DETERMINING THE GROWTH STAGES OF CORN AND SOYBEANS

Keith Glewen, UNL Extension Educator
## Corn

**Postemergence (See page 40 for spray additives)** (continued)

<table>
<thead>
<tr>
<th>Herbicide</th>
<th>Rate Per Acre</th>
<th>Application Time</th>
<th>Remarks and Approximate Cost Per Acre Broadcast</th>
</tr>
</thead>
<tbody>
<tr>
<td>RESOLVE Q</td>
<td>1.25 oz</td>
<td>Corn up to 20&quot; or V7</td>
<td>May be tank-mixed with glyphosate herbicides if applied to Roundup Ready corn, or with imazapic if applied to LibertyLink corn. For additional control of kochia, Resolve may be tank-mixed with Starane or dicamba. Cost: $10.00.</td>
</tr>
<tr>
<td>RESOURCE</td>
<td>4.0-6.0 oz</td>
<td>Corn V2-V10 Broadleaf weeds less than 4&quot;</td>
<td>Especially effective for controlling velvetleaf. Rate may be increased to 8 oz when using drop nozzles. Cost: $7.00-$10.25.</td>
</tr>
<tr>
<td>SOLIDA</td>
<td>1.0 oz</td>
<td>Corn up to 12&quot; or V6, whichever is most restrictive</td>
<td>Apply to weeds less than 3 inches tall. May be tank-mixed with glyphosate (for Roundup Ready hybrids), glufosinate (for Liberty LInk hybrids), and other herbicides labeled for corn. Cost $13.00.</td>
</tr>
<tr>
<td>SPIRIT</td>
<td>1.0 oz</td>
<td>Corn 4-24&quot; If greater than 20&quot; (V6), use drops Weeds 2-8&quot;</td>
<td>Soybean rotation interval is 10 months south of I-80 and 18 months north of I-80. More rotation restrictions on soils with pH greater than 7.8. Refer to Beycon for OP insecticide restrictions. Cost: $13.00.</td>
</tr>
<tr>
<td>STARANE ULTRA</td>
<td>0.4 pt</td>
<td>VE-V5 corn Sweet corn up to V4 Weeds less than 8&quot;</td>
<td>Especially effective for controlling kochia. Can be tank-mixed with other postemergence herbicides to improve broadleaf weed control. Cost: $14.50.</td>
</tr>
<tr>
<td>STATUS</td>
<td>5.0 oz</td>
<td>Corn 4-36&quot;</td>
<td>Do not mix with products containing dicamba, 2,4-D or clopyralid. Use NIS or COC plus ammonium nitrogen fertilizer. Do not exceed 12.5 oz per season. Supresses grasses less than 3&quot; tall. Allow a minimum of 15 days between applications of Status. Cost: $16.00.</td>
</tr>
<tr>
<td>STATUS + GLYPHOSATE*</td>
<td>2.5 oz</td>
<td>Corn V2-V10</td>
<td>Use drop nozzles when corn height exceeds 24&quot;. Use NIS or a high surfactant oil blend plus an ammonium nitrogen fertilizer. Cost: $11.50.</td>
</tr>
<tr>
<td>STEADFAST</td>
<td>0.75 oz</td>
<td>Corn to 20&quot; or V6 Weeds 2-4&quot;</td>
<td>Steadfast may be tank-mixed with atrazine (0.5-1.0 lb), Callisto + atrazine (1.5-3.0 oz + 0.5 lb), dicamba (4-8 oz), or Hormet (2-3 oz) to broaden weed control spectrum. Follow directions of the most restrictive label. Do not tank-mix with OP insecticides. Cost: Steadfast $18.00 Steadfast + Callisto + atrazine $31.00-$38.50.</td>
</tr>
<tr>
<td>STEADFAST AT2*</td>
<td>14.0 oz</td>
<td>Corn to 12&quot; or V6 Weeds 2-4&quot;</td>
<td>May be tank-mixed with Callisto, dicamba, Distinct or Hormet. Do not tank-mix with OP insecticides. Cost: $21.00.</td>
</tr>
<tr>
<td>STOUT</td>
<td>0.5-0.75 oz</td>
<td>Corn to 16&quot; or V5</td>
<td>May be tank-mixed with other labeled postemergence herbicides to broaden weed control spectrum. Do not tank-mix with OP insecticides. Use COC or NIS and ammonium nitrogen fertilizer. Do not use liquid N as a carrier. Cost: $71.50-$77.25.</td>
</tr>
<tr>
<td>WIDEMATCH</td>
<td>1.33 pt</td>
<td>Corn spike to V5 Weeds less than 8&quot;</td>
<td>For control of kochia and Canada thistle. Applications made after V5 must use drop nozzles. Do not apply less than 90 days before harvest. Crop injury (stem curvature, stunting, brace root injury) may occur with some hybrids. Cost: $11.75.</td>
</tr>
<tr>
<td>YUKON</td>
<td>4.0-8.0 oz</td>
<td>Spiked to 36&quot; Weeds 1-6&quot;</td>
<td>For corn more than 20 inches, use drop nozzles. Observe dicamba label precautions. Add Accent for grass control. Cost: $12.00-$24.00.</td>
</tr>
</tbody>
</table>

