



Wheat Development Stages

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Summary

Understanding the development of wheat, including bread wheat (*Triticum aestivum*) and durum wheat (*Triticum durum*), is crucial for optimizing management practices and maximizing yield potential in Arizona. The Feekes growth scale offers a standardized framework for identifying key developmental stages in wheat (Miralles and Slafer, 2024). Accurate identification of these stages enables timely decisions concerning irrigation, fertilization, pest control, and disease management. This manuscript outlines the major growth stages, from germination through maturation, and discusses their significance for optimizing production. Special emphasis is placed on the management implications at each developmental phase to promote effective and sustainable wheat production.

Feekes 1 (Germination & Emergence)

- This stage begins when the seed absorbs water and germinates. The first leaf is fully unfolded and visible on the main shoot, shortly after the coleoptile breaks the soil surface. The coleoptile is a protective, sheath-like leaf that surrounds the emerging shoot apex.
- Stand establishment is critical for achieving high yields. It is measured by the number of plants or tillers per square foot. Late-planted wheat has less time to produce tillers; therefore, a higher seeding rate is recommended to compensate for reduced tillering.
- Figure 1.1 - 1.3 shows early seedling emergence begins with the appearance of the coleoptile and first leaf above the soil surface (Lollato, 2018).

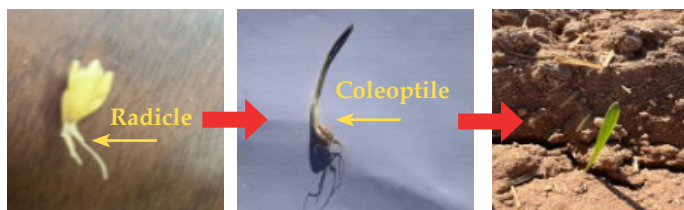


Figure 1.1
(Image Credit: Bhupinder Singh)

Figure 1.2
(Image Credit: Bhupinder Singh)

Figure 1.3
(Image Credit: Bhupinder Singh)

Feekes 2 (Beginning of Tillering)

- A tiller is a secondary shoot that develops from the base of the main stem and shares the same root system. Tillering determines the potential number of grain heads.
- During this stage, maintenance of plant stands is essential. Damage caused by insects, diseases, or herbicide injury cannot be corrected later in the season. Proper nutrient and moisture management supports optimal root and tiller development. Tillers developing at the base of the plant are illustrated in Figure 2.



Figure 2. (Image Credit: Bhupinder Singh)

Feekes 3 (Tillers Formed)

- Wheat can continue forming tillers, depending on planting date, genetic potential, and environmental conditions. Most tillers that contribute to grain yield are formed during this period.
- Herbicide applications typically provide more effective control, helping reduce weed competition.



Figure 3. (Image Credit: Bhupinder Singh)

Feekes 4 (Beginning of Erect Growth)

- At this stage, most tillers have formed, and the plant begins transitioning from a prostrate to a more upright growth habit.
- Leaf sheaths thicken and lengthen. Early pest monitoring is recommended. The overall plant structure at this stage is shown in Figure 4.



Figure 4. (Image Credit: Bhupinder Singh)

Feekes 4 (Beginning of Erect Growth)

- During this stage, the growing point differentiates below the soil surface, determining head size and the number of spikelets. The vertical elongation of the stem and strengthened leaf sheaths during this stage are illustrated in Figure 5.
- Tillers formed after this stage generally do not contribute significantly to yield. Nitrogen application at this time may influence seed size and seed weight but will not increase the number of heads (Lollato, 2018).
- Weed control decisions should be finalized before or during this stage. Herbicide applications after this stage may result in head sterility or distortion.

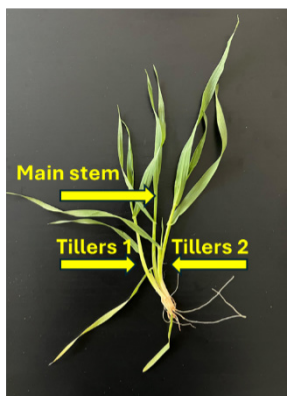


Figure 5. (Image Credit: Bhupinder Singh)

Feeke 6 First Node Visible

- The first node becomes visible above the soil surface. This marks the beginning of the jointing stage. The developing wheat head is located above this node inside the stem. This stage can be

identified by removing lower leaves and sheaths, then split the stem to locate the developing head.

