Spectrum Analytic Inc.

WHEAT GROWTH STAGES, THEIR SIGNIFICANCE to YIELD and PLANT SAMPLING

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In the United States, wheat growth is typically described by one of two systems. They are the Feekes scale and the Zadoks scale. There are others in use around the world, but these two are the most common in this country. The Zadoks scale has the most divisions and is the most descriptive. However, it is probably safe to say that the Feekes scale is used more extensively. While the Feekes scale is typically not referred to with sub-divisions in commercial agriculture (1.0, 1.1, 1.2, etc), I have included these sub-divisions when appropriate.

FEEKES 1.0: Emergence until the onset of tillering.

One shoot formed. This stage can be subdivided (1.1, 1.2, etc.) according to the number of leaves unfolded from a single shoot.

An adequate and proper plant population is one of the basics to achieving top yields. Late planted wheat has less time to tiller and should be compensated for with higher populations. This is to provide a similar number of potential grain-bearing shoots. If early forage production is a goal, producers should increase seeding rates and depend less on tiller formation to produce early forage growth.

Plant Sampling: Not a recommended sample

FEEKES 2.0: Beginning of tillering.

A tiller is a shoot which originates in the axil of a leaf or at the coleoptilar node. Once established, secondary tillers may arise from the axils of the primary tillers and tertiary tillers may develop from the secondary tillers, etc.

If stands are thin, but uniform, an early N application may enhance the rate of tillering, thus increasing the potential number of heads per square foot at harvest. If heat units are available, excess N applied at this time can lead to lush, vegetative growth which can make the crop more susceptible to winter-kill, foliar fungal diseases, and aphid injury. Adequate P is critical to rooting and tiller development. Growers should carefully scout for aphid and other insect infestations during Feekes 2.0 and 3.0, as stress from insect injury can reduce tiller formation.

Plant Sampling: Entire above-ground portion of the plant. 30 – 50 plants.

FEEKES 3.0: Tillers formed.

Leaves begin to twist spirally. Many winter wheats are prostrate or "creeping" at stage 3. Winter wheat can continue to tiller for several weeks. Depending upon planting date and weather conditions, tillering can either be interrupted by or completed prior to the onset of winter dormancy. Most of the tillers that contribute to grain yield potential are completed during this stage.

Many weed control decisions should be made before or during Feekes stage 3.0. Once wheat has achieved full canopy, little problem is experienced from weeds. Growers should carefully scout for aphid and other insect infestations during Feekes 2.0 and 3.0, as stress from insect injury can reduce tiller formation.

Plant Sampling: Entire above-ground portion of the plant. 20 – 30 plants.

FEEKES 4.0: Beginning of erect growth, leaf sheaths lengthen.

Most tillers have been formed by this stage, and the secondary root system is developing. Winter wheat with a prostrate vegetative growth habit begins to grow erect. Leaf sheaths thicken. The growing point is still below the soil.

Continue scouting for insects and weeds. Some growers initiate grazing during Feekes 4.0.

Plant Sampling: Entire above-ground portion of the plant 20 – 30 plants.

FEEKES 5.0: Leaf sheaths strongly erect. All meaningful tiller development has ceased.

Many varieties of winter wheat which are prostrate during tillering grow vertically at this stage. In early planted wheat in southern areas of the U.S., this stage can occur prior to the onset of winter dormancy. Further development of winter wheat requires vernalization, or a period of cool weather. During Feekes stage 5, and after vernalization, the growing point (while below the soil) differentiates. This means that all leaves have been formed, and the growing point(s) will begin to develop an embryonic head. The size of the heads, or number of spikelets per spike, is determined. Tillers developed after Feekes 5.0 have little or no effect on yield.

Nitrogen applied at Feekes 5 can affect the number of seed per head and seed size, but will not likely affect the number of heads harvested. Later N applications will not affect the potential number of seed per head, but can increase the weight and protein content of the seed. Nutrient and environmental stress during this stage can have a significant effect on yield by reducing the number of seed per head. Therefore having good fertility in place and correct irrigation management at this stage is critical.

If the wheat is to be grazed at this stage, care should be taken. Final plant size, leaf area, and yield are closely related to the severity of grazing. Tall varieties are more tolerant of severe grazing at this stage of growth. Rotate cattle with a goal of leaving a minimum of 3 to 4 inches of green leaf area going into Feekes stage 6.0.

Plant Sampling: Entire above-ground portion of the plant. 20 – 30 plants.

FEEKES 6.0: First node visible.

