

# Soybean Growth and Development



This presentation is similar to the previous Corn Growth and Development presentation. These slides explain how a soybean plant develops during the season and how stress at different growth stages relates to crop yield loss.

Insects, diseases, weeds, and other disorders are most likely to be more problematic during certain stages of a soybean plant's development. Because of this, understanding the growth stage of a plant aids the producer, agronomist, or crop scout in efficiently and effectively scouting their fields.

# Outline

- The soybean plant
- Growth staging
- Vegetative stages
- Reproductive stages
  - Bloom
  - Pod development
  - Seed development
  - Maturity
- Conclusions



We will begin by discussing a little bit of the history and biology of the soybean plant, as well as the names of the different plant parts of soybean.

Once we know the various parts of the plant we can then stage, or determine how developed, a soybean plant and a soybean field are.

Then we will go over the vegetative and reproductive stages of development and conclude the presentation.

## The soybean plant

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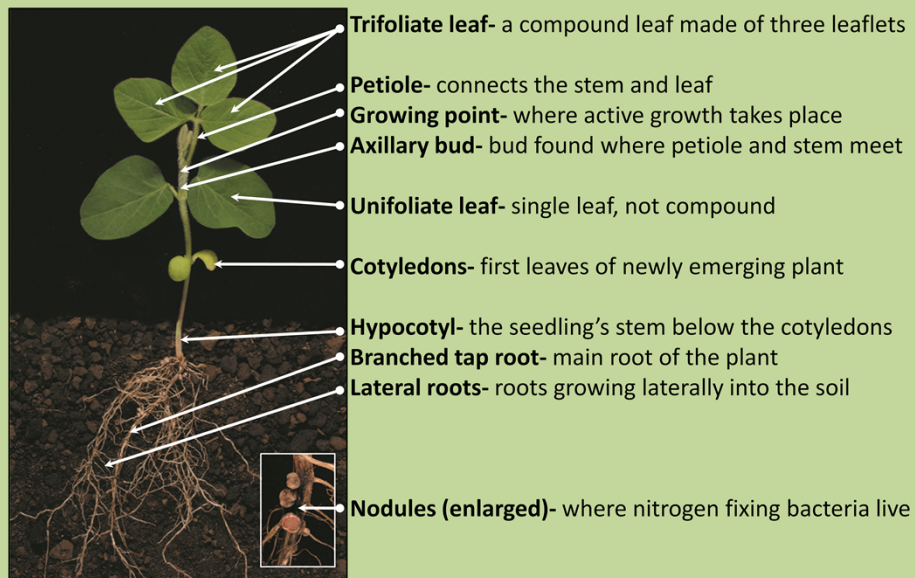
- Domesticated about 4,500 years ago in China
- The U.S. grows the most soybeans in the world
- North central states grow majority of soybeans
- Nine different maturity groups: 00 (in the north) to IX (in the south)
- Group II and III grown in Iowa
- Symbiotic relationship exists between soybean and nitrogen fixing bacteria

Domestication of the soybean plant occurred about 4,500 years ago in China. Currently, the United States grows the most soybeans in the world and the north central states grow the majority of soybeans in the U.S.

There are nine different soybean maturity groups grown in the U.S. These groups range from 00 which are grown in the northernmost states to IX which are grown in the southern half of Florida. In the top two-thirds of Iowa, maturity group II is grown and maturity group III is best suited for the bottom third of Iowa.

Soybeans have an interesting relationship with a nitrogen fixing bacteria. Soybeans gain nitrogen from these bacteria and in return, the bacteria obtain carbohydrates from the soybean. This kind of relationship, where both organisms benefit, is called a symbiotic relationship.

# Soybean plant parts



Understanding the different parts of the soybean plant are important for staging fields.

**Trifoliate leaf**- a compound leaf made up of three leaflets, so it appears as though it is three separate leaves, but it is attached to the plant by a single petiole. The number of trifoliate leaves is used to determine vegetative growth stage.

**Petiole**- connects the stem and leaf.

**Growing point**- where active growth takes place.

**Axillary bud**- bud found in the upper angle of where the petioles and stem meet.

**Unifoliate leaf**- a single leaf, not compound. These leaves only develop near the beginning of soybean growth, after cotyledons emerge, but before trifoliate leaves are produced.

**Cotyledons**- first leaves of newly emerging plant, these are also called seed leaves.

**Hypocotyl**- the seedling's stem below the cotyledons.

**Branched tap root**- main root of the plant.

**Lateral root**- roots growing laterally into the soil.

**Nodules (enlarged)**- where the nitrogen fixing bacteria are located.



## **Stress and crop yield loss**

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- At each growth stage of soybean, certain aspects of management must be considered.
- Various problems are associated with each stage and can interfere with growth at that stage.
- Problems include adverse soil conditions, weeds, insects, diseases, and other disorders.
- Problems that occur early in the season may contribute to the yield loss experienced at the end of the season during harvest.
- We will examine various problems for the stages of soybean throughout the growing season.

