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Corn Growth and Management

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Knowing the growth stages and growth processes of corn allows growers to time field operations properly to meet windows of opportunity. Proper timing of fertilizer, irrigation, cultivation, harvest and pesticide application can improve yields significantly.

Vegetative Stages

1. VE (emergence), 2. V1 (first leaf), 3. V2 (second leaf), 4. V3 (third leaf), 5. V(n) (nth leaf) and 6. VT (tasseling)

1. Germination and Emergence (VE): Corn seed begins germination when the seed contains at least 30% moisture. The first seedling structure to emerge from the corn seed is the radicle (root), followed by the coleoptile (shoot) with the enclosed plumule (first leaves and growing point). Emergence of the radicle first allows the young seedling to anchor in the soil and obtain an adequate supply of water and later obtain water and nutrients. To emerge, the first internode on the corn plant (the mesocotyl) elongates toward the soil surface and continues until the coleoptile reaches light. If not planted too shallowly, the crown of the corn plant usually establishes at about ¾ inch from the soil's surface. Corn emerges after the accumulation of about 125 growing degree days (GDDs). Each new leaf takes 80-85 GDDs to emerge.

2. V1 to V2: These growth stages occur about one week after the plant emerges. Because the root system is relatively small and the soil is cool, fertilizer nutrients stimulate early plant growth. However, the amounts of nutrients required are relatively small, and fertilizer placed in a band where the primary roots will contact it will allow effect uptake at this stage. The seedling (seminal) roots of the corn plant in the first whorl (groups of roots arising from a node) are elongating.

3. V3 to V5: Two to three weeks after the plant emerges, the V3 stage begins. A frost (light freeze) or hail may destroy the exposed leaves but will not damage the growing point below the soil surface, so damage to the plant above the soil surface at this time usually results in very little reduction in yield.. Leaf and ear shoots are being initiated and this initiation will be complete by V5 (potential ear shoot number is determined). Also by V5, a microscopically small tassel is initiated at the growing point.

4. V6 to V7: Three weeks after the plant emerges, the plant enters the V6 stage. The root system is well-distributed in the soil and extends about 18 inches in depth and 24 inches in radius. The third root whorl is elongating.

5. V8 to V9: Four weeks after the plant emerges, it enters V8. Nutrient deficiencies, if present, become more obvious. Nutrient deficiencies at this stage seriously restrict leaf growth. Corn can respond to "rescue" applications of some nutrients (e.g. N, K, S and Zn) at this stage, although applications may require high-clearance equipment so the crop is not damaged. The fourth whorl of nodal roots is elongating.

6. V10 to V11: Five weeks after the plant emerges, it enters V10. The corn plant begins a steady and rapid increase in nutrient and dry-matter accumulation. The time between the appearance of new leaves is shortened after the V10 stage to about 50 GDDs per leaf, with a new leaf appearing every two to three days.
7. V12 to V13: Six weeks after the plant emerges, V12 begins. Moisture or nutrient deficiencies may reduce the potential number of seeds on the cob by limiting the length of the cob and thereby seriously reducing the number of kernels per row. The kernel number per cob is determined during the period from V10 to V17. The length of time for the plant to develop through these stages affects harvestable yield.
8. V14 to V15: Seven weeks after the plant emerges, V14 begins. The corn plant at V15 is only 12 to 15 days away from R1 (silking). Silks are just beginning to grow from the upper ears. A new leaf stage can occur every one to two days. Brace roots from the sixth node are developing, and the permanent roots have continued to elongate and proliferate, eventually reaching a depth of about 5 to 8 feet and spreading several feet in all directions.
9. V16 to V17: Eight weeks after the plant emerges, it is entering the late vegetative stages. The earliest maturing hybrids used in North Dakota may develop only 16 leaves. Because of high transpiration rates by the crop at this stage, drought stress can develop quickly if soil moisture is limited. Moisture stress two weeks before or after silking can cause a large grain yield reduction (Table 1). In general, this is true for other types of environmental stresses (hail, high temperature, nutrient deficiencies) during this time. Tips of upper-ear shoots may be visible at the top of leaf sheaths by V17 in hybrids that develop more than 16 leaves.
10. V18: and other numbered vegetative stages that may follow Silks from the basal ear ovules have been the first to elongate, followed by silks from ovules above them, and ending with the silks from the ear tip ovules. Brace roots are growing from above-ground nodes and can provide support to the plant and reduce the risk of lodging. Ear development is continuing rapidly, with the plant only one week away from viable silking.
11. VT (tasseling) Stage: VT occurs two to three days before silking, when the last branch of the tassel is completely visible but silks have not emerged yet from the ear shoot. The plant has reached full height and the pollen shed begins. The time between VT and R1 can vary with different hybrids and due to environmental conditions. All leaves have emerged. Pollen shed (pollen drop) normally occurs during the late morning or early evening. Hail damage is more serious at this time than for any other growth period. The complete loss of a pollen source would result in no grain formation.

