

Corn

Growth and Management

QUICK GUIDE

Reviewed by

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

Knowledge of the plant growth process provides the means to enhance the corn crop. Plant symptoms occurring during certain growth stages help the grower determine the cause and effect of a deficiency, disease or other crop problem and take timely measures.

Producers have several methods of staging corn. The leaf collar method uses a counting system of “collared” (when the leaf partially unclasps the stem or culm) leaves during the vegetative growth stages and includes the first emerging round-tipped leaf in the count. This is the most commonly used staging method.

Another less common method is similar but does not count the first emerging leaf, only the later, pointed-tipped leaves. A third method of staging commonly is used by the crop insurance industry and simply counts all leaves visible, whether rounded or pointed and collared or not.

Knowing the staging method used to describe the stage of plant growth is essential. Herbicide labels that don’t refer to the leaf-collar method may (or may not) skip counting the first true leaf (rounded-tipped leaf). To clarify, some labels may refer to the height of the weeds for application timing.

Being off one or two leaf stages due to differing descriptions may not always be critical, but it can lessen the treatment benefits and create confusion in interpreting labels, troubleshooting problems and dealing with others, such as insurance adjusters. Consistent staging descriptions can help apply herbicides at the right time and avoid crop damage.

Vegetative Stages

VE (emergence)
V1 (first leaf)
V2 (second leaf)
V3 (third leaf)
V(n) (nth leaf)
VT (tasseling)

Reproductive Stages

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

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Vegetative

Vegetative Growth Stages

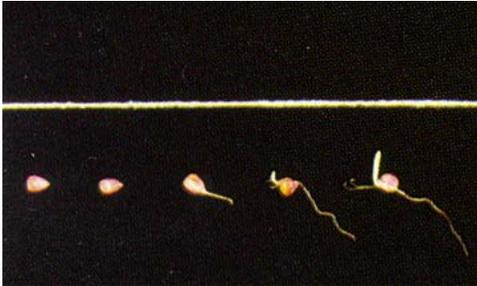


Figure 1. Germination and emergence zero, two, four, five and six days after planting.

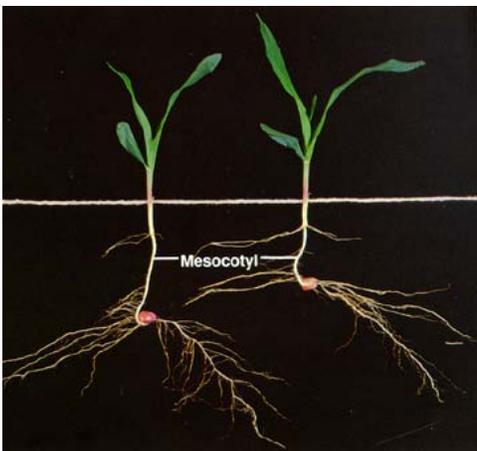


Figure 2. V2 plant.



Figure 3. V3 plant.

1. Germination and Emergence (VE)

Corn seed begins germination when the seed contains at least 30 percent 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.

At the VE stage, the growing point is normally 1 to 1.5 inches below the soil surface. The growing point remains below the soil surface for **three to four weeks**, protecting this growing point from physical injury, including frost, surface insects or grazing animals.

Effect of Planting Dates on Corn Grain Yield

Planting Date	Yield	
	Potential (%)	Good Planting Range
May 1	100	
May 5	97	
May 10	94	
May 15	91	
May 20	88	
May 25	86	
May 30	83	

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, higher concentrations of 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 **roots** of the corn plant in the **first whorl** are elongating.

3. V3 to V5

Two weeks after the plant emerges, the V3 stage begins. Cultivation too near the plant after this time will destroy some of the permanent root system. 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.

Growth of the seedling root system essentially has ceased. Root hairs are present on nodal roots. The **roots** of the **second whorl** are elongating. The nodal roots now form the major part of the root system. **Leaf and ear shoots are being initiated** and this initiation will be complete by V5 (potential ear shoot number is determined).

Vegetative

Vegetative Growth Stages

Also by V5, a microscopically small tassel is initiated at the growing point. The above-ground plant height is about 8 inches when the tassel is initiated, but the growing point is still at or just under the soil surface. However, soil temperature can affect the growing point. Cold soil temperatures can:

- increase the time between leaf stages
- increase the total number of leaves formed
- delay tassel formation
- reduce nutrient availability

Weeds also are competing for water, nutrients and light. Chemicals, cultivation and higher plant populations or crop rotation used in crop planning can reduce weed pressure and limit the competition to the corn crop.

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. The plant is **absorbing greater amounts of nutrients**, so fertilizer applications in amounts adequate to replace soil needs are beneficial at this time.

