
Secondary dormancy lost		99		

Sources: Conley, et al. 2003. Management of Soft Red Winter Wheat. IPM1022. Univ. of Missouri. Alley, et al. 1993. Intensive Soft Red Winter Wheat Production: A Management Guide. Pub. 424-803. Virginia Coop. Extension. Johnson, Jr., et al. Arkansas Wheat Production and Management. MP404. Univ. of Arkansas. Coop. Ext. Serv.



Figure 4. Wheat plants at Feekes 5 growth stage.



Figure 5. Wheat field at Feekes 5 growth stage.



Figure 6. Wheat plants at Feekes 6/jointing growth stage.

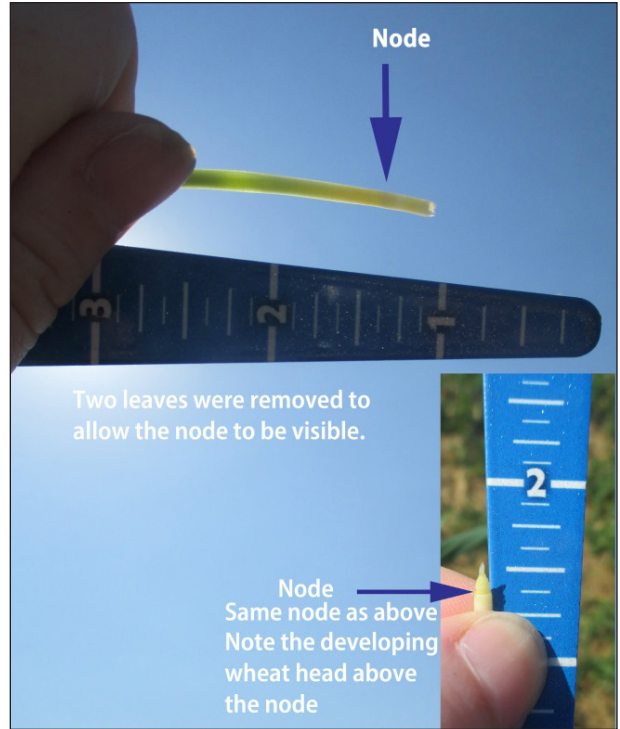


Figure 7. The node and developing wheat head at Feekes 6 growth stage.



Figure 8. Wheat field at Feekes 6 growth stage.



Figure 9. Wheat plants at Feekes 9/flag leaf growth stage.



Figure 10. Wheat field at Feekes 9 growth stage.



Figure 11. Wheat head at Feekes 10.5/heading growth stage.



Figure 12. Wheat head at Feekes 10.5.1/beginning flowering growth stage.



Figure 13. Wheat head at Feekes 10.5.2/flowering growth stage.



Figure 14. Wheat head at Feekes 10.5.3/full flower growth stage.



Figure 15. Wheat field at Feekes 11.3/physiological maturity growth stage.



Figure 16. Wheat field at Feekes 11.4/harvest maturity growth stage.



Figure 17. Wheat field following harvest.