At each growth stage of soybean, certain aspects of management must be considered. This is because various problems are associated with each stage and can interfere with growth at that stage. Problems include adverse soil conditions, weeds, insects, diseases, and other disorders. Problems that occur early in the season may contribute to the yield loss experienced at the end of the season during harvest. We will examine problems for the stages of soybean throughout the growing season.

# Growth staging

- Growth stages may overlap in a field.
- A growth stage for a field begins when at least 50 percent of the plants have reached or are beyond a certain stage.
- The Soybean Field Guide 2<sup>nd</sup> Edition provides disease scouting information by growth stage.



Firstly, it is important to know how to determine the growth stage for a field of soybeans. Growth stages may overlap within a field and because of this, a growth stage for a field begins when at least 50 percent or more of the plants within that field have reached or are beyond a particular stage.

The Soybean Field Guide 2<sup>nd</sup> Edition provides scouting information by growth stage for many diseases and insects (beginning page 20). This makes it useful to know the growth stage of a field so you know what will most likely be problematic during those periods of development.

## Vegetative stages

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- Vegetative Stages
  - VE: Emergence
  - VC: Unrolled unifoliate leaves
  - V1: First unrolled trifoliate leaf
  - V2: Second unrolled trifoliate leaf
  - V(n): Each successive unrolled trifoliate leaf

There are several vegetative stages of the soybean plant. We will discuss some of the features of those stages and examine some of the problems to look out for.

## Vegetative stages VE-V1

- VE: emergence (7-14 days after planting)
- VC: unifoliate leaves unroll
- V1: 1<sup>st</sup> trifoliate leaf unrolls (7-10 days after VE)



**VE**

**VC**



**V1**

The first stage after planting is **VE**, or emergence. This occurs 7-14 days after planting, depending on environmental conditions and the depth the seeds were planted. The cotyledons open during this time and the plant uses energy that is stored in them. The cotyledons are also capable of photosynthesis. Soybean plants have growing points above ground, making them very vulnerable to damage during this stage.

At **VC**, the unifoliate leaves are entirely unrolled. Food reserves in the cotyledons are still being used during this time.

**V1** occurs when the first trifoliate leaf is unrolled (7-10 days after VE). This first trifoliate leaf is now providing enough photosynthesis to supply the young plants needs.

## Vegetative stages VE-V1

- Problems to watch for:

- Soil temperature, crusting
- Flooding, frost, hail
- Bean leaf beetle feeding
- Pythium root rot, Phytophthora root and stem rot
- Common early season pathogens like Fusarium, Rhizoctonia, Phomopsis, and a few other early season root “rots”
- Weed competition



Problems to watch for during VE-V1:

- Soil temperature and crusting (page 52, Soybean Field Guide 2<sup>nd</sup> Edition)
- Flooding, frost, and hail (pages 53, 52, and 54, Soybean Field Guide 2<sup>nd</sup> Edition)
- Bean leaf beetle feeding (page 46, Soybean Field Guide 2<sup>nd</sup> Edition)
- Pythium root rot and Phytophthora root and stem rot (page 27, Soybean Field Guide 2<sup>nd</sup> Edition)
- Common early season pathogens like Fusarium, Rhizoctonia, Phomopsis, and a few other early season root “rots” (see page 26, Soybean Field Guide 2<sup>nd</sup> Edition)
- Weed competition (see Weed Identification Field Guide)

*[soil crusting causes emergence problems and bean leaf beetle]*

## Vegetative stage V2

- V2: 2<sup>nd</sup> trifoliolate leaf unrolls
  - 6 to 8 inches tall
  - Nitrogen fixation can begin
- Problems to watch for:
  - Bacterial blight
  - Septoria brown spot
  - Rhizoctonia root rot
  - Flooding
  - Some problems may appear anytime during the season



**V2**

A **V2** soybean plant has two completely unrolled trifoliolate leaves and is 6 to 8 inches in height.

As mentioned before, there is a symbiotic relationship between the soybean and nitrogen fixing bacteria. This bacteria lives in the soil and uses root hairs to gain access to the soybean roots where it forms nodules. Nitrogen fixation begins at V2 to V3, with the bacteria supplying much of the nitrogen needed by the plant. Soil nitrate can actually decrease development of nodules.

Problems to watch for during V2:

- Bacterial blight (page 20, Soybean Field Guide 2<sup>nd</sup> Edition)
- Septoria brown spot (page 21, Soybean Field Guide 2<sup>nd</sup> Edition)
- Rhizoctonia root rot (page 26, Soybean Field Guide 2<sup>nd</sup> Edition)
- Flooding may still have a large impact on yield at this stage (page 53, Soybean Field Guide 2<sup>nd</sup> Edition)
- Keep in mind that some problems, like a few viruses (pages 24 and 25, Soybean Field Guide 2<sup>nd</sup> Edition) or lightening damage (page 56, Soybean Field Guide 2<sup>nd</sup> Edition), can appear at anytime during the growing season.



