Soybeans
Growth & Development

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Crop Protection and Cropping Systems Specialist

Soybeans

- Growth Stages
  - Vegetative
  - Reproductive

- Photosensitive
  - Day length signals plant to enter reproductive growth stages
  - Temperature can also play a role in this
**Soybean Maturity Groups**

- **Relative Maturity**
  - Rating system on i-80 corridor
  - Calendar day in September
  - Example
    - RM1.4 : R7 on September 14

- **System has evolved and RM varies by company**

**Soybean Plant Parts**

- **Cotyledons**
  - the actual seed that was planted
  - Splits in two halves
  - Supplies plant with nutrients
  - Eventually fall off but leave a scars behind
Soybean Plant Parts

- **Cotyledons**
- **Unifoliate**
  - First pair of primary leaves
  - Grow opposite to one another
  - Reference point for vegetative staging of plant
  - Short petioles

- **Trifoliate**
  - Compound leaves
  - Produced singularly
  - Alternate on stem
  - Long petioles
Soybean Plant Parts

- Cotyledons
- Unifoliate
- Trifoliate
- Growing points
- Stem nodes
- Tap root

Soybean Development Stages

- Vegetative Stage Method
  - Number of nodes on main stem that have fully developed leaf
- Fully Developed Leaf
  - Edges of leaves no longer touch
- Counts begin at the unifoliate leaves
Germination

- 50% of weight in water to germinate
- Radicle
  - Anchors seed
- Hypocotyl
  - Pulls cotyledons to surface
- Emergence
  - Typically 5-10 days
  - Influenced by moisture, temperature, variety, planting depth

Replant Considerations

- Narrowing row spacing
  - Drill: issues with depth uniformity
  - Less days to canopy closure
- Increase plant population (+10%)
- After June 15th
  - Could reduce MG by 0.5-1.0
  - Stick with maturity for the area
Nebraska Planting Dates

1980-2017: producer have planted an average of a ½ day earlier each year

Why Plant Early?

- After May 1
  - High yield year: 5/8 bu/day loss
  - Low yield year: ¼ bu/day loss

- Goal: Canopy Closure
  - Reduce evaporation from soil
  - More transpiration (ET)

- Saying in Soybeans
  - “Green to the eye by the 4th of July”
Timeline for Soybean Yield Components

VE - Emergence

- Cotyledons and growing point above soil surface
- Cotyledons supply plant with food
  - How many days?
VE - Emergence

- Cotyledons and growing point above soil surface
- Cotyledons supply plant with food
  - How many days?
  - 7-10 days

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VE - Emergence

- Cotyledons and growing point above soil surface
- Cotyledons supply plant with food
- Loss of both cotyledons can reduce yield 2-7%

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Soybean Emergence Issues

- Crusted soils
  - Cotyledons break off
  - Swollen hypocotyl
- Hypocotyl arc straightens out when exposed to light

Risk of Frost

- Plant tissue doesn’t freeze at 32F
  - Solutes in membranes of cells acts like weak antifreeze
- Tissues freeze at air temperatures of 28 to 30F
**VC Stage Defoliation**

**Dead or Alive?**

1. Alive
2. Alive
3. Alive
4. Alive
5. Alive
6. Dead

Sometime stems appear intact but plant dies

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**VC – Unifoliate**

- Cotyledons and unifoliates fully expanded
- Cotyledons supply energy for the plant
  - Loss 70% of their dry weight to nutrient reallocation

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**V1 Stage**

- Cotyledons were main source of energy until this stage
- N fixing root nodules begin to form
  - Infection of *Bradyrhizobium japonicum* bacteria

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**Active Nodulation**

- N fixation continues all the way through R6
- Actively N fixing nodule is pink in the middle when split open
- Green, brown or white means no active fixation occurring
- ____-____% of N is provided through N fixation
Active Nodulation

- N fixation continues all the way through R6
- Actively N fixing nodule is pink in the middle when split open
- Green, brown or white means no active fixation occurring
- \( \frac{46 - 74}{74} \% \) of N is provided through N fixation

V2 Stage

- Active N-fixation has likely began
- Rapid lateral root growth in top 6 inches of soil between rows

Soybean Loss Adjustment Standards Handbook 2016
Timeline for Soybean Yield Components

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Timeline for Soybean Yield Components

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**V5 Stage**

- Lateral roots reach across 30 inch row
- VC-V5: new V stage every 5 days
- V5-R5: new V stage every 3.7 days
- By V6, roots can penetrate 2.5 to 3.25 feet

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**V5 and Dry Matter Accumulation**

Rapid dry matter accumulation begins at V5

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Hail Damage in Soybeans

Stand Density and Number of Nodes

Stem Nodes vs. Branch Nodes

% of Maximum vs.
Low Stand Density High

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Stand Density and Number of Nodes

- **Stem Nodes**
- **Branch Nodes**

% of Maximum vs. Stand Density:
- Low
- High

Recommended Plant Populations

<table>
<thead>
<tr>
<th>120,000</th>
<th>150,000</th>
</tr>
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</table>

**Table 1.** Soybean stands and yields at four seeding rates, averaged from five sites and 20 replications in 2008.

<table>
<thead>
<tr>
<th>Planting Rate</th>
<th>Stand (percentage)</th>
<th>Yield (bu/ac)</th>
</tr>
</thead>
<tbody>
<tr>
<td>90,000</td>
<td>93.5</td>
<td>68.1</td>
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<td>120,000</td>
<td>91.0</td>
<td>69.5</td>
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<td>150,000</td>
<td>90.3</td>
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<td>180,000</td>
<td>88.5</td>
<td>69.6</td>
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</table>
### Soybean Reproductive Stages