The growing point is above the soil surface and rapid stem elongation begins. Some tillers (suckers) may have initiated. Sucker development varies with hybrid, plant density, fertility and other environmental conditions.

Row-applied fertilizer is less critical now as nodal roots have proliferated throughout the soil. Nitrogen can be side-dressed up to V8 if placed in moist soil and excessive root pruning and injury of above-ground plant parts are avoided.

5. V8 to V9

Four weeks after the plant emerges, it enters V8. **Macronutrient and micronutrient deficiencies can appear** at this time. Foliar applications may correct some soil deficiencies, especially if applied before the symptoms. Nutrient deficiencies at this stage seriously restrict leaf growth.

The **fourth whorl of nodal roots** is elongating. Several ear shoots are present. A potential ear shoot will form at every above-ground node except the upper six to eight. Initially, each ear shoot develops faster than the one above, but growth of the lower ear shoots slows. Only the upper one or two ear shoots eventually form harvestable ears.

Prolific hybrids tend to form more than one harvestable ear, especially at lower plant populations. Removal of all the unfurled leaves of the plant at this stage (by frost or hail) may result in a 10 to 20 percent reduction in final grain yield.

Flooding at this or any earlier stage when the growing point is below ground can kill the corn plants in a few days, especially if temperatures are high. Flooding at later stages, with the growing point above the soil surface, is not as detrimental.



Figure 4. V6 plant.



Figure 5. Magnified tassel of V7 plant.



Figure 6. V9 plant.

Vegetative

Vegetative Growth Stages



Figure 7.
Magnified top
ear of V12 plant.

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, with a new leaf appearing every two to three days.

Demand for soil nutrients and water are relatively high to meet the needs of the increased growth rate. Moisture and nutrient deficiencies at this stage will influence the growth and development of the ears markedly. Fertilizer, especially phosphorus and potassium, is needed near the roots, which do not move appreciable distances in most soils. Dry soils also may make needed nutrients less available.

7. V12 to V13

Six weeks after the plant emerges, V12 begins. **Moisture or nutrient deficiencies** may reduce the potential number of seeds, as well as the ear size, seriously. These two components of yield have key development during the period from V10 to V17. The length of time for the plant to develop through these stages affects harvestable yield.

Early maturity hybrids normally progress through these stages in less time and have smaller ears than later hybrids. Higher plant populations are needed for earlier hybrids to produce grain yield similar to normal-maturity hybrids in the adapted region. Cultivation of plants at this time will destroy some of the plant roots. **Brace roots are developing** from the fifth node and the first above-ground node.



Figure 8. V12 plant.

8. V14 to V15

Seven weeks after the plant emerges, V14 begins. The corn plant at V15 is only 12 to 15 days (around one to five V stages) away from R1 (silking). This vegetative stage is the most critical period of seed yield determination. The number of ovules that develop silks, and thus the **number of kernels**, is being determined. Any nutrient or moisture deficiency or injury (such as hail or insects) may seriously reduce the number of kernels that develop.

The tassel is near full size but not visible from the top of the leaf sheaths. Silks are just beginning to grow from the upper ears. Upper-ear shoot development has surpassed that of lower ear shoots. A new leaf stage can occur every one to two days.

Brace roots from the sixth leaf 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. In some hybrids, brace roots also will develop from the eighth and ninth leaf nodes or even higher. Some corn plants in North Dakota may only develop 16 leaves.



Figure 9.
V15 plant.

9. V16 to V17

Eight weeks after the plant emerges, it is entering the late vegetative stages if the plant has not developed its total number of plant leaves already. During this time, plant stress can affect yield greatly.

Moisture stress two weeks before or after silking can cause a large grain yield reduction. In general, this is true for other types of environmental stresses (hail, high temperature, nutrient deficiencies) during this time.

The four-week period around silking is the most effective time for irrigation if the water supply is short. Tips of upper-ear shoots may be visible at the top of leaf sheaths by V17 in hybrids that develop more than 16 leaves. The tip of the tassel also may be visible by V17 in more prolific-leaf hybrids.

10. V18 and other numbered vegetative stages that may follow

The **vegetative plant is reaching full size in prolific-leaf hybrids.** Silks from the basal ear ovules have been the first to elongate, followed by the silks from the ear tip ovules. Brace roots are growing from above-ground nodes. These brace roots provide support to the plant and obtain water and nutrients from the upper soil layers during the reproductive plant stages.

Ear development is continuing rapidly, with the plant only one week away from viable silking at V18. Stress in these later vegetative stages will delay beginning silking more than beginning pollen shed (which might cause the corn to delay silking until pollen shed is partially or completely finished, causing the nick to be missed). Unfertilized ovules result in missing kernels on the ear, especially at the ear tip.