*Do not apply atrazine within 66 feet of where water runoff from a field will enter a stream, river, or pond. The total amount of atrazine applied cannot exceed 2.5 lb ai/A per calendar year. Use no more than 1.6 lb ai/A on highly erodible land with less than 30% crop residue. Using atrazine on soils with less than 1% organic matter increases carryover injury risk to susceptible crops, especially high pH soils. Do not use on sandy soils if water table is shallower than 30 ft. *Glyphosate rates are based on a 4 lb ai/gal or 3 lb ae/gal formulation. See pages 177-178 for information on common glyphosate formulations.
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.
Know how. Know **now**.
Know how. Know now.
HOW TO DETERMINE STAGES

CORN
• Vegetative - Count Collars
• Reproductive - Kernel Characteristics

SOYBEANS
• Vegetative - Count Single Leaf Scans
• Reproductive - Flowers
  - Pods
  - Seeds
WHY DETERMINE STAGES?

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

2. Final yield is profit or loss.

3. Don’t make the same mistakes at the same growth stage every year.
THREE CORN GROWTH STAGES 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)  Soybeans (Dicot)
1. Caryopsis  True Seed
2. Embryo - only part of Seed  Embryo is the Seed
3. Embryo  Embryo
   Coleoptile  Hypocotyl
   Plumule  Cotyledons
   Radicle  Radicle
   Coleorhiza
4. Seed Leaves  Seed Leaves
   One + Five  Two + Two
Know how. Know now.
Germination Process

**Corn**
1. Imbibe water
2. Activate enzymes
3. Cell Growth
4. Radicle Growth
5. COLEPTILE TO SURFACE

**Soybeans**
1. Imbibe Water
2. Activate Enzymes
3. Cell Growth
4. Radicle elongates
5. HYPOCOTYL TO SURFACE
## Germination Needs

<table>
<thead>
<tr>
<th>Crop</th>
<th>Water Requirement</th>
<th>Temperature</th>
<th>Oxygen</th>
<th>Enzymes for</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>40%</td>
<td>50°F +</td>
<td>Yes</td>
<td>Starches, Sugars</td>
</tr>
<tr>
<td>Soybeans</td>
<td>50% +</td>
<td>60°F +</td>
<td>Yes</td>
<td>Starches, Proteins, Oils</td>
</tr>
</tbody>
</table>

Dry wt

**Corn**

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

**Soybeans**

1. Water - 50% +
2. Temp - 60°F +
3. Oxygen - Yes
4. Enzymes for Starches, Proteins, Oils
HOW A CORN PLANT DEVELOPS

Radicle emerges first, followed by the coleoptile.
GERMINATION OF CORN

Radicle emerges first, followed by the coleoptile.
Corn Emergence (VE)
Know how. Know now.

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
Know how. Know **now.**

**HOW A CORN PLANT DEVELOPS**

![V2 Seedling Diagram]

- **5. Coleoptile**
- **6. Radicle**
- **7. Mesocotyl**
- **8. Seminal Roots**
- **9. Nodal Roots**

Soil Surface
Know how. Know now.