<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>Beginning Bloom</td>
</tr>
<tr>
<td>R2</td>
<td>Full Bloom</td>
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<tr>
<td>R3</td>
<td>Beginning Pod</td>
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<tr>
<td>R4</td>
<td>Full Pod</td>
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<tr>
<td>R5</td>
<td>Beginning Seed</td>
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<tr>
<td>R6</td>
<td>Full Seed</td>
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<tr>
<td>R7</td>
<td>Beginning Maturity</td>
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<tr>
<td>R8</td>
<td>Full Maturity</td>
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</table>

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**R1: Beginning Flower**

- At least one flower on any node on the main stem
- Flower period
  - 3 to 4 weeks
  - Peaks R2/R3, ends ~R5
- Vertical root growth rates sharply increase and remain high through R5

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**Timeline for Soybean Yield Components**

- **V Stages**
  - VE
  - VC
  - V1
  - V2
  - V5
  - R1
  - R2
  - R3
  - R4
  - R5
  - R6
  - R7
  - R8

- **Stem**
  - Initial extension growth
- **Branches**
  - First trifoliate leaf appearance
- **Flowers**
  - First flower cluster
- **Flowers Aborted**

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**Timeline for Soybean Yield Components**

- **V Stages**
  - V1: Flowering
  - V2: early pod fill
  - V3: pod fill
  - V4: seed fill
  - V5: mature

- **Key Points for R2: Full Flower**
  - Open flower at one of two upper most nodes
  - 25% of dry weight accumulated
  - 50% of total node number
  - Defoliation of 50% will reduce yield by 60%
  - Rapid increase in N-fixation rate through R6

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Flower and Pod Abscission in Canopy

Abscission greatest in canopy with least amount of light

25% 50% 75% 100%
Flower and pod abscission

Bill Wiebold
Plant Sciences
Univ. of Missouri

Up to 3 clusters per node
2-12 flowers per cluster
Nearly all flowers fertilized
______% of all flower abort

2019 Crop Scout Training
Flower and Pod Abscission in Canopy

- Abscission greatest in canopy with least amount of light
- Up to 3 clusters per node
- 2-12 flowers per cluster
- Nearly all flowers fertilized
- 60-85% of all flowers abort

Bill Wiebold
Plant Sciences
Univ. of Missouri

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R3: Beginning Pod

- Pod is 3/16 inch long at one of the four upper most nodes
- Yield parameters
  - Base population
  - Pod number
  - Seeds per pod
  - Seed weight
- Ability to modify these factors decreases from R1 to R5

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R3 and Irrigation

- Number of yield parameters affected
- Irrigation likely to provide greatest return
  - Soybean plant uses 1/3 inch per day at R3
  - 85 bu – 19.25 inches
  - \( \frac{522,714}{\text{gallons/acre}} \)

Soybeans and Evapotranspiration

- \( \text{Estimated Soybean ET} \) (m/day)
- \( \text{Actual ET} \)
- \( \text{Average ET} \)
- \( \text{Long-term Average ET} \)

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Distribution of Pods in Canopy

All nodes produce flowers, Why is yield greatest in the middle to upper canopy?

Yield

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R4: Full Pod

- Pod is ¾ inch long at one of the four upper most nodes
- Pod number is determined at this stage
- Rapid pod growth and beginning seed development
- Seeds
  - most prone to abortion
  - seeds won’t increase until pod is at full size

Timeline for Soybean Yield Components

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<th>V Stages</th>
<th>VE</th>
<th>VC</th>
<th>V1</th>
<th>V2</th>
<th>V5</th>
<th>R1</th>
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<th>R3</th>
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Timeline for Soybean Yield Components

Pod Abscission Raceme Location

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Pod Abscission Raceme Location

1. 90%
2. 75%
3. 40%
4. 3%
5. 1%

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Plant Sciences
Univ. of Missouri

Stand Density and Pod Number

Number of pods per plant vs. Stand Density

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Management of Late-Season Soybeans

Fungicides/Insecticides and Hail

- Three year Study (Sisson et al. 2016)
  - Strobilurin Fungicides (Plant Health Benefits)
    - Headline (pyraclostrobin)
    - Quadris (azocystrobin)
  - Insecticide
    - Fastac: Alpha-cypermethrin

- R3 fungicides provided little yield preserving benefits in the absence of significant disease pressure
- No difference in fungal disease potential in plots with or without hail
- Increased potential for bacterial plant pathogens (bacterial blight / pustule)
  - Bacterial plant pathogens are not controlled by fungicides
Management of Late-Season Soybeans

- Late season insecticide applications
  - Take about beneficial insects
- Secondary pest issues
  - Two-spotted spider mite
  - Soybean aphid

R5: Beginning Seed

- Seed is 1/8 of inch long at one of the top four nodes
- Rapid seed filling and redistribution of matter/nutrients
- Maximum
  - Height
  - Node number
  - Leaf area
- Root growth begins to slow

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Timeline for Soybean Yield Components

Timeline for Soybean Yield Components

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R6: Full Seed

- Seed fills pod cavity at one of the four upper most nodes
- Total plant pod weight is maximized
- Dry weight and nutrient accumulation rate slows
- Roots can reach up to 6 ft in depth
- Frost event:
  - 20-35% yield loss
  - 10-20” of lateral root growth

Timeline for Soybean Yield Components

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Timeline for Soybean Yield Components

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R7: Beginning Maturity

- One pod on the main stem has achieved a mature pod color
- Seed Moisture
  - 50-60%
- Frost Event
  - 0-5% yield loss
R8: Full Maturity

- 95% of pods reach mature pod color
- 25-35% seed moisture
- Additional 5-10 days of drying after R8 to reach 15% moisture
- Frost Event:
  - 0% yield loss

Timeline for Soybean Yield Components

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What questions do you have?

Twitter: @justinmcmachan

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