Nebraska Lincoln EXTENSION

Know how. Know **now.**

# DETERMINING THE GROWTH STAGES OF CORN AND SOYBEANS

**Keith Glewen, UNL Extension Educator**

IANR

# Corn

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

| Herbicide | Rate Per Acre | Application Time | Remarks and Approximate Cost Per Acre Broadcast |
|---|---|---|---|
| RESOLVE Q | 1.25 oz | Corn up to 20″ or V7 | May be tank-mixed with glyphosate herbicides if applied to Roundup Ready corn, or with Ignite if applied to LibertyLink corn. For additional control of kochia, Resolve may be tank-mixed with Starane or dicamba. Cost: $10.00. |
| RESOURCE | 4.0-6.0 oz | Corn V2-V10 Broadleaf weeds less than 4″ | Especially effective for controlling velvetleaf. Rate may be increased to 8 oz when using drop nozzles. Cost: $7.00-$10.25. |
| SOLIDA | 1.0 oz | Corn up to 12" or V6, whichever is most restrictive | 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 |
| SPIRIT | 1.0 oz | Corn 4-24″ If greater than 20″ (V6), use drops Weeds 2-8″ | 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 Beacon for OP insecticide restrictions. Cost: $13.00. |
| STARANE ULTRA | 0.4 pt | VE-V5 corn Sweet corn up to V4 Weeds less than 8″ | Especially effective for controlling kochia. Can be tank-mixed with other postemergence herbicides to improve broadleaf weed control. Cost: $14.50. |
| STATUS | 5.0 oz | Corn 4-36″ | 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″ tall. Allow a minimum of 15 days between applications of Status. Cost: $16.00. |
| STATUS + GLYPHOSATE◆ | 2.5 oz 32.0 oz | Corn V2-V10 | Use drop nozzles when corn height exceeds 24″. Use NIS or a high surfactant oil blend plus an ammonium nitrogen fertilizer. Cost: $11.00. |
| STEADFAST | 0.75 oz | Corn to 20″ or V6 Weeds 2-4″ | 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 Hornet (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. |
| STEADFAST ATZ■ | 14.0 oz | Corn to 12″ or V6 Weeds 2-4″ | May be tank-mixed with Callisto, dicamba, Distinct or Hornet. Do not tank-mix with OP insecticides. Cost: $21.00. |
| STOUT | 0.5-0.75 oz | Corn to 16″ or V5 | 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: $11.50-$17.25. |
| WIDEMATCH | 1.33 pt | Corn spike to V5 Weeds less than 8" | 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. |
| YUKON | 4.0-8.0 oz | Spike to 36″ Weeds 1-6″ | For corn more than 20 inches, use drop nozzles. Observe dicamba label precautions. Add Accent for grass control. Cost: $12.00-$24.00. |

■Do not apply atrazine within 66 feet of where water runoff from a field will enter a stream, river, or standpipe. 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.

Nebraska Lincoln EXTENSION

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# 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.**

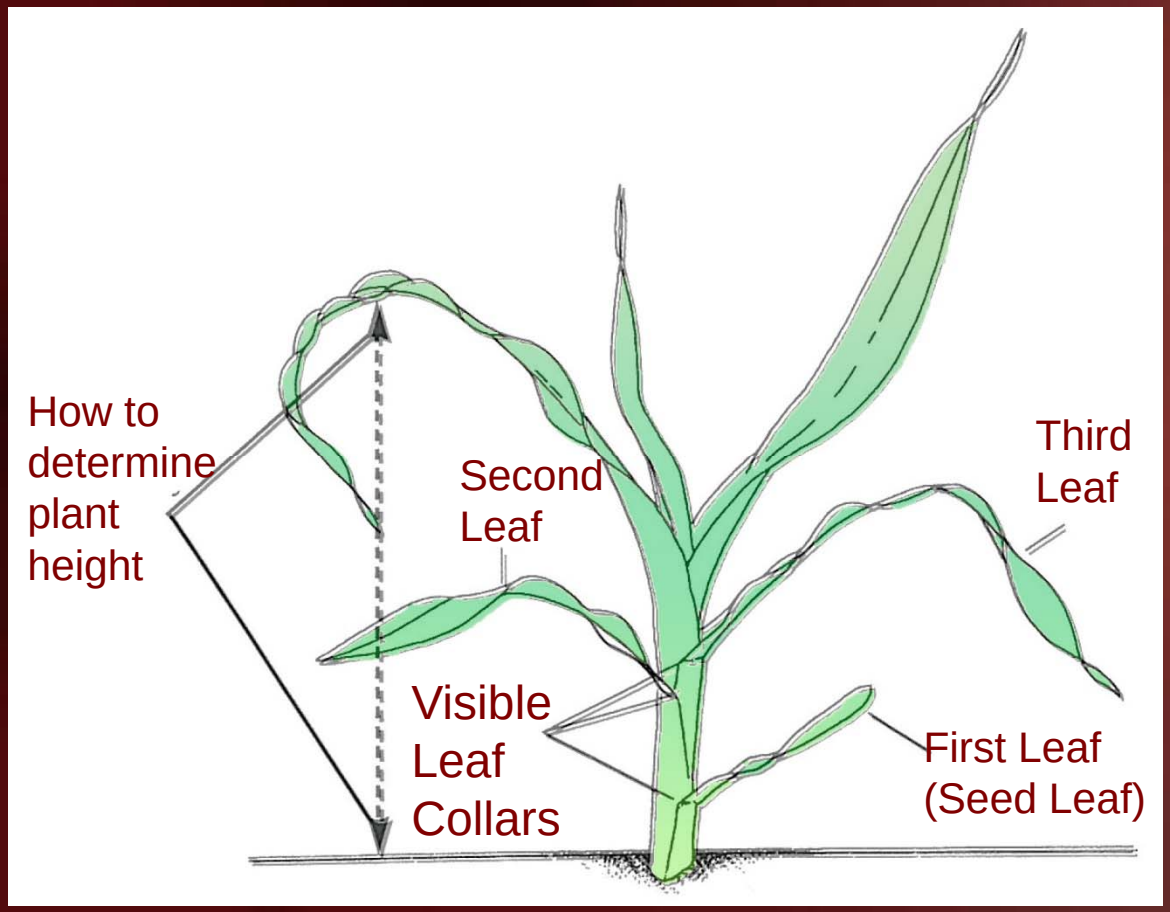
2. **Final yield is profit ↑ or loss ↓.**

