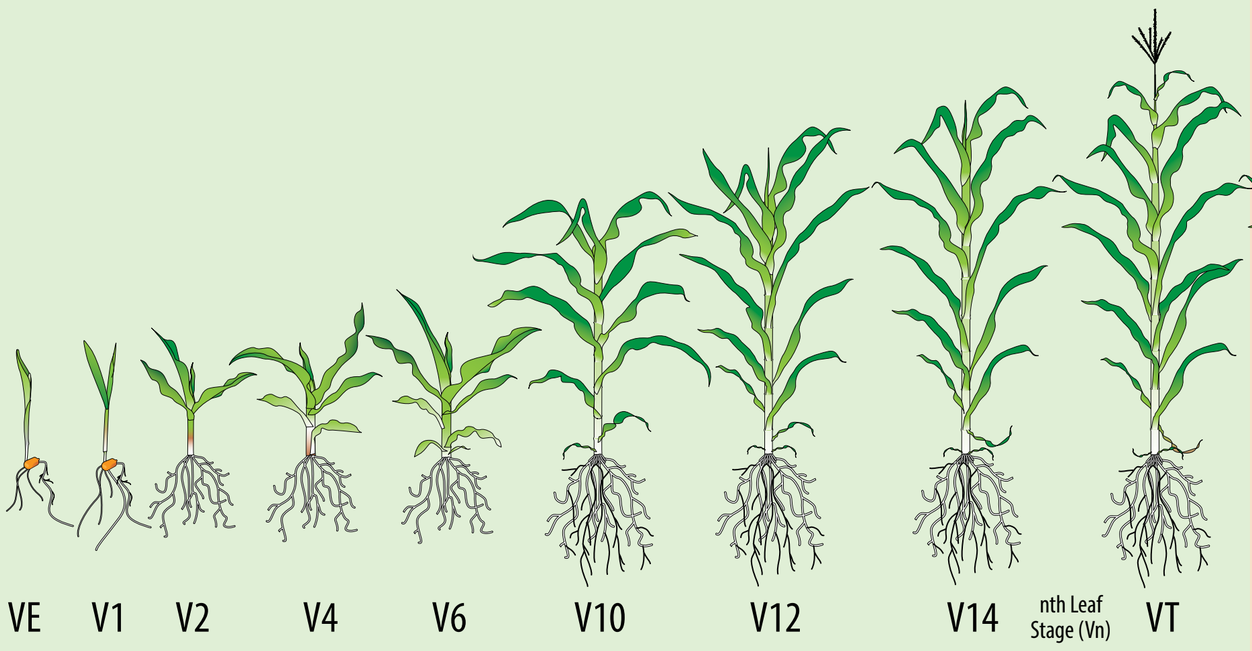
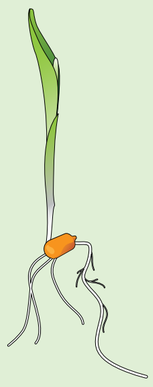
# Corn Growth and Development




Vegetative

Reproductive

## Corn Development Stages

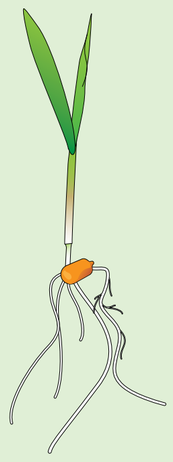


### VE – Emergence

Emergence occurs when the first leaves, called the spike or the coleoptile, appear above the soil surface. The seed absorbs water (about 30% of its weight) and oxygen for germination. The radicle root quickly emerges near the tip of the kernel, depending on soil moisture and temperature conditions. The coleoptile emerges from the embryo side of the kernel and is pushed to the soil surface by mesocotyl elongation. The mesocotyl encloses the plumule leaves that open as the structure approaches the soil surface.

#### Management

Ideal soil temperatures (50 to 55 degrees Fahrenheit) and moisture conditions promote rapid emergence (5 to 7 days). Optimum seed placement varies from 1 to 2 inches deep. Appropriate planting depth is critical for optimal emergence. Cold, dry, and deep planting can delay emergence for several days.

