DETERMINING
THE GROWTH STAGES
OF CORN

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Restrictions for Use of Adjuvants on Corn

DO NOT use adjuvants after the V8 stage and prior to the VT stage of corn growth. (The VT stage is defined as when the last branch of the tassel is completely visible outside of the whorl). A compatibility agent, another fungicide, or an insecticide may be included in the tank mix, if needed and labeled for use in corn. Refer to the tank mix pesticide label for specific use directions and restrictions. Always follow the most restrictive label. Consult a BASF representative or local agricultural authority for more information concerning use of additives.
WHY DETERMINE STAGES?

1. Some fraction of final yield is determined at each growth stage.

2. Final yield is profit \( \uparrow \) or loss \( \downarrow \).

3. Don’t make the same mistakes at the same growth stage every year.
Table 6. Impact on grain yield of various factors occurring during corn development.

<table>
<thead>
<tr>
<th>Factor</th>
<th>Corn development stage</th>
<th>Percent yield impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frost (&lt; 28 F)</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>Hail (max)</td>
<td>0</td>
<td>53</td>
</tr>
<tr>
<td></td>
<td>81</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>Drought/Heat (%/day)</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>Flooding (&lt;48 h)</td>
<td>severe</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>0</td>
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<tr>
<td></td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**HOW TO DETERMINE STAGES**

**CORN**
- Vegetative - Count Collars
- Reproductive - Kernel Characteristics

**SOYBEANS**
- Vegetative - Count Single Leaf Scans
- Reproductive - Flowers
  - Pods
  - Seeds
Three Corn Growth States in Use Today

1. Collar method – Agronomic System
   - Most precise
   - Most reproducible

2. Leaf Method – Crop Insurance
   - All leaves 50% exposed are counted
   - Most descriptive

3. Plant Height – SWAG System
   - Neither precise nor descriptive
   - Most deceptive

How to Determine Plant Height

- V3 – Collar method
- 5 Leaf – Leaf Method
- 6 – 12” – Height Method
**Corn Vegetative Stages**

- **VG** – Germination
- **VE** - Emergence
- **V1** - Collar of First Leaf Visible
- **V6** - Collar of Sixth Leaf Visible
- **VT** - Tassel visible but not shedding pollen

**Seed**

- **Corn (Monocot)**
  1. Caryopsis
  2. Embryo - only part of Seed
  3. Embryo
     - Coleoptile
     - Plumule
     - Radicle
     - Coleorhiza
  4. Seed Leaves
     - One + Five

- **Soybeans (Dicot)**
  1. True Seed
  2. Embryo is the Seed
  3. Embryo
     - Hypocotyl
     - Cotyledons
     - Radicle
  4. Seed Leaves
     - Two + Two
# Germination Process

<table>
<thead>
<tr>
<th>Corn</th>
<th>Soybeans</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Imbibe water</td>
<td>Imbibe Water</td>
</tr>
<tr>
<td>2. Activate enzymes</td>
<td>Activate Enzymes</td>
</tr>
<tr>
<td>3. Cell Growth</td>
<td>Cell Growth</td>
</tr>
<tr>
<td>4. Radicle Growth</td>
<td>Radicle elongates</td>
</tr>
<tr>
<td>5. COLEPTILE TO SURFACE</td>
<td>HYPOCOTYL TO SURFACE</td>
</tr>
</tbody>
</table>
Germination Needs

Corn
1. Water - 40% Dry wt
2. Temp - 50°F+
3. Oxygen - Yes
4. Enzymes for Starches, Sugars

Soybeans
Water - 50% + Dry wt
Temp - 60°F+
Oxygen - Yes
Enzymes for Starches, Proteins, Oils

Germination of Corn

Radicle emerges first, followed by the coleoptile.
Corn Emergence (VE)
VE Stage

Coleoptile reaches soil surface

V1 Stage – Above Ground

First leaf emerges
V1 Stage – Below Ground

Nodal root development

V2 Stage – Two Leaves Fully Emerged

- Reached when 2 leaves are fully emerged with collars visible
- Time between V1 and V2 is short (3-4 days)
- Occurs at about 255 GDU
**V2 Stage – Below Ground**

Root hair formation

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**Corn Growing Degree Days**

- Each day has a slightly different average temperature.
- Temperature affects corn growth rate.
- Attempt to relate temperature to corn growth rate.

- **Corn Growing Degree Day**
  - Base 50° F
  - Max 86° F
  - Min 50° F
Corn Growing Degree Days

<table>
<thead>
<tr>
<th>Corn Maturity (Days)</th>
<th>GDD</th>
</tr>
</thead>
<tbody>
<tr>
<td>85 to 100</td>
<td>2100 – 2400</td>
</tr>
<tr>
<td>101 to 130</td>
<td>2400 – 2800</td>
</tr>
<tr>
<td>131 to 145</td>
<td>2900 – 3200</td>
</tr>
</tbody>
</table>

GDD Requirements of a 2700 GDD Hybrid

<table>
<thead>
<tr>
<th>Growth Stage</th>
<th>GDD</th>
</tr>
</thead>
<tbody>
<tr>
<td>V2</td>
<td>200</td>
</tr>
<tr>
<td>V6</td>
<td>475</td>
</tr>
<tr>
<td>V12</td>
<td>870</td>
</tr>
<tr>
<td>VT</td>
<td>1135</td>
</tr>
<tr>
<td>R1</td>
<td>1400</td>
</tr>
<tr>
<td>R6</td>
<td>2700</td>
</tr>
</tbody>
</table>


Corn Growing Degree Days

- Corn Growing Degree Day
- Base 50°F
- Max 86°F
- Min 50°F

- Example 1:
  - 74°F average daily temperature
  - 74 – 50 = 24 GDD

- Example 2:
  - 90°F average daily temperature
  - 86 – 50 = 36 GDD
**V3 to V4 Stage – Above Ground**

- **V3**
  - 3 Collars
  - Nodal roots active.
  - Growing point below ground

- **V6**
  - 6 collars
  - Growing point above ground.
  - Tassel and ear development starting.