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**

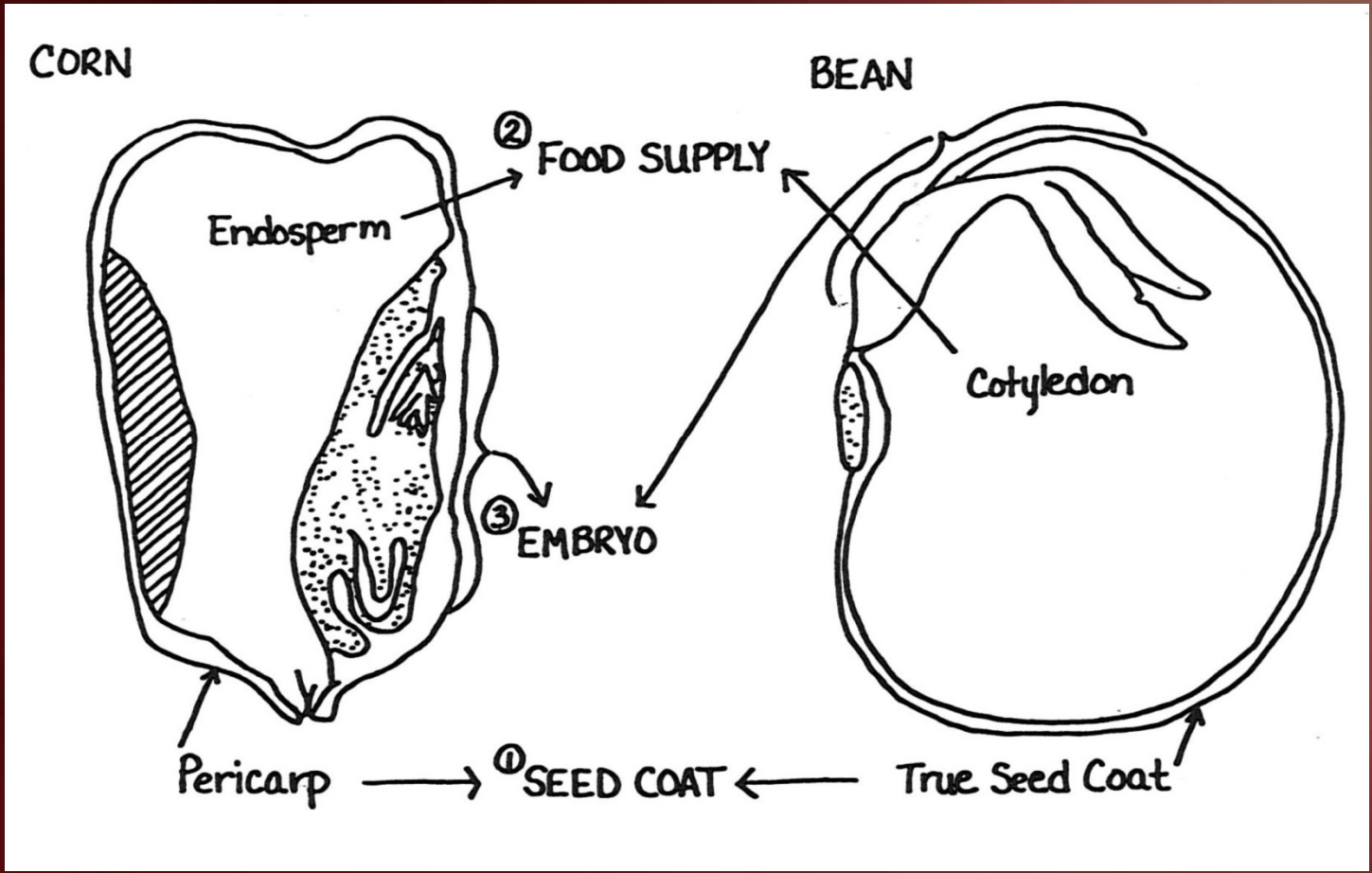
**V6 - Collar of Sixth Leaf Visible**

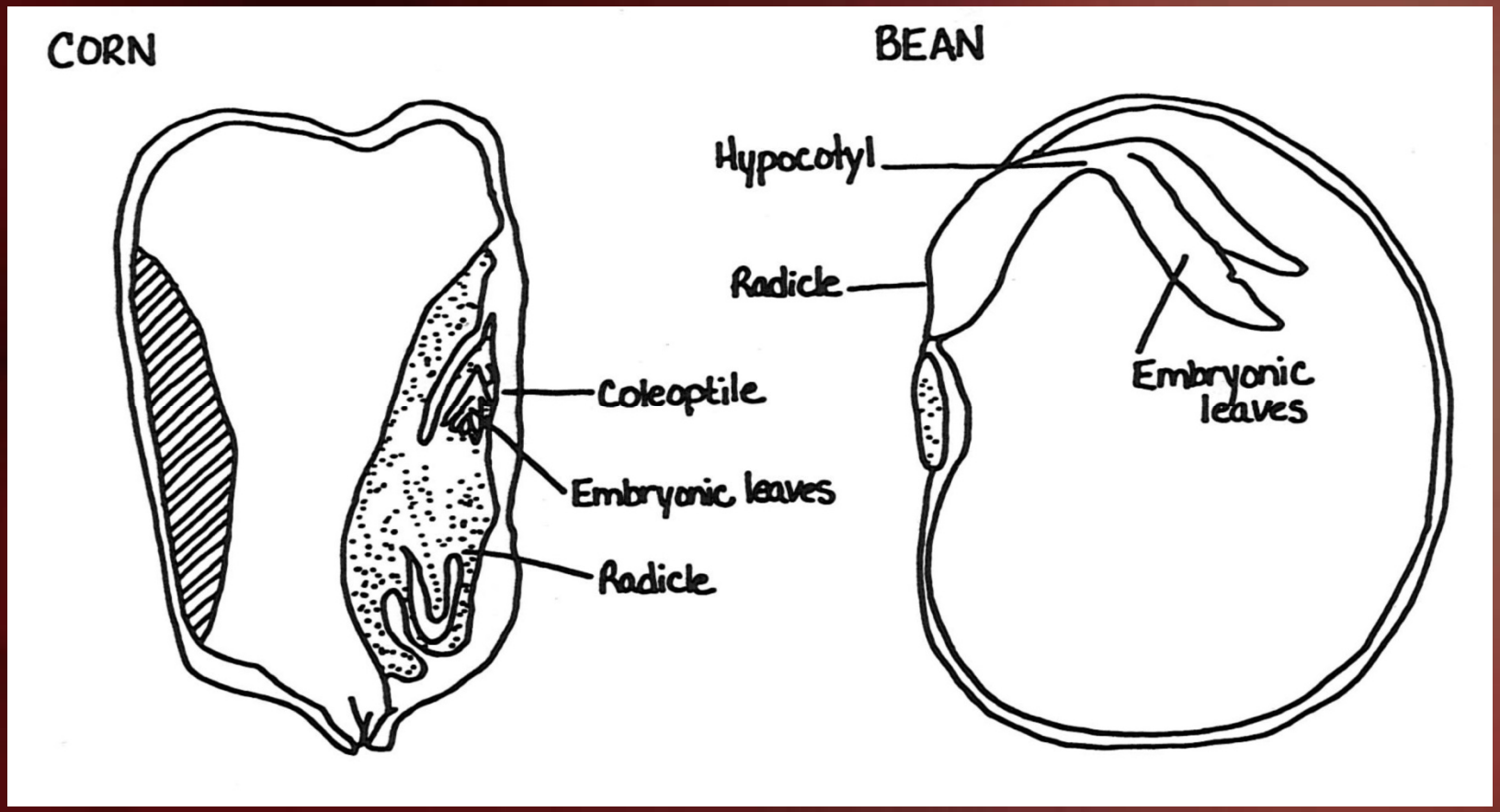
**VT - Tassel visible**
**but not shedding pollen**