## Vegetative stage V(n)

- V(n): successive vegetative stages
  - As the plant continues to develop trifoliate leaves, V stage increases accordingly
  - Vegetative growth continues for a time after reproductive stages start, but plants are then known by reproductive characteristics
- Problems to watch for during V(n) stages:
  - Begin scouting for soybean cyst nematodes in later V stages, early R stages
  - Soybean aphid scouting in mid-June
  - Grasshoppers, potential for spider mites
  - Many problems mentioned on previous slides
  - Herbicide injury

**V(n)** stages are successive vegetative stages. As the plant continues to develop trifoliate leaves, V stage increases accordingly. For example, a V3 plant has 3 unrolled trifoliate leaves and a V6 plant has 6 unrolled trifoliate leaves.

Plants continue to develop trifoliate leaves even after entering into the reproductive stages. However, the plant is staged according to reproductive characteristics after they begin to appear.

Problems to watch for during V(n) stages:

- Begin scouting for soybean cyst nematodes in later V stages and early R stages (page 32, Soybean Field Guide 2<sup>nd</sup> Edition).
- Scouting for soybean aphid should begin in mid-June (pages 38 and 39, Soybean Field Guide 2<sup>nd</sup> Edition).
- Grasshoppers, potential for spider mites (pages 47 and 45, Soybean Field Guide 2<sup>nd</sup> Edition)
- Many of those previously mentioned problems in earlier V stages can still be problematic during later V stages.
- Many post herbicides are applied to both corn and soybean fields during late May through early July. Scout for drift from neighboring fields, overlap injury, and direct application injuries, tank contamination, or adjuvant issues (pages 62-66, Soybean Field Guide 2<sup>nd</sup> Edition).

## Reproductive stages

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- Reproductive Stages
  - R1: Beginning bloom
  - R2: Full bloom
  - R3: Beginning pod development
  - R4: Full pod
  - R5: Beginning seed
  - R6: Full seed
  - R7: Beginning maturity
  - R8: Full Maturity

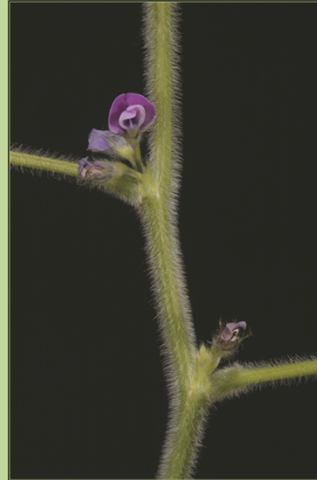
Reproductive stages of the soybean plant begin when 1 flower opens at any node (beginning bloom). Full maturity occurs when at least 95 percent of the pods have reached mature color.

## Reproductive stages: R1 & R2

### Beginning and full bloom

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- R1: Beginning bloom occurs when at least 1 flower is open at any node
- R2: Full bloom occurs when either of the two top nodes have an open flower



Beginning bloom occurs when at least 1 flower is open at any node and is referred to as **R1**. Flowers develop from axillary buds. The first flowering will happen somewhere between the 3<sup>rd</sup> and 6<sup>th</sup> node (the place where a stem and leaf meet), and will continue both up and down along the stem. Weather conditions that cause an extended flowering period can be beneficial for yield.

**R2** is called full bloom and occurs when either of the two top nodes of the plant have an open flower (nodes must have a trifoliate leaf fully formed). Plant dry weight and nutrients quickly accumulate during this period and roots have grown across the 30 inch spacing between rows.

## Reproductive stages: R1 & R2

### Beginning and full bloom

- Problems to watch for:
  - Bacterial pustule, Fusarium wilt, powdery mildew, Septoria brown spot
  - Sudden death syndrome
  - Grasshoppers, spider mites, soybean aphid
  - Flooding, Drought



Problems to watch for:

- Bacterial pustule, Fusarium wilt, powdery mildew, Septoria brown spot (pages 20, 26, 23, and 21, Soybean Field Guide 2<sup>nd</sup> Edition)
- Sudden death syndrome (page 28, Soybean Field Guide 2<sup>nd</sup> Edition)
- Grasshoppers, spider mites, soybean aphid (pages 47, 45, and 38-40, Soybean Field Guide 2<sup>nd</sup> Edition)
- Flooding may have the greatest impact on yield during R1-R3 as well as V1-V2, drought can cause flower abortion (page 53, Soybean Field Guide 2<sup>nd</sup> Edition)

*[grasshopper, sudden death syndrome, and symptoms of Fusarium wilt]*

## Reproductive stage: R3 & R4

### Beginning and full pod

- R3: Beginning pod is when pods are  $\frac{3}{16}$  inch long at 1 of the top 4 nodes on the main stem with a fully developed leaf
- R4: Full pod is when pods are  $\frac{3}{4}$  inch long in the same location as above



**R4**

Beginning pod, called **R3**, is when pods are  $\frac{3}{16}$  inch long at one of the top four nodes on the main stem with a fully developed leaf.