- **V12**
  - 12 collars
  - Ear size, kernel size and kernel number being determined.
  - Limits on water and/or nutrients will reduce yields.

**Corn Growth Stages**
V4 Stage – Below Ground

- Cuticle rapid change from V5 to V8 - wax becomes a smooth film on the leaves.
- Spray retention increases from approximately 30% at V4 to about 80% at V6
- Changes in leaf surface characteristics have been shown to correlate well with corn tolerance of post-emergence herbicides
Corn Nodal Root System

Corn Growth Stages
Growth rate rapidly increases. Greater demand for nutrients and water.

Ear shoot.
Ear shoot.
Growing point.
Ear shoot.

Upper Ear Shoots & Tassel Dissected From a V9 Plant

Node #10  #11  #12  #13  Tassel
Both kernel size and kernel number are being determined. Any limits on water or nutrients at this phase will drastically impact yields. Earlier maturing hybrids will pass through this phase faster than later maturing hybrids.

V12

Corn Growth Stages

V15
15 collars
Rapid growth, about 10 to 12 days before silking. Most sensitive to stress.

VT
Tassel
Last tassel branch is visible but prior to silking. Complete leaf loss will cause nearly 100% yield loss.
**V15 to Vnth Stage – Above Ground**

- Nth stage = Flag leaf
- 16-18 leaves for <100 day corn
- 18-21 leaves for 100-110 day corn
- Vnth occurs when collar of last leaf is showing

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**V15 to Vnth Stage – Factors Causing Plant Stress**

- Corn needs 0.30 inches of water per day.
- Irrigated N applications should be made by V18.
- Lodging can reduce yields 12-31% if it occurs after V17.
Brace roots grow and support the corn plant.

V18

Lower part of plant  Upper part of plant

Grain Crops Extension, University of Kentucky
VT - Tassle

Occurs when last branch of tassel is visible but before silks emerge.

Most susceptible to hail damage at this stage.

Complete leaf loss at VT will result in little to no yield.

Corn Reproductive Stages

R1 - Silk
R2 - Blister
R3 - Milk
R4 - Dough
R5 - Dent
R6 - Mature
**Corn Growth Stages**

**R1**

- **Silking**
  - N and P uptake are rapid.
  - About 50% of total N is taken up after R1.
  - K uptake is nearly complete.
  - Water needed for pollination.
  - Pollination occurs.

**R2**

- **Blister**
  - Ear size nearly complete.
  - Silks begin to dry out.
  - A miniature corn plant is being formed in each fertilized kernel.

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**R1 Stage – Pollen Shed and Silking**

- Silks are visible
- Pollen shed begins
R1 Stage – Fertilization

- Each silk is attached to an ovule.
- Pollen lands on silk which form the pollen tube.
- Silks that fall off have been fertilized.

R2 Stage – The Blister Stage

- R2 Silks drying out
- White, blister-like kernels
**R3 Stage – The Milk Stage**

- R3 Stage corn ear
- Yellow on the outside
- Milky inside from starch accumulation
- Silks are brown and dried out
- 35 days to maturity

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**Corn Growth Stages**

**R4 Dough**

Kernels have accumulated ½ of total dry weight.
Five leaves have formed in the kernel.

**R5 Dent**

Most kernels have dented and are near 55% moisture at start.
Starch layer has formed and progresses down the kernel.
R4 Stage – The Dough Stage

Milkline movement through kernel

R5 Stage – The Dent Stage
Black layer has formed
- 131 days after emergence
- Kernels are 30-35% moisture
- 100% of dry weight has accumulated

**R6 Stage – Physiological Maturity**

**Corn Growth Stages**

<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>R6</td>
<td>Black layer has formed at bottom of kernel. Kernel is about 30 to 35% moisture.</td>
</tr>
</tbody>
</table>
# Planting Date and GDD

**Hybrid:** DKC67-91: 119 CRM  
3000 GDD to Black Layer

<table>
<thead>
<tr>
<th>Planting Date</th>
<th>GDD As of 06/26/05</th>
<th>Difference From First Planting</th>
</tr>
</thead>
<tbody>
<tr>
<td>April 20</td>
<td>1155</td>
<td>---</td>
</tr>
<tr>
<td>May 3</td>
<td>1029</td>
<td>126</td>
</tr>
<tr>
<td>May 18</td>
<td>825</td>
<td>330</td>
</tr>
<tr>
<td>May 31</td>
<td>596</td>
<td>559</td>
</tr>
<tr>
<td>June 15</td>
<td>281</td>
<td>874</td>
</tr>
</tbody>
</table>

From University of Kentucky Ag Weather Center: [http://www.agwx.ca.uky.edu/](http://www.agwx.ca.uky.edu/)  
Growing Degree Day calculator: [http://www.agwx.ca.uky.edu/cgi-bin/cropdd_www.pl](http://www.agwx.ca.uky.edu/cgi-bin/cropdd_www.pl)