# 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.**




CORN
BEAN
Coleoptile
Embryonic leaves
Radicle
Hypocotyl
Radicle
Embryonic leaves

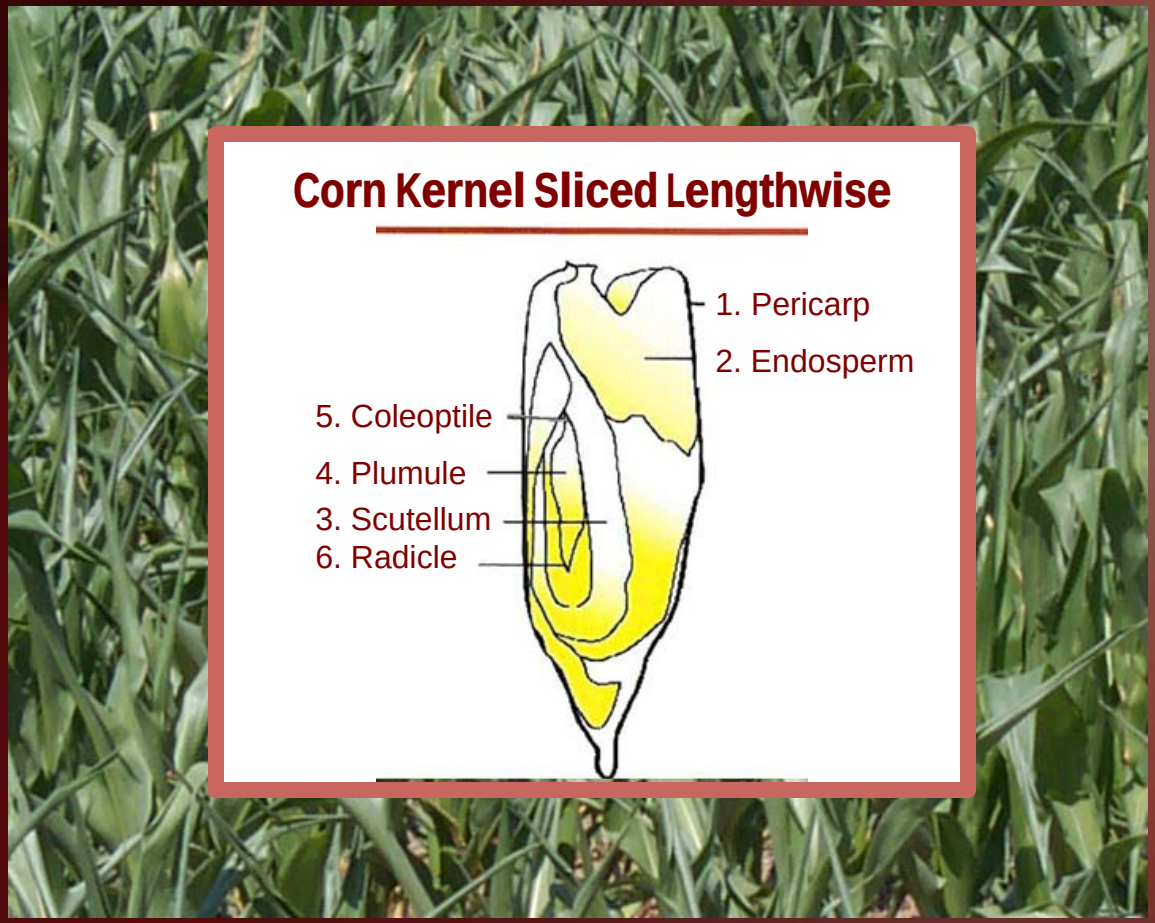
# Germination Process

| | Corn | Soybeans |
|---|---|---|
| 1. | Imbibe water | Imbibe Water |
| 2. | Activate enzymes | Activate Enzymes |
| 3. | Cell Growth | Cell Growth |
| 4. | Radicle Growth | Radicle elongates |
| 5. | **COLEPTILE TO SURFACE** | **HYPOCOTYL TO SURFACE** |

# Germination Needs

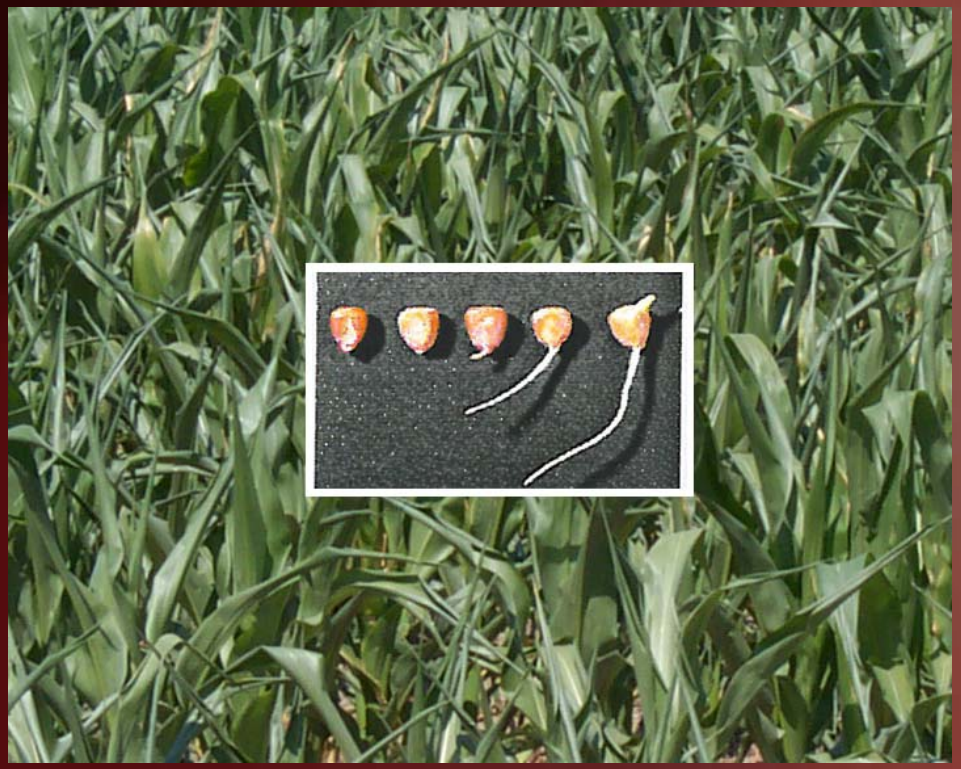
| | Corn | Soybeans |
|---|---|---|
| 1. | Water - 40% Dry wt | Water - 50% + Dry wt |
| 2. | Temp - 50 F+ | Temp - 60F+ |
| 3. | Oxygen - Yes | Oxygen - Yes |
| 4. | Enzymes for<br>Starches<br>Sugars | Enzymes for<br>Starches<br>Proteins<br>Oils |