**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>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
Minimum and maximum temperatures for crop and pest management models (Pope, IC-492(8) p. 46, May 17, 2004).

<table>
<thead>
<tr>
<th>Crop or Pest</th>
<th>Minimum °F</th>
<th>Maximum °F</th>
<th>Information Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>50</td>
<td>86</td>
<td>crop development</td>
</tr>
<tr>
<td>Soybean</td>
<td>50</td>
<td>86-90</td>
<td>crop development</td>
</tr>
<tr>
<td>Black cutworm</td>
<td>50</td>
<td></td>
<td>300 DD from egg to cutting</td>
</tr>
<tr>
<td>Stalk borer</td>
<td>41</td>
<td></td>
<td>predicting migration</td>
</tr>
<tr>
<td>Bean leaf bettle</td>
<td>46</td>
<td></td>
<td>2nd generation emergence</td>
</tr>
<tr>
<td>Seedcorn maggot</td>
<td>39</td>
<td></td>
<td>seed treatment on replant</td>
</tr>
<tr>
<td>Alfalfa weevil</td>
<td>48</td>
<td></td>
<td>larval presence in fields</td>
</tr>
<tr>
<td>Western bean cutworm</td>
<td>50</td>
<td></td>
<td>adult emergence / egglaying</td>
</tr>
</tbody>
</table>
V3 TO V4 STAGE – ABOVE GROUND
<table>
<thead>
<tr>
<th>V3</th>
<th>Nodal roots active. Growing point below ground</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 Collars</td>
<td></td>
</tr>
</tbody>
</table>
V3 TO V4 STAGE – BELOW GROUND
V4 STAGE – BELOW GROUND

Root System of 'Normal' Plant, V4 Leaf Stage

Healthy mesocotyl

RLNielsen, Purdue Univ., 2000
CORN NODAL ROOT SYSTEM
Corn Growth Stages

V6

Growing point above ground. Tassel and ear development starting.

6 collars
Know how. Know now.
• Growing point moves above soil surface.
• Nodal root system is the major functional root system.
Know how. Know now.

V6 TO V8 – ABOVE GROUND

• Above ground –
  6 to 8 leaf collars

• 8-10 leaves

• Rapid stalk elongation begins
Know how. Know now.

Corn Growth Stages

6th Leaf
4th Leaf
5th Leaf
6th Node
7th Node
6th Node
5th Node
1st - 4th Nodes

L. Abendroth 2005
University of Nebraska
Corn Growth Stages

**V12**

12 collars

Ear size, kernel size and kernel number being determined. Limits on water and/or nutrients will reduce yields.
| 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.  |
• 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
• 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.
CORN REPRODUCTIVE STAGES

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

<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>R1</strong> Silking</td>
<td>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.</td>
</tr>
<tr>
<td><strong>R2</strong> Blister</td>
<td>Ear size nearly complete. Silks begin to dry out. A miniature corn plant is being formed in each fertilized kernel.</td>
</tr>
</tbody>
</table>
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
### Corn Growth Stages

<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>R4 Dough</strong></td>
<td>Kernels have accumulated ½ of total dry weight. Five leaves have formed in the kernel.</td>
</tr>
<tr>
<td><strong>R5 Dent</strong></td>
<td>Most kernels have dented and are near 55% moisture at start. Starch layer has formed and progresses down the kernel.</td>
</tr>
</tbody>
</table>
R4 STAGE – THE DOUGH STAGE

Milkline movement through kernel
R6 STAGE – PHYSIOLOGICAL MATURITY

- Black layer has formed
- 131 days after emergence
- Kernels are 30-35% moisture
- 100% of dry weight has accumulated
**Corn Growth Stages**