The yield of prolific-eared hybrids (two or more ears per plant) is more stable under stress conditions, although nonprolific hybrids (strongly single-eared) that are available often will outyield prolific hybrids under nonstress conditions.



Figure 10. V18 plant.

Yield Reduction in Corn Due to Drought

Age of the Corn Plant	Stage	Yield Reduction per Drought Day (%)	% Total Reduction
1-33 days*	GE-V5	—	—
Next 22-32 days	V6-V15	2.0	25
Next 5-15 days	V16-R2	6.0	50
Next 20-30 days	R3-R5	1.5	25
Next 5-15 days**	R6	—	—

*Yield reduction depends on many variables, including germination and upper soil profile moisture.

**Overall drought period will affect yield reduction. A continuous drought may result in 100 percent reduction.

Vegetative Growth Stages



Figure 11. VT plant.

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.

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. All leaves have emerged and the complete loss of a pollen source would result in no grain formation.

Critical Field Corn Growth Stages

Growth Stage	Days after Emergence	Growth Event	Importance
V3	9-12	Seminal root system and ear shoots initiated	Seedling vigor seen, ears established
V4 to V5	14-21	Ear shoot initiation complete	Number of kernel rows determined
V6	21-25	Nodal root system established	Plant's ability to take up nutrients and water is established
V12 to V14	42-49	Number of ovules determined	Number of kernels per row determined
R1 (silking)	63-68	Pollen shed begins, brace roots establish, near maximum root mass	Kernel fertilization, support ear weight, kernel fill

Reproductive Stages and Kernel Development

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.

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. **Nutrient content by leaf analysis is highly related to the final grain yield at this time.** A response to previously applied fertilizer can be seen.

2. R2 Blister

This stage is about 12 days after silking. The kernels are white and shaped like a blister. The cob is close to full size. Silks darken and dry. Hot, dry conditions will cause the silks to darken even more. Irrigation, if needed, can ensure adequate moisture for grain production. Kernels are in a steady and rapid period of seed-fill (this continues to R6). **Starch is just beginning to accumulate** in the watery endosperm (the kernels are about 85 percent moisture).

3. R3 Milk

This stage is about 20 days after silking. Kernels are beginning to yellow on the outside but contain a milky white inner fluid (starch accumulation; the kernel is at about 80 percent moisture). Most of the kernels have grown out from the surrounding cob material.

The endosperm cell 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 and kernel moisture content has decreased). The embryo of the seed is growing while the kernels are just beginning to dry at the top (dent).

Kernels have accumulated 50 percent of their dry weight and have about 70 percent moisture. Unfavorable environmental conditions or nutrient deficiencies still can result in unfilled kernels and “chaffy” ears.

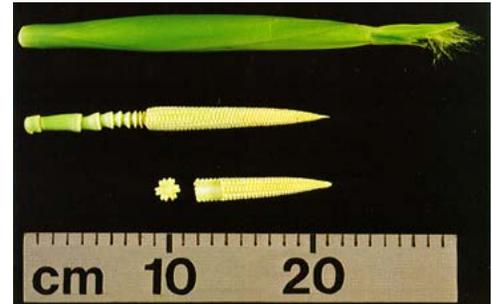


Figure 12. R1 ear and shank.



Figure 13. R2 ear and shank.



Figure 14. R3 ear and shank.



Figure 15. R4 ear and shank.

Reproductive Stages and Kernel Development



Figure 16. R5 ear and shank.



Figure 17. R6 ear and shank.

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5. R5 Dent

This stage is about 36 days after silking. 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 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 a premature black layer formation. 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 10 days to three weeks before the average first killing frost date should be selected).

Kernels at this stage have about 55 percent moisture. At around 48 days after silking, all the kernels should be fully dented. The seed embryo is morphologically mature. Dry-matter accumulation in the kernels will cease soon.

Corn Grain Frost Injury Yield Reduction

Kernel Development	Kernel Moisture	Days after R1	Days to PM* (R6)	Yield Reduction
R4 – Dough	70%	26	31-37	35-50%
R5 – Dent	50%	36	20-23	10-20%
R5.5 – Mid-Dent	40%	48	10-12	4-5%
R6 – PM*	30-35%	55	0	0%

*PM is Physiological Maturity (black layer)

6. R6 Physiological Maturity

This stage is about 55 days after silking. **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 percent** (varying with hybrids and environmental conditions).

At 20 to 26 percent moisture, grain harvested still will need artificial drying to be stored safely; thus, more field dry-down often is used (rate of field dry-down varies with hybrid and environmental conditions). Shelled corn can be stored safely at 13 to 15 percent moisture.

Corn Moisture Content and Drydown

Stage	Approximate Moisture
R5 (dent)	50-55%
R6 (PM)	30-35%
Field Drydown from	
30-25%	¾% per day
below 25%	¼% per day