# HOW A CORN PLANT DEVELOPS



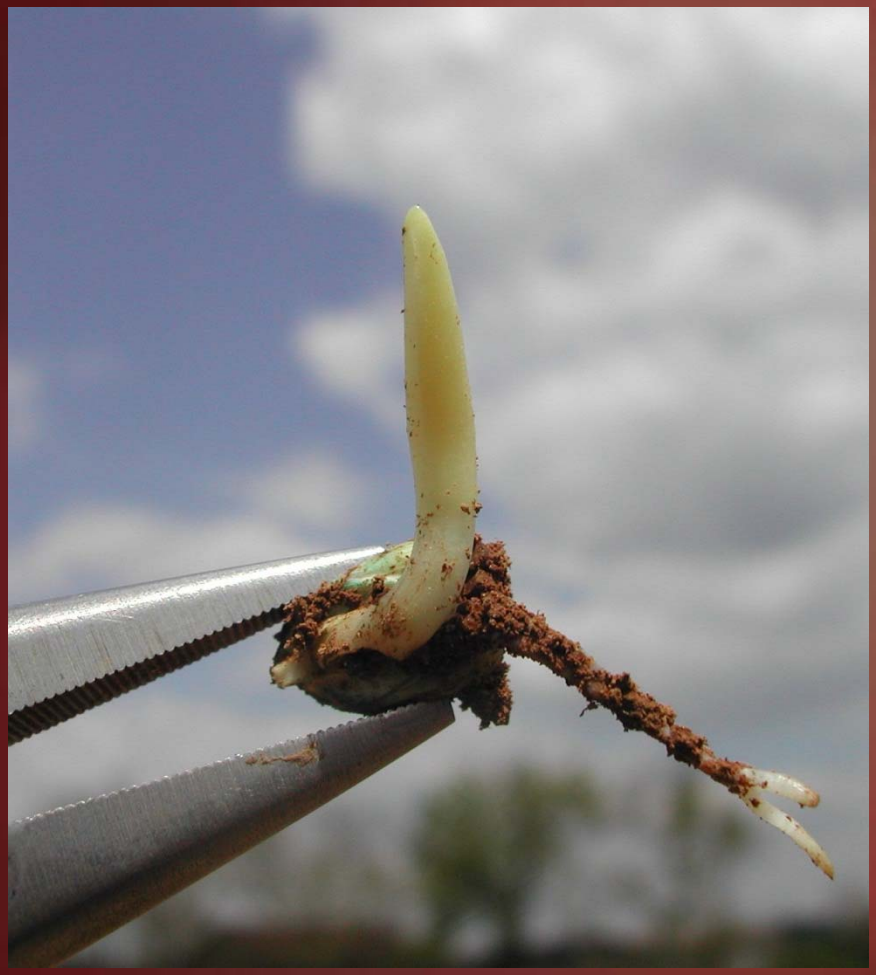

**Radicle emerges first, followed by the coleoptile.**

# GERMINATION OF CORN



**Radicle emerges first, followed by the coleoptile.**

# Corn Emergence (VE)



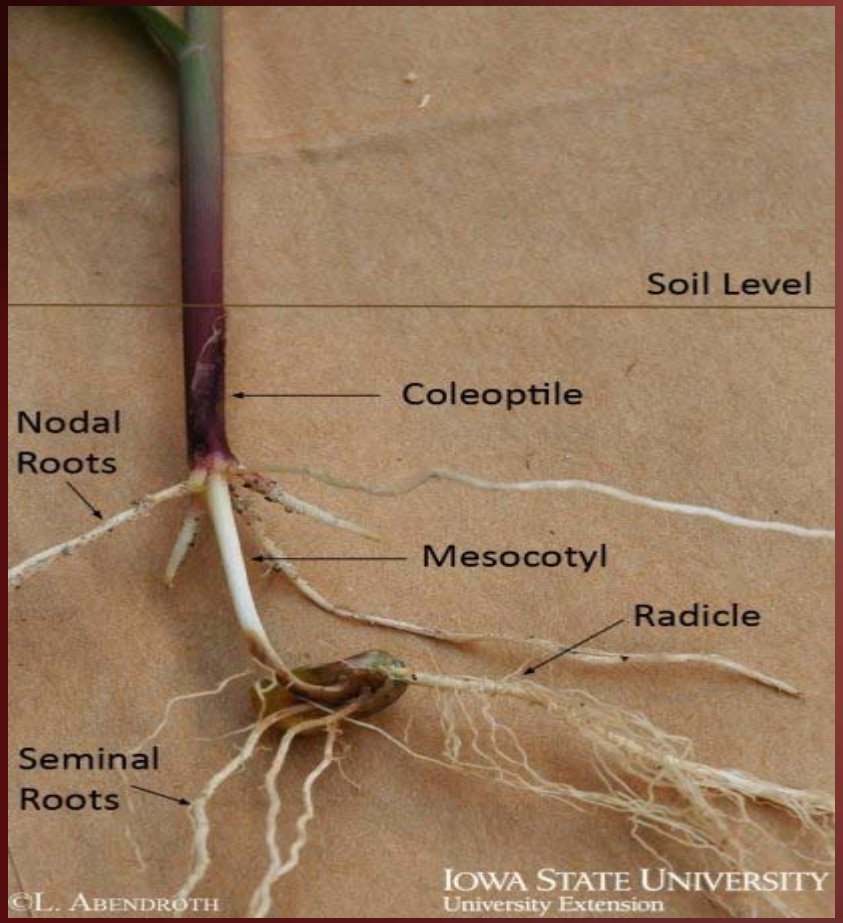
# VE STAGE


**Coleoptile reaches soil surface**

# V1 STAGE – ABOVE GROUND


**First leaf emerges**

# V1 STAGE – BELOW GROUND




**Nodal root development**

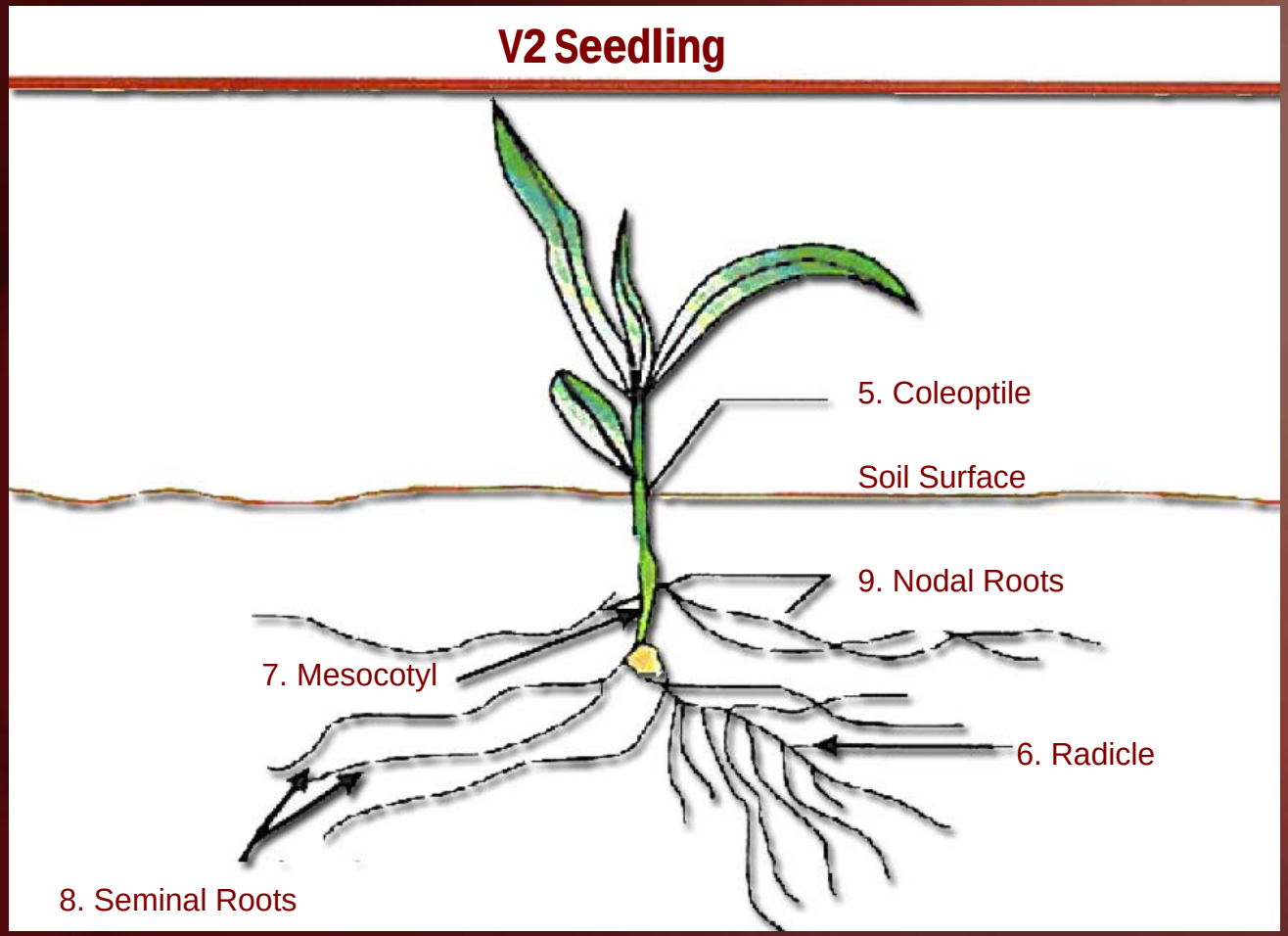
# V2 STAGE – TWO LEAVES FULLY EMERGED

- **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**

# HOW A CORN PLANT DEVELOPS



# 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

| Corn Maturity (Days) | GDD |
|---|---|
| 85 to 100 | 2100 – 2400 |
| 101 to 130 | 2400 – 2800 |
| 131 to 145 | 2900 – 3200 |

## GDD Requirements of a 2700 GDD Hybrid

| Growth Stage | GDD |
|---|---|
| V2 | 200 |
| VT | 1135 |
| R1 | 1400 |
| R6 | 2700 |

From NCH-40 Growing Season Characteristics and Requirements in the Corn Belt. National Corn Handbook.

# 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).**

| Crop or Pest | Minimum °F | Maximum °F | Information Use |
|---|---|---|---|
| **Corn** | 50 | 86 | crop development |
| **Soybean** | 50 | 86-90 | crop development |
| **Black cutworm** | 50 | | 300 DD from egg to cutting |
| **Stalk borer** | 41 | | predicting migration |
| **Bean leaf bettle** | 46 | | 2nd generation emergence |
| **Seedcorn maggot** | 39 | | seed treatment on replant |
| **Alfalfa weevil** | 48 | | larval presence in fields |
| **Western bean cutworm** | 50 | | adult emergence / egglaying |

