Wheat Growth and Development

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Leaf and Tiller Development

- Germination: Seeds absorb water and oxygen. The hypocotyl, seminal roots, and the coleoptile (flattened structure) are the first to emerge from the seed. Temperatures between 54 and 77 degrees Fahrenheit are optimal for germination.

Feekes 1 - Emergence: Light above the soil stops coleoptile growth. The radicle emerges through the tip of the coleoptile. Three leaves fully develop before tillering initiation. The seminal rooting system develops. The first three leaves develop from the seed and soil surface.

Feekes 2 - Tiller initiation: Tiller primordia encased in a protective structure called the prophyll. If there are three leaves visible, a tiller will be visible on the base of the first leaf. Full-formed tillers contribute more to grain yield than spring-formed tillers. The secondary rooting system starts to develop.

Feekes 3 - Complete tillering: Primary tillers develop in the axils of the first four leaves. Complete tillering is determined by the number of tillers on the main stem. Secondary tillers may develop from the base of primary tillers. Tiller growth is also protected by their sequential formation. The development of the secondary rooting system increases extensively.

Winter dormancy: Vegetative growth is reduced, lowering temperatures reduce water hardness in winter wheat. Vernalization requirements range from three to six weeks below 32 degrees Fahrenheit.

Feekes 4 - Composition of tillers: Once requirements are met, the growing point differentiates and the embryonic head reaches the double ridge stage. Depending on the season and planting date, some tillers are visible before the double ridge stage. Genetic potential and environmental conditions determine the number of tillers on a tiller. Tillers with three or more leaves are nutritionally independent from the main stem.

Feekes 5 - Leaf sheaths strongly erect: The pseudo stem is strongly erect, and leaf sheaths are elongated. The developing head reaches the terminal spikelet stage and is pushed up into the pseudo stem. The potential number of spikelets per head is determined at Feekes 5. The first hollow stem stage occurs when there is an approximately 0.6 inch of hollow stem below the developing head. Crop water use is about 0.3 inch per day.

Feekes 6 - First node of stem visible: The first node of the stem becomes visible. This is a result of internode elongation. Nodes are marked and visible up to the interlobe elongate much like a telescope. Sensitivity to low temperatures increases as the developing head moves up the stem. Crop water demand increases to about 0.25 inch per day.

Feekes 7 - Second node of stem visible: As the second node of the stem forms, the next-to-last leaf is just visible. Demand for water and nutrients increases. Temperatures lower than 24 degrees Fahrenheit can damage the developing head.

Feekes 8 - Last leaf visible: The flag leaf starts to emerge from the leaf sheath above the third or fourth node. Strong partitions of photosynthates to the developing head. Crop water demand increases to about 0.3 inch per day.

Feekes 9 - Ligule of flag leaf visible: The flag leaf is completely emerged from the leaf sheath. The flag leaf and the next-to-last leaf combine to form about 70 to 96% of the photosynthates used for grain fill and must be protected for the plant to develop its full potential.

Feekes 10 - Boots: The head is made visible by the developing head growing above a structure called a bole. The flag leaf and pedicel elongate and the developing head is pushed through the flag leaf sheath. Temperatures below 28 degrees Fahrenheit may cause damage to the developing head.

Feekes 10.5 - Head emergence and flowering: The first visible florets emerge from the head. The first florets will push through the flag leaf sheath. Sensitivity to low temperatures increases as the developing head moves up the stem. Crop water demand increases to about 0.25 inch per day.

Feekes 10.5.1 - Flowering (anthesis): Flowering begins shortly after the head is fully emerged and lasts 5 to 6 days, starting slightly above the middle portion of the head. Feekes 10.5.1 occurs when flowering is complete at the top of the head and Feekes 10.5.2 occurs when flowering is complete at the base. The number of flowers pollinated determines the number of kernels per spike. At this stage, wheat is extremely susceptible to frost injury at temperatures below 32 degrees Fahrenheit.

Feekes 10.5.2 - Milk stage: A milklike fluid begins to exude through the flag leaf sheath. Feekes 10.5.2 occurs when about 75 to 90% of the photosynthates used for grain fill are complete. The flag leaf sheath becomes fragile and is easily torn by shears. The second node is fully visible.

Feekes 10.5.3 - Hard dough stage: The wheat starts to become hard and more nutritious. Feekes 10.5.3 occurs when none of the photosynthates used for grain fill are used. The flag leaf sheath begins to toughen and is slightly stronger. The second node is fully visible.

Feekes 11 - Ripe stage: Hard dough stage continues as kernels develop their full potential. Feekes 11.0 occurs when kernels are hard and kernels cannot be cracked by hand. Feekes 11.1 occurs when kernels are hard and kernels cannot be cracked by hand. Feekes 11.2 occurs when kernels are hard and kernels cannot be cracked by hand. Feekes 11.3 occurs when kernels are hard and kernels cannot be cracked by hand. Feekes 11.4 occurs when kernels are hard and kernels cannot be cracked by hand.

Feekes 15 - Winter hardiness: Feekes 15 occurs when kernels are hard and kernels cannot be cracked by hand. Feekes 15 occurs when kernels are hard and kernels cannot be cracked by hand. Feekes 15 occurs when kernels are hard and kernels cannot be cracked by hand. Feekes 15 occurs when kernels are hard and kernels cannot be cracked by hand.

Feekes 15.1 - Grain filling: Maximum dry weight and maximum grain size are achieved. Feekes 15.1 occurs when kernels are hard and kernels cannot be cracked by hand. Feekes 15.2 occurs when kernels are hard and kernels cannot be cracked by hand. Feekes 15.3 occurs when kernels are hard and kernels cannot be cracked by hand. Feekes 15.4 occurs when kernels are hard and kernels cannot be cracked by hand.

Feekes 15.5 - Hard dough stage: The kernels start to become hard and more nutritious. Feekes 15.5 occurs when kernels are hard and kernels cannot be cracked by hand. Feekes 15.6 occurs when kernels are hard and kernels cannot be cracked by hand. Feekes 15.7 occurs when kernels are hard and kernels cannot be cracked by hand. Feekes 15.8 occurs when kernels are hard and kernels cannot be cracked by hand.

Feekes 15.9 - Ripe stage: The kernels start to become hard and more nutritious. Feekes 15.9 occurs when kernels are hard and kernels cannot be cracked by hand. Feekes 15.10 occurs when kernels are hard and kernels cannot be cracked by hand. Feekes 15.11 occurs when kernels are hard and kernels cannot be cracked by hand. Feekes 15.12 occurs when kernels are hard and kernels cannot be cracked by hand.