Plant Physiology

Critical Stages in the Life of a Corn Plant

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Nature greatly influences corn growth and yield. However, the corn producer can manipulate the environment with managerial operations including hybrid selection, soil tillage, crop rotation, soil fertilization, irrigation, and pest control. A producer who understands growth and development of corn will understand the importance of timeliness when using production practices for higher yields and profit.

Our objective with this article is to aid those in corn production in understanding how a corn plant develops by explaining corn growth and development of stages critical for determining yield and identifying practices needed for optimum growth and production. A producer who understands the corn plant can use production practices more efficiently and timely to obtain higher yields and profits.

Identifying Stages of Development

The staging system most commonly used is the Iowa System. It divides plant development into vegetative (V) and reproductive (R) stages.

Vegetative Stages	Reproductive Stages
VE Emergenece	R1 Silking
V1 First leaf	R2 Blister
V2 Second leaf	R3 Milk
V3 Third leaf	R4 Dough
*	R5 Dent
*	R6 Physiological maturity
*	
Vnth	
VT tasseling	

Subdivisions of the V stages are designated numerically as V1, V2, V3, through Vn, where n represents the last stage before Vt (tasseling). The six subdivisions of the reproductive stages are designated numerically.

Each leaf stage is defined according to the uppermost leaf whose collar is visible. Beginning at about V6, increasing stalk and nodal root growth combine to tear the small lowest leaves from the plant. To determine the leaf stage after lower leaf loss, split the lower stalk lengthwise and inspect for internode elongation. The first node above the first elongated stalk internode generally is the fifth leaf node. The internode usually is about one centimeter in length. This fifth leaf node may be used as a replacement reference point for counting to the top leaf collar. In a corn field all plants will not be in the same stage at the same time. Each specific V or R stage is defined only when 50% or more of the plants in the field are in or beyond that stage.

Although each stage of development is critical for proper corn production we will focus on VE, V6, V12, V18, R1, and R6. Yield components and the number of Growing Degree Units required at each growth stage are described below.

Stage	GDU	Potential Yield	Actual Yield
VE	125	ears/area	
V6	470	kernels rows/ear	"factory"
V12	815		kernel rows/ear
V18	1160	kernels/row	
R1	1250	kernel weight	kernel number
			ears/area
R6	2350		kernel weight

Stage VE Determination of potential ear density

- Approximately 7-10 days after planting (125 GDU)

Photo 1

Aboveground

- Coleoptile tip emerges above soil surface *(Photo 1)*
- Elongation of coleoptile ceases
- 1st true leaves rupture from the coleoptile tip *(Photo 2)*

Belowground

- Mesocotyl and coleoptile elongation
- Elongation of mesocotyl ceases when coleoptile emerges above soil surface
- Growing point is below the soil surface
- Completed growth of seminal root system (radicle + seminal roots)
  Seminal root system supplies water and nutrients to developing seedling
- Nodal roots are initiated
  Nodal roots are secondary roots that arise from belowground nodes.

Photo 2

Troubleshooting

- Watch forseed attacking insects: (see chart on page 9)
- Germination and emergence delayed when:
  Inadequate moisture
  Cool soil temperatures (<50°F)
- Planting depth around 1.5-2.0"
  1st leaves will emerge belowground if seed planted to deep, or soil is cloddy or crusted
- Herbicide injury: coleoptiles will be corkscrew shaped, and have swollen mesocotyls
- Frost will not affect yield (<28 F)
- Hail will not affect yield (max)
- Severe yield losses from flooding (>48 h)

Management Guide

- Banding small amounts of starter fertilizer to the side and slightly below the seed can improve early vigor, especially when soils are cool.
- If conservation tillage is implemented add 30-60 GDU to VE
- If planting date is <April 25 add 10-25 GDU to VE
- If planting date is >May 15 subtract 50-70 GDU to VE
- Seeding depth: add 15 GDU for each inch below 2 inches to VE
- Seed-bed condition: soil crusting or massive clods add 30 GDU to VE
- Seed-zone soil moisture: below optimum, add 30 GDU to VE

Stage V6 Potential plant parts ("factory") developed

- 24-30 days after emergence (475 GDU)

Photo 3

Photo 4

Aboveground

- All plant parts are present
- Growing point and tassel (differentiated in V5) are above the soil surface *(Photo 3)*
- Stalk is beginning a period of rapid elongation
- Determination of kernel rows per ear begins
  Strongly influenced by hybrid genetics
- Tillers (suckers) begin to emerge at this time
- Degeneration and loss of lower leaves
- New leaf emerging (V-stage) about every 3 days

Belowground

- Nodal root system is established (approx. 18" deep X 15" wide) *(Photo 4)*
  This is now the main functional root system of the plant

Troubleshooting:

- Lodged plants
  Rootworm eggs will soon hatch and larvae begin feeding on root systems
- Foliar defoliation from hail ,wind, and leaf feeding corn borers
  May decrease row number
- 100% yield loss to frost caused from plant death
- 53% yield loss to hail when completely defoliated
- Severe yield loss to flooding

Management Guide

- Time to apply nitrogen (up to V8) before rapid uptake period in corn
  Precise fertilizer placement is less critical

Stage V12 Potential kernel rows determined

- 42-46 days after emergence (815 GDU)

Aboveground

- Number of kernel rows is set
- Number of ovules (potential kernels) on each ear and size of ear is being determined
  Strongly affected by environmental stresses
- New V-stage approximately every 2 days

Belowground

- Brace root formation begins stabilizing the upper part of the plant.

Troubleshooting

- Moisture Deficiencies will reduce potential number of kernels and ear size
  Plant is utilizing 0.25 inches per day.
  Water use rates for corn shown below.