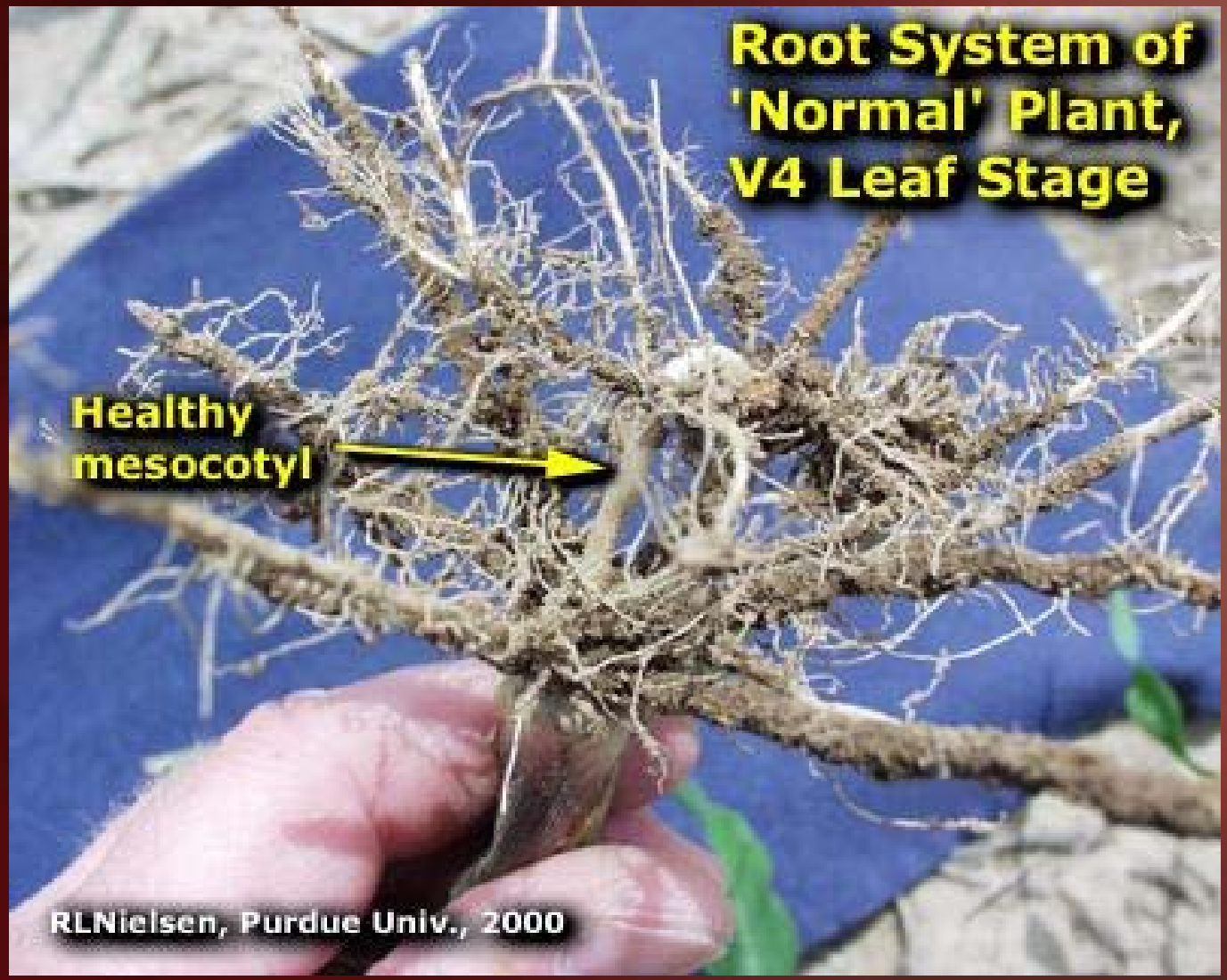
# V3 TO V4 STAGE – ABOVE GROUND

# Corn Growth Stages

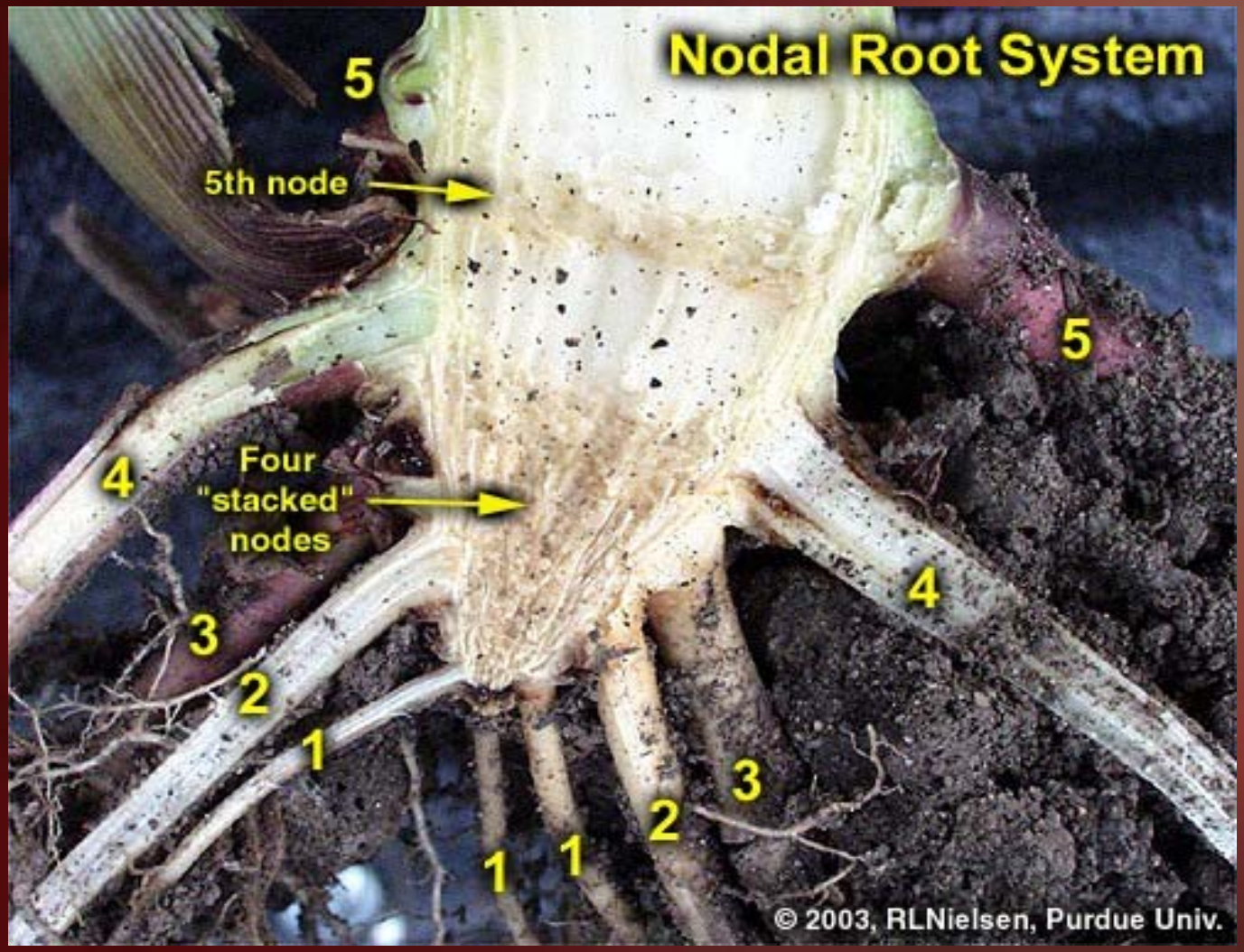
| | |
|---|---|
| **V3**<br>**3 Collars** | **Nodal roots active.**<br>**Growing point below ground** |

# V3 TO V4 STAGE – BELOW GROUND

# V4 STAGE – BELOW GROUND



# CORN NODAL ROOT SYSTEM



# Corn Growth Stages

| | |
|---|---|
| **V6**<br>**6 collars** | **Growing point above ground. Tassel and ear development starting.** |