Reproductive Stages and Kernel Development

R1 (silking), R2 (blister), R3 (milk), R4 (dough), R5 (dent) and R6 (physiological maturity)

1. R1 Silking: The plant is about 55 to 66 days after emergence. This stage begins when silks are visible and pollination occurs. Pollination is when pollen grains contact the new, moist silks. A pollen grain grows down the silk and fertilizes the ovule in about 24 hours. Upon this fertilization, the ovule is a kernel. Silks grow about 1 to 1.5 inches per day and continue growing until fertilization. Normally, for all silks on a single ear to emerge and be pollinated takes two to three days. Moisture stress or nutrient deficiency will result in poor pollination and seed set. The largest yield reduction occurs with stress at silking (early R1). Potassium uptake is essentially complete, and nitrogen and phosphorus uptake is rapid in the plant.
2. R2 Blister: This stage is about 12 days after silking. The kernels are white and contain a clear liquid. The cob is close to full size. Silks darken and dry. Irrigation, if needed, can ensure adequate moisture for grain production. Starch is just beginning to accumulate in the watery endosperm (the kernels are about 85% moisture). Kernels are in a steady and rapid period of seed-fill (continues to R6).

3. R3 Milk: This stage is about 20 days after silking. Kernels are beginning to yellow (for yellow corn) on the outside but contain a milky white inner fluid (starch accumulation; the kernel is at about 80% moisture). Most of the kernels have grown out from the surrounding cob material. The endosperm (the starchy center of the kernel) division in each seed is complete and growth will be due to cell expansion and starch accumulation. Stress is not as severe at R3 as at R1; however, yield reduction can occur due to a reduction in the number of kernels that ultimately develop and to the final size and weight of the kernels. Very little root growth occurs after R3.

4**. R4 Dough:** This stage is about 26 days after silking. The kernel has thickened to a pasty (doughy) consistency from the earlier milky state (starch has continued to accumulate). The embryo of the seed is growing while the kernels are just beginning to dry at the top (dent). Kernels have accumulated 50% of their dry weight and have about 70% moisture.

5. R5 Dent: This stage is about 36 days after silking. For dent types, nearly all kernels are dented or denting. Drying kernels show a small, hard, white layer on top. A white line (known as the milk line or starch line) can be seen across the kernel shortly after denting (starch line position indicates maturity; it will advance toward the kernel tip with maturity). Stress at this point can reduce kernel weight but not kernel number. A hard frost can stop dry-matter accumulation and cause premature black layer formation (Table 3). Yields also may be influenced due to field losses from frost-damaged ears, which are slower to dry and delay harvest. (This indicates hybrids that are mature at least seven to 10 days before the average first killing frost date should be selected).

6. R6 Physiological Maturity: This stage is about 55 days after midsilk. All kernels have attained maximum dry weight. The starch line has advanced completely to the kernel tip and a brown or black layer is present (black layer progresses on the ear from the tip kernels to the basal kernels in about 10 days). Harvest for silage can be done now or slightly earlier, but grain harvest will require more drying. Husks and many of the leaves are no longer green, but the stalk may be green. At black layer, the average kernel moisture is 30% to 35% (averaged across hybrids and environmental conditions). At 20% to 26% moisture, grain harvested still will need artificial drying to be stored safely; thus, more field dry-down often is used (rate of field drydown varies with hybrid and environmental conditions). Shelled corn can be stored safely at 13% to 15% moisture.