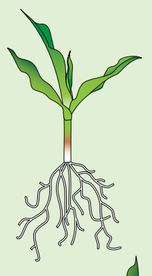


### V1 – First-Leaf

One leaf with collar visible (structure found at the base of the leaf). The first leaf in corn has a rounded tip. From this point until flowering (R1 stage), leaf stages are defined by the uppermost leaf with visible collars. The growing point is located below the surface until the late V5 stage.

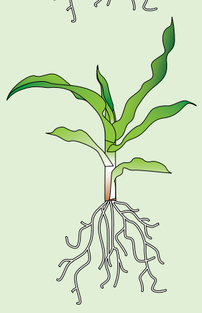
#### Management

Scout for proper emergence (e.g., 30 plants in 17½ feet for 30-inch row spacing = 30,000 plants per acre), early-season weeds, insects, diseases, and other production issues.



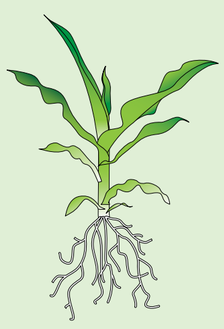
### V2 – Second-Leaf

Nodal roots begin to emerge below ground. Seminal roots begin to senesce. Frost is unlikely to damage corn seedling, unless it is extremely cold or the corn was shallowly planted.



### V4 – Fourth-Leaf

Nodal roots are dominant, occupying more soil volume than seminal roots. Leaves still developing on apical meristem (primary growth of the plant).



### V6 – Sixth-Leaf

Six leaves with collar visible. The first leaf with the rounded tip is senescent; consider this point when counting leaves. The growing point emerges above the soil surface. All plant parts are initiated. Sometime between V6 and V10, the potential number of rows (ear girth) is determined. Potential row number is affected by genetics and environment and is reduced by stress conditions. The plant increases in height due to stalk elongation; nodal roots are established in the lowest, below-ground nodes of the plant.

#### Management

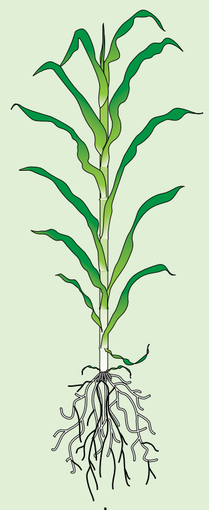
Scout for weeds, insects, and diseases. Rapid nutrient uptake begins at this stage. Timing nutrient applications to match this uptake enhances the potential for greater nutrient use efficiency, particularly for mobile nutrients such as nitrogen.

### V10 – Tenth-Leaf

Brace roots begin to develop in the lower above-ground nodes of the plants. Until this stage, rate of leaf development is approximately 2 to 3 days per leaf.

#### Management

Nutrient (potassium = K > nitrogen = N > phosphorous = P) and water (0.25 inch per day) demands for the crop are high. Heat, drought, and nutrient deficiencies will affect potential number of kernels and ear size. Scout for root lodging issues and diseases (e.g., common rust, brown spot). Weed control is critical since corn does not tolerate early-season competition for water, nutrients, and radiation well.

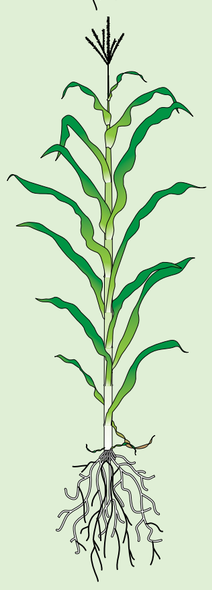


### V14 – Fourteen-Leaf

Rapid growth. This stage occurs approximately two weeks before flowering. Highly sensitive to heat and drought stress. Four to six extra leaves will expand from this stage until VT.

#### Management

Scout for root lodging issues, greensnap (likely to occur from V10 to VT) and diseases (e.g., common rust, brown spot). Abnormal corn ears can occur and be obvious from this time until flowering.