Prior to this stage the nodes (swollen areas in a stem identifying a joint between stem sections) are formed, but compressed together below the soil line. At Feekes stages 6.0 the first node appears above the soil line. The node is normally visible, or can be felt as a swelled area in the stem. When in doubt, split the stem with a sharp knife or razor to find the node. Most wheat varieties have hollow stems below this first node. This stage will not occur prior to the onset of cold weather, because vernalization is required in winter wheat prior to spikelet differentiation. Above this node is the head, or spike, which is being pushed upwards. At this stage the spike is fully differentiated and contains all of the potential spikelets and florets or seed forming branches. The true stem is now forming.

Head size can no longer be affected by fertilizer applications. While most small grains can still show a significant yield response to N at this stage, it will not be as strong as when applied by Feekes stage 5.0. Some mechanical injury from fertilizer applications can occur at this stage, but if the crop is under a nutrient stress, the response should more than offset the injury.

Applications of phenoxy herbicides after Feekes stage 6.0 can be translocated into the developing spike, causing sterility or distortion and reduced yields. Sulfonyl urea herbicides are safe at this growth stage. Be sure to consult the manufacturer's label for specific instructions of herbicide applications. All grazing should cease by Feekes stage 6.0. Significant yield losses can occur due to loss of leaf area and mechanical injury by livestock.

Plant Sampling: Entire above-ground portion of the plant. 20 – 30 plants.

FEEKES 7.0: Second node and next to last leaf visible.

This stage is characterized by the rapid expansion of the spike and the appearance of a second node above the soil surface.

Plant Sampling: Entire above-ground portion of the plant. 20 – 30 plants.

FEEKES 8.0: Flag leaf visible.

The flag leaf is the last upper youngest leaf on a stem. This growth stage begins when the flag leaf begins to emerge from the whorl. The flag leaf makes up about 75% of the effective leaf area that contributes to grain fill. When the flag leaf emerges, at least 3 nodes are visible above the soil surface. Occasionally a fourth node can be found. To confirm that the flag leaf is emerging, split the leaf sheath above the highest node. If the head and no additional leaves are found inside, Feekes stage 8.0 is confirmed.

At Feekes 8.0, the grower should decide whether to use a foliar fungicide or not. This decision should be based upon the following considerations:

- Is a fungal disease present?
- Does the crop have resistance to the fungal disease, or is the disease spreading rapidly?
- Does the crop yield potential warrant the cost of application of the fungicide?
- Is the crop under stress?
- If the answer to the first three answers is yes, and the fourth no, fungicides are warranted.

N applications at Feekes stage 8.0 and later can increase grain protein, but will probably not have a significant effect on final yield.

Irrigation scheduling is critical between Feekes stage 8.0 and 11.1 (mid-grain). The crop should not be stressed from about 10 days prior to bloom through the late milk stage, if maximum yield is to be expected.

Plant Sampling: Entire above-ground portion of the plant. 20 – 30 plants.

FEEKES 9.0: Ligule of flag leaf visible.

This stage is determined by the full emergence of the flag leaf. The full emergence of the flag leaf is determined by being able to see the ligule (a "fleshy" collar-like structure) at the base of the flag leaf. From this stage on, the leaves are referred to by their relation to the flag leaf, i.e.; the first leaf below the flag leaf is F-1, the second below is F-2, etc. A wheat plant typically produces 7 to 9 true leaves, not including the leaves on the tillers.

Plant Sampling: Flag leaf, 20 – 30 leaves.

FEEKES 10.0: Boot stage.

The head is fully developed, but has not yet emerged from the leaf sheath below the flag leaf. The leaf sheath containing the fully developed head is called the "boot". Feekes stage 10 is divided into multiple sections as follows.

10.0	boot stage	10.5	heading complete
10.1	awns visible, heads emerging through slit of flag leaf sheath	10.5.1	beginning flowering
10.2	heading ¼ complete	10.5.2	flowering complete to top of spike
10.3	heading ½ complete	10.5.3	flowering complete to base of spike
10.4	heading ¾ complete	10.5.4	kernels watery ripe

Wheat is largely self-pollinating. Most florets are pollinated before the anthers (end of stamen containing pollen) are extended. Although tillers have developed over a several week period, bloom in a given plant is usually complete in a few days.

Plant Sampling: Flag leaf, 20 – 30 leaves.

FEEKES 11.0: **Ripening.** (No picture)

This stage refers only to the maturity or development of the grain. It is sub-divided as follows.

11.1	milky ripe
11.2	mealy ripe
11.3	kernel hard
11.4	harvest ready

Bloom occurs 4 to 5 days after heading. The grain fill period varies somewhat, depending on climate, requiring about 30 days in a high stress environments to more than 50 days in high yield, low stress environments.

Plant Sampling: Not a recommended sampling stage.

REFERENCES

Miller, Travis D. 1992. Growth Stages of Wheat: Identification and Understanding Improve Crop Management. Better Crops. 76, 3: 12-17.