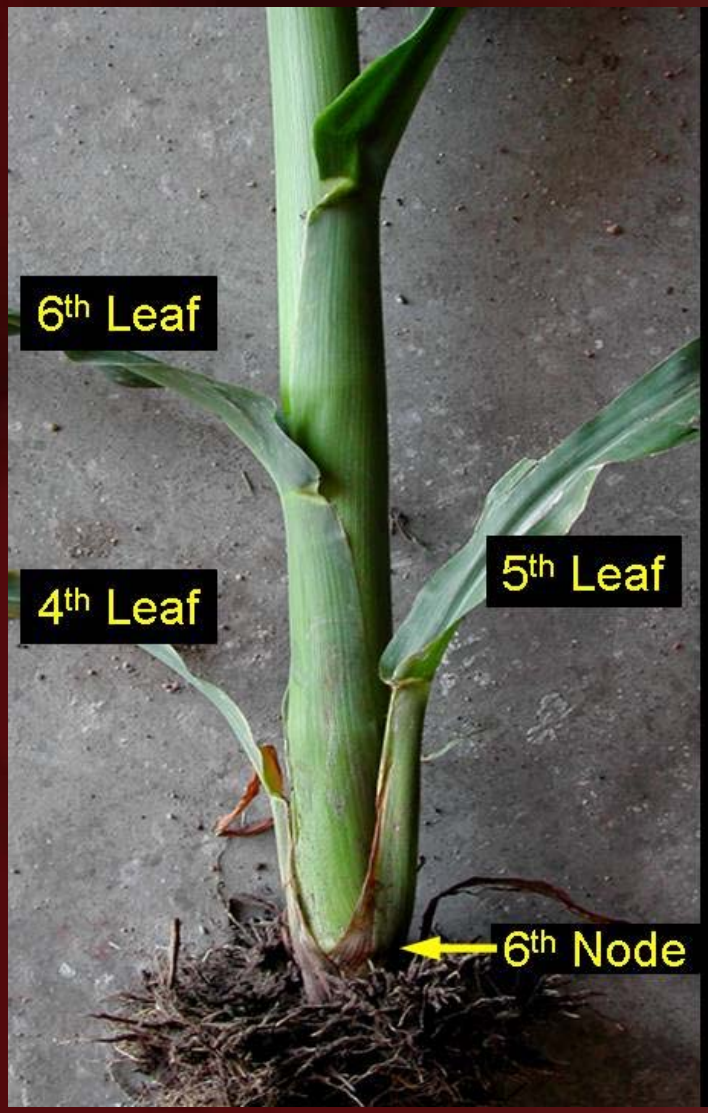
# V6 TO V8 – BELOW GROUND

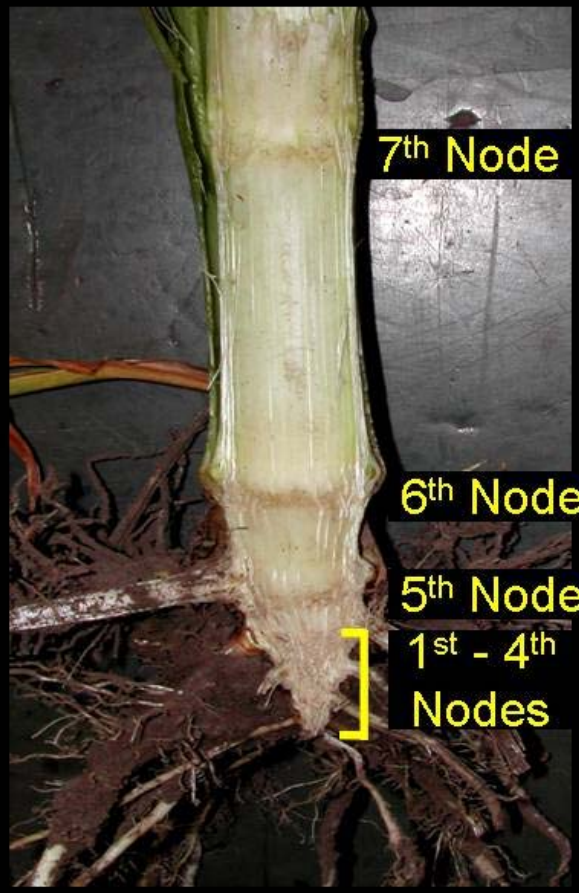
- **Growing point moves above soil surface.**
- **Nodal root system is the major functional root system.**

# V6 TO V8 – ABOVE GROUND

- **Above ground – 6 to 8 leaf collars**
- **8-10 leaves**
- **Rapid stalk elongation begins**

# Corn Growth Stages




L. Abendroth 2005
University of Nebraska

# Corn Growth Stages

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

# Corn Growth Stages

| | |
|---|---|
| **V15**<br>15 collars | Rapid growth, about 10 to 12 days before silking.<br>Most sensitive to stress. |
| **VT**<br>tassel | Last tassel branch is visible but prior to silking.<br>Complete leaf loss will cause nearly 100% yield loss. |