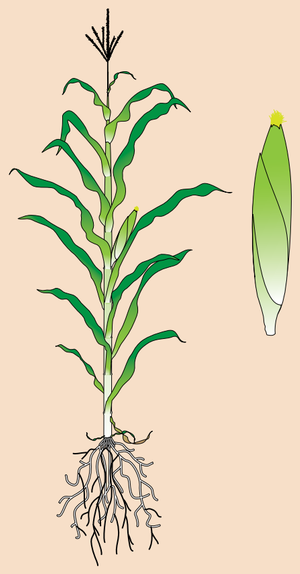


### VT – Tassel

Potential kernels per row is set, final potential grain number (number of ovules), and potential ear size are being determined. Last branch of the tassel is visible at the top of the plant. Silks may or may not have emerged. The plant is almost at its maximum height.

#### Management

Nutrient (K > N > P) and water (0.30 inch per day) demands for the crop are close to maximum. Heat and drought will affect potential number of kernels. Scout for insects (e.g., corn leaf aphid, western bean cutworm, corn earworm, fall armyworm) and diseases (e.g., gray leaf spot, southern rust, northern leaf blight). Total leaf defoliation severely affects final yields.

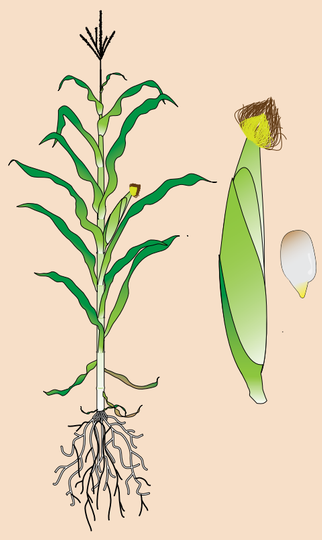


### R1 – Silking

Flowering begins when a silk is visible outside the husks. The first silks to emerge from the husk leaves are those attached to potential kernels near the base of the ear. Silks remain active until pollinated. Pollen falls from the tassel to the silks, fertilizing the ovule to produce an embryo. Potential kernel number is determined. Maximum plant height is achieved. Following fertilization, cell division is occurring within the embryo.

#### Management

Nutrient (N and P accumulation is still progressing, K is almost complete) and water (0.33 inch per day) demands are at the peak. Heat and drought will affect pollination and final grain number. Defoliation by hail or other factors such as insects will produce a large yield loss.

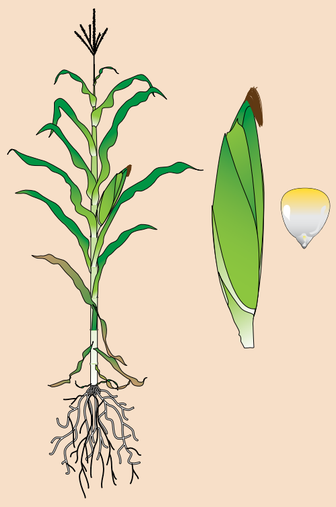


### R2 – Blister

Silks darken and begin to dry out (approximately 12 days after R1). Kernels are white and blister-like in shape and contain a clear fluid. Kernels are approximately 85% moisture; embryos develop in each kernel. Cell division is complete. Grain filling commences.

#### Management

Stress can reduce yield potential by reducing final grain number (abortion).

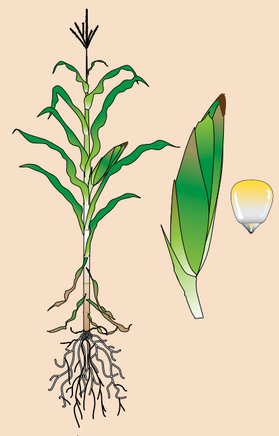


### R3 – Milk

Silks dry out (approximately 20 days after R1). Kernels are yellow, and a milk-like fluid can be squeezed out of the kernels when crushed between fingers. This fluid is the result of the starch accumulation process.

#### Management

Stress will still cause kernel abortion, initially from the ear tip.

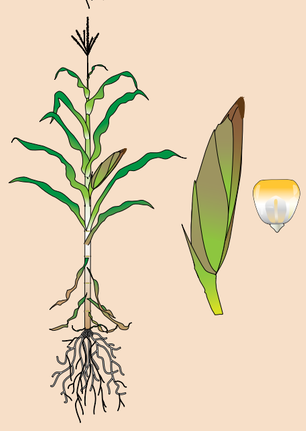


### R4 – Dough

Starchy material within the kernels has dough-like consistency (approximately 26 to 30 days after R1). Rapid accumulation of starch and nutrients occurs; kernels have 70% moisture and begin to dent on the top. Material squeezed out of the kernel has dough-like consistency.