**R6 Physiological Maturity**

- Blacklayer has formed at bottom of kernel.
- Kernel is about 30 to 35% moisture.
## 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://wwwagwx.ca.uky.edu/](http://wwwagwx.ca.uky.edu/)
Growing Degree Day calculator: [http://wwwagwx.ca.uky.edu/cgi-bin/cropdd_www.pl](http://wwwagwx.ca.uky.edu/cgi-bin/cropdd_www.pl)
## 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 07/11/05</th>
<th>Difference from First Planting</th>
</tr>
</thead>
<tbody>
<tr>
<td>April 20</td>
<td>1503</td>
<td>---</td>
</tr>
<tr>
<td>May 3</td>
<td>1377</td>
<td>126</td>
</tr>
<tr>
<td>May 18</td>
<td>1173</td>
<td>330</td>
</tr>
<tr>
<td>May 31</td>
<td>944</td>
<td>559</td>
</tr>
<tr>
<td>June 15</td>
<td>629</td>
<td>874</td>
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Growing Degree Day calculator: [http://wwwagwx.ca.uky.edu/cgi-bin/cropdd_www.pl](http://wwwagwx.ca.uky.edu/cgi-bin/cropdd_www.pl)
## Corn growth and development stages when yield components are determined

<table>
<thead>
<tr>
<th>Growth Stage</th>
<th>Yield components</th>
<th>GDU</th>
<th>Potential</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>VE</td>
<td>Ears/area</td>
<td>125</td>
<td></td>
<td>------</td>
</tr>
<tr>
<td>V6</td>
<td>Kernel rows/ear</td>
<td>470</td>
<td>&quot;Factory&quot;</td>
<td></td>
</tr>
<tr>
<td>V12</td>
<td>Kernel rows/ear</td>
<td>815</td>
<td></td>
<td></td>
</tr>
<tr>
<td>V18</td>
<td>Kernels/row</td>
<td>1160</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R1</td>
<td>Kernel weight</td>
<td>1250</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R6</td>
<td>Kernel weight</td>
<td>2350</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Relationship between kernel growth stage and development.

<table>
<thead>
<tr>
<th>Stage</th>
<th>Calendar days to maturity (average)</th>
<th>Growing degree units (GDUs to maturity)</th>
<th>Percent of Maximum Yield</th>
<th>Moisture Content</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Grain</td>
<td>Whole plant</td>
<td>Grain</td>
<td>Whole Plant</td>
</tr>
<tr>
<td>Silk (R1)</td>
<td>55-60</td>
<td>1100-1200</td>
<td>0</td>
<td>50-55</td>
</tr>
<tr>
<td>Blister (R2)</td>
<td>45-50</td>
<td>875-975</td>
<td>0-10</td>
<td>55-60</td>
</tr>
<tr>
<td>Late milk-dough (R4)</td>
<td>35-40</td>
<td>650-750</td>
<td>30-50</td>
<td>65-75</td>
</tr>
<tr>
<td>Early Dent (R5)</td>
<td>25-30</td>
<td>425-525</td>
<td>60-75</td>
<td>75-85</td>
</tr>
<tr>
<td>Fully Dented (5.50-5.75)</td>
<td>13-17</td>
<td>200-300</td>
<td>90-95</td>
<td>100</td>
</tr>
<tr>
<td>Physiologic maturity (R6)</td>
<td>0</td>
<td>0</td>
<td>100</td>
<td>95-100</td>
</tr>
</tbody>
</table>

* Black layer formation and/or milk disappearance from kernels under development. Premature frost or extended cold temperatures may cause black layer formation at earlier stages and wetter moistures.
## Impact on grain yield (% yield loss) of various abiotic factors occurring during corn development

<table>
<thead>
<tr>
<th>Factor</th>
<th>VE</th>
<th>V6</th>
<th>V12</th>
<th>V18</th>
<th>R1</th>
<th>R6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frost (&lt; 28 F)</td>
<td>0</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>Hail (max)</td>
<td>0</td>
<td>53</td>
<td>81</td>
<td>100</td>
<td>100</td>
<td>0*</td>
</tr>
<tr>
<td>Drought/ Heat (%)</td>
<td>--</td>
<td>--</td>
<td>3</td>
<td>4</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>Flooding (&lt;48 h)</td>
<td>severe</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

* No ear dropage
Yield components of corn = Ears per unit area X Kernel weight X Kernels per ear (Row number x Kernels per row)

Potential v. Actual Yield Components

- Potential = maximum number or size; attrition always occurs.
- Actual = result of growth process after attrition.