Water Use Rate (inches/day)	Growth Stage
0.25	12 leaf
0.28	early tassel
0.30	silking
0.26	blister kernel
0.24	milk
0.20	dent
0.18	full dent

- Nutrient Deficiencies, will reduce potential number of kernels and ear size
  Large amounts of nitrogen, phosphorous, and potassium are being utilized at this stage
- 100% yield loss to frost caused from plant death
- 81% yield loss to hail when completely defoliated
- 3%/day yield loss to drought or heat (leaf rolling by mid-morning)
- Flooding (<48 h) will not affect yield

Management Guide

- Potential kernel number and ear size is also related to the length of time available for their determination. Early hybrids- progress faster through growth stages and usually have smaller ears than late hybrids.

Stage V18 Potential kernels per row determined

- 56 days after emergence (1160 GDU)

Photo 5

Aboveground

- Ear development is rapid
- The upper ear shoot is developing faster than other shoots on the stalk

Belowground

- Brace roots are now growing from nodes above the soil surface. They will scavenge the upper soil layers for water and nutrients during reproductive stages. *(Photo 5)*

Troubleshooting

- Moisture deficiency will cause lag between pollen shed and beginning silk ("nick")
  Largest yield reductions will result from this stress
  Plant using 0.30 inches per day

- Lodging will cause 12-31% yield reduction
- 100% yield loss to frost (<28 F) caused from plant death
- 100% yield loss to hail (max) when completely defoliated
- 4% yield loss per day due to drought or heat when leaf rolling by mid-morning
- Flooding (<48 h) will not affect yield

Management Guide

- Nitrogen applied through irrigation water, should be applied by V18

Stage R1 Actual kernel number and potential kernel size determined

- 69-75 days after emergence (1250 GDU)

Aboveground

- Begins when any silks are visible outside the husks *(Photo 6)*
- Pollen shed begins and lasts 5-8 days per individual plant *(Photo 7)*
- Silk emergence takes 5 days
  Silks elongate from base of ear to tip of ear
  Silks elongate until pollinated
- Silks outside husks turn brown
- The plant has now reached its maximum height
- First 7-10 days after fertilization cell division occurs within kernel
- Remaining R stages, endosperm cells fill with starch

Photo 6

Photo 7

Belowground

- The plant must have a healthy root system because proper uptake of moisture and nutrients
are critical at this time

Troubleshooting

- Hot and Dry weather results in poor pollination and seed set
  Dehydrates silks (delay silking) and hastens pollen shed
  Causes plants to miss window for pollination
  Decreases yield 7% per day (leaf rolling by mid-morning)
- Moisture deficiencies at this time will reduce yields 7% per day
- Rootworm beetle clips silks which prevents pollination if less than a ½" of silk is showing
- 100% yield loss to frost (<28 F) caused from plant death
- 100% yield loss to hail when completely defoliated
- Flooding (<48h) will not affect yield at this stage

Management guide

- Rootworm beetle control should be implemented if 4-5 beetles are observed feeding near ear tip.
- Stresses that reduce pollination result in a "nubbin" (an ear with a barren tip)

Stage R6 Actual kernel weight determined

- 130 days after emergence or 50-60 days after silking (2350 GDU)

Photo 8

Aboveground

- Physiological maturity is reached when all kernels on the ear have attained their dry matter maximum accumulation
- The hard starch layer has advanced completely to the cob
  Goes from top of kernel to base of cob
- A black abscission layer has formed (Photo 8)
  This indicates that moisture and nutrient transport from the plant has ceased
- Kernels are at 30-35% moisture and have attained 100% of dry weight (Photo 9)

Photo 9

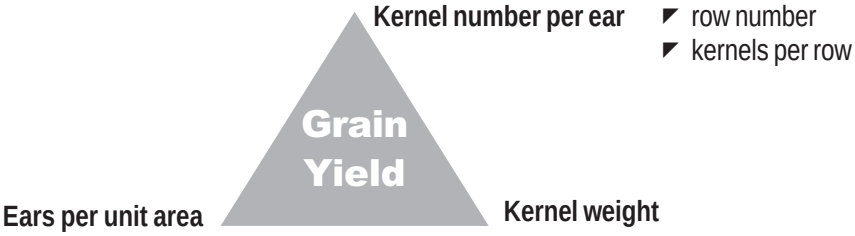
Management Guide

- Grain is not ready for safe storage
  Needs to be at 13-15% moisture for long-term storage
  May be advantageous to let crop partially dry in the field
- Silage harvest would be slightly earlier than R6 as milkline moves down towards kernel tip
- Frost has no effect on yield at this point. However, lodging from disease, insect damage or can result in physical loss of yield.

Conclusion

For most of Wisconsin hybrids (~100 day), each plant typically develops 20-21 leaves, silks about 65 days after emergence, and matures about 120 days after emergence. All normal plants follow this same general pattern of development, but specific time intervals between stages and total leaf numbers developed may vary between different hybrids, seasons, planting dates and locations. The rate of plant development for any hybrid is directly related to temperature, so the length of time between the different stages will vary as the temperature varies. Environmental stress may lengthen or shorten the time between vegetative and reproductive stages.

The length of time required for the yield components of ear density, kernel number, kernel weight varies between hybrids and environmental conditions.



Ears per unit area, kernal number per ear and kernal weight all contribute to yield. These yield components of corn are determined early in the life cycl;e of the corn plant. It is true that yield is the end product but the plant must go through a number of stages to produce yield. Understanding this process won't necessarily put "money in your pocket", but by knowing when yield components are determined helps to interpret management and environmental factors influencing yield.