#### Management

Stress can produce unfilled or shallow kernels and "chaffy" ears. Impact of frost on grain quality can be severe when it occurs at this stage (25 to 40% yield loss from light to killing frost, respectively).

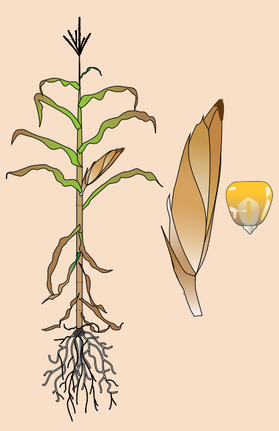


### R5 – Dent

Most of the kernels are dented. Kernel moisture declines to approximately 55% (38 to 42 days after R1) as the starch content increases.

#### Management

Stress can reduce kernel weight. Silage harvest is approaching (at around 50% kernel milk).

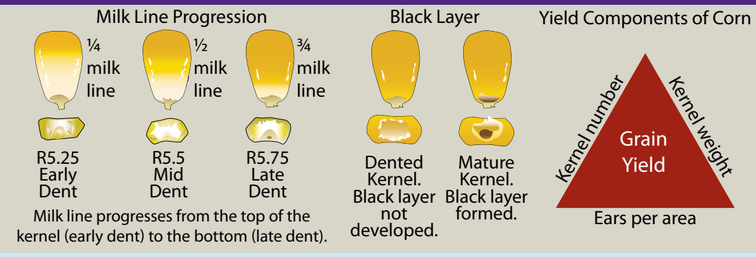


### R6 – Maturity

A black layer forms at the base of the kernel, blocking movement of dry matter and nutrients from the plant to the kernel (50 to 60 days after R1). Kernels achieve maximum dry weight (30 to 35% moisture) and are physiologically mature.

#### Management

Grain is not ready for safe storage. Frost or any biotic or abiotic stress does not impact yields after this development stage. Lodging from disease, insect damage, or hail can result in physical loss of yield. Harvest can proceed, but recommended moisture for long-term storage is 14.5%. Scout fields for ear drop due to things such as European corn borer damage.




**Yield components and critical growth stages for their definition in corn production.**

| Stage | Yield Components | |
|---|---|---|
| | Potential | Actual |
| **VE** | Ears/area | — |
| **V6** | Kernel rows/ear | "Factory"[3] |
| **V12** | — | Kernel rows/ear |
| **V18** | Kernels/row | — |
| **R1**[1,2] | Kernel weight<br>Ears/area | Kernel number<br>R1 to R5 |
| **R6** | — | Kernel weight |

[1] Potential Kernel Weight = set when cell division takes place in the endosperm, 7 to 10 days after pollination (R1-R2 or the "lag" phase of the sigmoidal kernel growth curve).

[2] R1 = potential kernel ovules and kernel number, if no stress is affecting pollination and final kernel development.

[3] Factory = After tassel initiation at V5, all corn plant parts are already developed to support ear and grain development.

**Growth stages, moisture content, and total dry matter progression for corn during the reproductive period.**[1]

| R Stage | Moisture % | Dry Matter (% of Total Dry Weight) | Average per Substage | |
|---|---|---|---|---|
| | | | Growing Degree Days, °F | Days |
| 5.0 | 60 | 45 | 75 | 3 |
| 5.25 (¼ milk line) | 52 | 65 | 120 | 6 |
| 5.5 (½ milk line) | 40 | 90 | 175 | 10 |
| 5.75 (¾ milk line) | 37 | 97 | 205 | 14 |
| 6.0 (Physiological maturity) | 35 | 100 | | |

[1] Abendroth, L.J., R.W. Elmore, M.J. Boyer, and S. K. Marlay. 2011. *Corn Growth and Development*. PMR 1009. Iowa State Univ. Extension. Ames Iowa.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Based on information from *How a Corn Plant Develops,* Special Report No. 48, 1986 and *Corn Growth and Development,* PMR 1009, 2011. Iowa State University Extension.

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