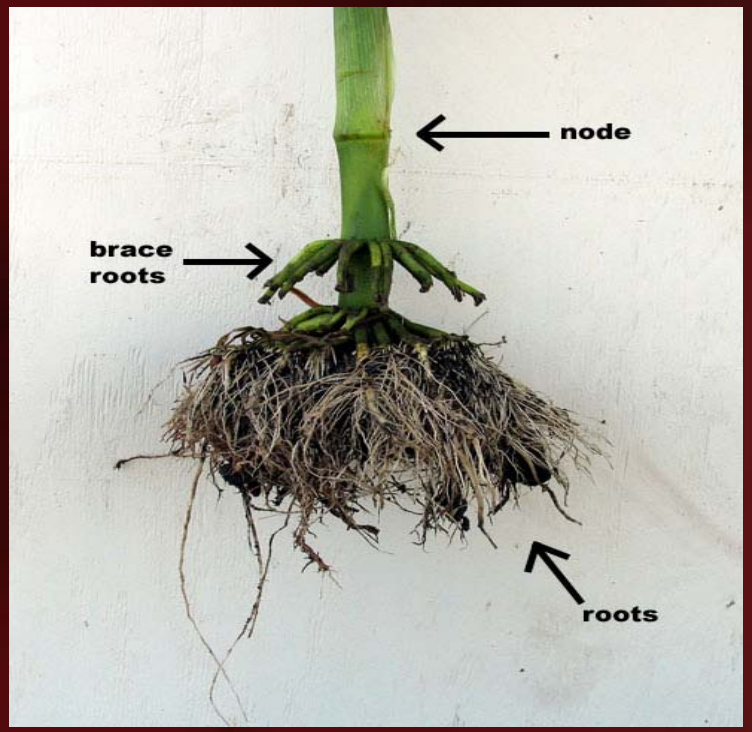
# V15 TO VNTH STAGE – ABOVE GROUND

- **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**

# 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.**

# V15 TO VNTH STAGE – BELOW GROUND




**Brace roots grow and support the corn plant.**

# CORN REPRODUCTIVE STAGES

**R1 - Silk**

**R2 - Blister**

**R3 - Milk**

**R4 - Dough**

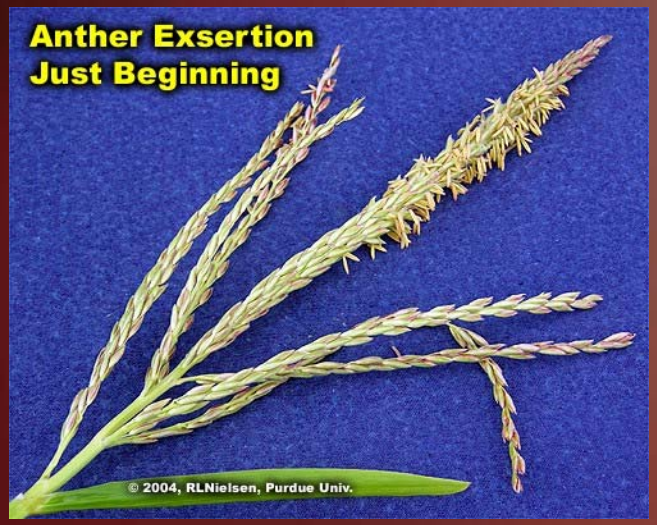
**R5 - Dent**

**R6 - Mature**

# Corn Growth Stages

| | |
|---|---|
| **R1**<br>**Silking** | N and P uptake are rapid.<br>About 50% of total N is taken up after R1.<br>K uptake is nearly complete.<br>Water needed for pollination.<br>Pollination occurs. |
| **R2**<br>**Blister** | Ear size nearly complete.<br>Silks begin to dry out.<br>A miniature corn plant is being formed in each fertilized kernel. |

# 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

| | |
|---|---|
| **R4**<br>**Dough** | **Kernels have accumulated ½ of total dry weight.**<br>**Five leaves have formed in the kernel.** |
| **R5**<br>**Dent** | **Most kernels have dented and are near 55% moisture at start.**<br>**Starch layer has formed and progresses down the kernel.** |

# R4 STAGE – THE DOUGH STAGE


**Milkline movement through kernel**

# R5 STAGE – THE DENT STAGE

# 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**<br>**Physiological Maturity** | **Blacklayer has formed at bottom of kernel.**<br>**Kernel is about 30 to 35% moisture.** |

# Planting Date and GDD

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

| Planting Date | GDD As of 06/26/05 | Difference From First Planting |
|---|---|---|
| April 20 | 1155 | --- |
| May 3 | 1029 | 126 |
| May 18 | 825 | 330 |
| May 31 | 596 | 559 |
| June 15 | 281 | 874 |

From University of Kentucky Ag Weather Center: http://wwwagwx.ca.uky.edu/
Growing Degree Day calculator: http://wwwagwx.ca.uky.edu/cgi-bin/cropdd_www.pl

# Planting Date and GDD

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

| Planting Date | GDD As of 07/11/05 | Difference from First Planting |
|---|---|---|
| April 20 | 1503 | --- |
| May 3 | 1377 | 126 |
| May 18 | 1173 | 330 |
| May 31 | 944 | 559 |
| June 15 | 629 | 874 |

From University of Kentucky Ag Weather Center: http://wwwagwx.ca.uky.edu/
Growing Degree Day calculator: http://wwwagwx.ca.uky.edu/cgi-bin/cropdd_www.pl

## Corn growth and development stages when yield components are determined

| Growth Stage | | Yield components | |
|---|---|---|---|
| | GDU | Potential | Actual |
| **VE** | 125 | Ears/area | ----- |
| **V6** | 470 | Kernel rows/ear | "Factory" |
| **V12** | 815 | ----- | Kernel rows/ear |
| **V18** | 1160 | Kernels/row | ----- |
| **R1** | 1250 | Kernel weight | Kernel number<br>Ears/area |
| **R6** | 2350 | ----- | Kernel weight |

## Relationship between kernel growth stage and development.

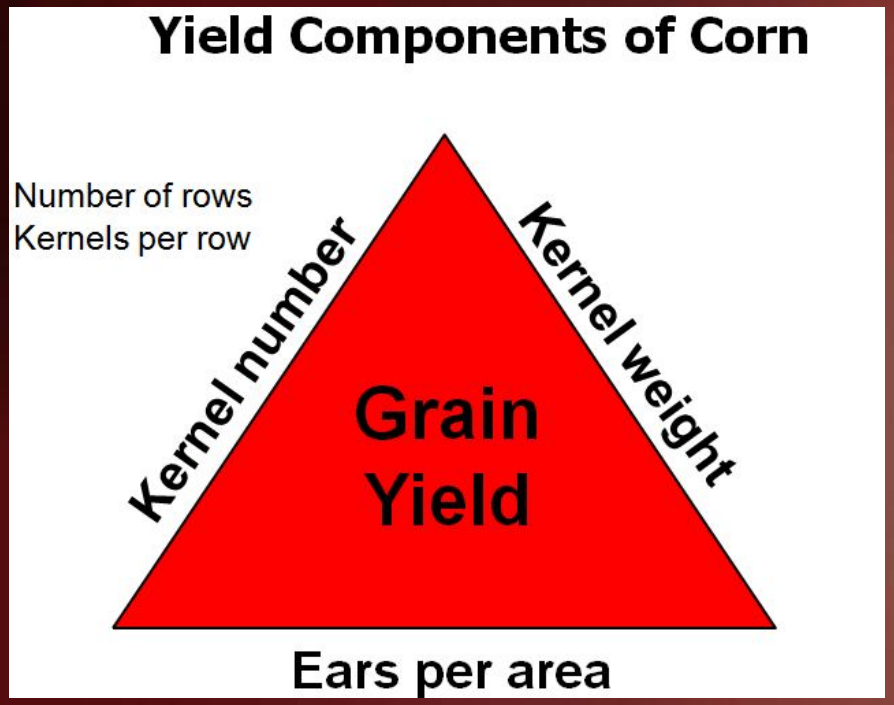
| | | | Percent of Maximum Yield | | Moisture Content | |
|---|---|---|---|---|---|---|
| **Stage** | Calendar days to maturity (average) | Growing degree units (GDUs to maturity) | Grain | Whole plant | Grain | Whole Plant |
| **Silk (R1)** | 55-60 | 1100-1200 | 0 | 50-55 | -- | 80-85 |
| **Blister (R2)** | 45-50 | 875-975 | 0-10 | 55-60 | 85-95 | 80-85 |
| **Late milk-dough (R4)** | 35-40 | 650-750 | 30-50 | 65-75 | 60-80 | 75-80 |
| **Early Dent (R5)** | 25-30 | 425-525 | 60-75 | 75-85 | 50-55 | 70-75 |
| **Fully Dented (5.50-5.75)** | 13-17 | 200-300 | 90-95 | 100 | 35-40 | 65-70 |
| **Physiological maturity (R6) *** | 0 | 0 | 100 | 95-100 | 25-35 | 55-65 |

*** 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

| Factor | VE | V6 | V12 | V18 | R1 | R6 |
|---|---|---|---|---|---|---|
| Frost (< 28 F) | 0 | 100 | 100 | 100 | 100 | 0 |
| Hail (max) | 0 | 53 | 81 | 100 | 100 | 0* |
| Drought/Heat (%/day) | -- | -- | 3 | 4 | 7 | 0 |
| Flooding (<48 h) | severe | | 0 | 0 | 0 | 0 |

* 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.