- Most herbicide applications should be completed before this stage to prevent crop injury.

Second Node Becomes Visible

- The second node appears as another swollen area on the stem.
- The upper node may be hidden by the leaf sheath and must be detected by touch.
- If only one node is present, the plant remains in the previous stage.
- The appearance of the second node along the stem is shown in Figure 6.

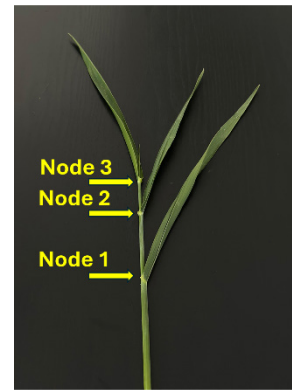


Figure 6. (Image Credit: Bhupinder Singh)

Feekes 8 (Flag Leaf Visible, but Still Rolled Up)

The flag leaf begins emerging from the whorl. This is one of the most critical stages for yield development. Flag leaf morphology traits influence overall canopy structure and light interception, thereby affecting photosynthetic efficiency (Wise et al., 2011). Protecting it from disease and insect damage is essential. Fungicide applications may be considered if disease symptoms are present. The emergence of the flag leaf, which plays a critical role in grain filling, is shown in Figure 7.



Figure 7. (Image Credit: Bhupinder Singh)

Feekes 9 (Ligule of Flag Leaf Visible)

The flag leaf is fully emerged, and its ligule becomes visible. A ligule is a thin appendage located on the upper inner side of the leaf blade where it meets the leaf sheath, preventing water and debris from entering the sheath. Full emergence of the flag leaf and visible ligule is presented in Figure 8. After this stage, insect damage can significantly reduce yield potential. The plant is transitioning into the boot stage.

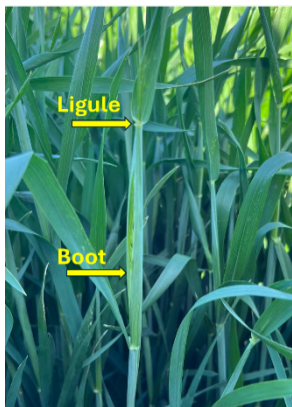


Figure 8. (Image Credit: Bhupinder Singh)

Feekes 10 & 11

Boot Stage

The wheat head is fully developed but enclosed within the swollen flag leaf sheath. This is a critical stage for managing foliar diseases. Fungicide applications during the boot stage can protect yield potential (Figure 8).

Heading

Heading occurs when the wheat head emerges from the flag leaf sheath. Nitrogen application at pre-heading affects yield, and at post-heading affects grain protein. Heading progression:

- Awns visible
- 25% heading complete
- 50% heading complete
- 75% heading complete

Flowering

- Flowering begins when anthers are extruded from florets, typically starting at the center of the spike.
- Wheat is self-pollinating, and most pollination occurs before anthers are visible. Flowering typically completes within 5 days.
- The extrusion of anthers during anthesis is illustrated in Figure 9.

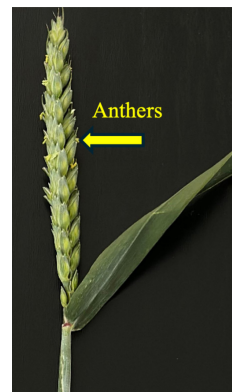


Figure 9. (Image Credit: Bhupinder Singh)

Ripening and Maturation

Boot Stage

- Watery ripe (Figure 10) – clear fluid when crushed
- Milky ripe – milk-like fluid present
- Dough stage – soft, doughy consistency
- Hard kernel stage – firm but divisible
- Mature stage (Figure 10) – hard and not divisible
- Harvest ripe stage – grain ready for harvest and long-term storage. Timely harvesting is essential to avoid yield loss from lodging, disease, or sprouting, as well as reduced grain quality. Birds feeding on mature wheat just before harvest can also cause yield loss.



Figure 10. (Image Credit: Bhupinder Singh)

References

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