Full pod, or **R4**, is when pods are  $\frac{3}{4}$  inch long in the same location as those in the R3 stage. It is crucial to reduce stress during this stage as the most yield damage from a stress can occur between R4 and right after R6.

## Reproductive stage: R3 & R4

### Beginning and full pod

- Problems to watch for:
  - Cercospora leaf blight, brown stem rot, stem canker
  - White mold, downy mildew, frogeye leaf spot
  - Green cloverworm, soybean looper, soybean aphid
  - Japanese beetle, spider mite
  - Nutrient deficiencies



Problems to watch for:

- Cercospora leaf blight, brown stem rot, stem canker (pages 22 and 29, Soybean Field Guide 2<sup>nd</sup> Edition)
- White mold, downy mildew, frogeye leaf spot (pages 30, 23, and 22, Soybean Field Guide 2<sup>nd</sup> Edition)
- Green cloverworm, soybean looper, soybean aphid (pages 42, 44, and 38-40, Soybean Field Guide 2<sup>nd</sup> Edition)
- Japanese beetle, spider mite (pages 43 and 45, Soybean Field Guide 2<sup>nd</sup> Edition)
- Nutrient deficiencies (pages 57-61, Soybean Field Guide 2<sup>nd</sup> Edition)

[frogeye leaf spot]



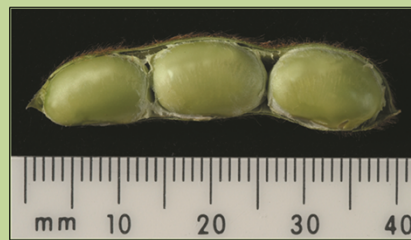
## Reproductive stage: R5 & R6

### Beginning and full seed

- R5: Beginning seed is when seeds are 1/8 inch long in the pod at 1 of the 4 top nodes on the main stem
- R6: Full seed is when green seeds fill pod capacity at the same location as above



Pod of an R5 plant



Pod of an R6 plant

At **R5**, or beginning seed, seeds are 1/8 inch long in the pod at 1 of the 4 top nodes on the main stem. Seed nutrient and dry weight increases rapidly and the plant reaches the pinnacle of its growth: height, leaf area, and nodes. Resources from vegetative plant parts are redistributed to the seeds. Plants require a lot of water and nutrients during this time period.

When soybeans reach **R6**, or full seed, green seeds fill pod capacity at 1 of the 4 top nodes on the main stem, though the plant may have beans in various stages of development on it. The rapid acquiring of dry weight and nutrients in the plant and seed slows. Leaves start to yellow.

## Reproductive stage: R5 & R6

### Beginning and full seed

- Problems to watch for:
  - Anthracnose, charcoal rot, pod and stem blight
  - Sudden death syndrome, brown stem rot, white mold
  - Grasshoppers, Japanese beetles, bean leaf beetles, stink bugs
  - Hail
  - Drought



Problems to watch for:

- Anthracnose, charcoal rot, pod and stem blight (pages 31 and 30, Soybean Field Guide 2<sup>nd</sup> Edition)
- Sudden death syndrome, brown stem rot, white mold (pages 28, 29, and 30, Soybean Field Guide 2<sup>nd</sup> Edition)
- Grasshoppers, Japanese beetles, bean leaf beetles, stink bugs (pages 47, 43, and 46, Soybean Field Guide 2<sup>nd</sup> Edition)
- Hail (page 54, Soybean Field Guide 2<sup>nd</sup> Edition)
- Drought (page 53, Soybean Field Guide 2<sup>nd</sup> Edition)

*[charcoal rot symptoms and the interior of a soybean stem infected by charcoal rot]*

## Reproductive stage: R7 & R8

### Beginning and full maturity

- R7: Beginning maturity occurs when 1 pod on the main stem reaches mature color
- R8: Full maturity occurs when 95 percent of pods reach mature color



**R7**



**R8**

When the plant reaches **R7**, or beginning maturity, 1 pod on the main stem will have attained its mature color: tan or brown. Seed maturity happens when dry weight is no longer accumulated in seeds. Yields are not really effected by stress at or after R7.

At **R8**, or full maturity, 95 percent of pods have reached mature coloration. When plants reach R8, a number of drying days are required before seed is at an appropriate moisture content for harvest.

## Reproductive stage: R7 & R8

### Beginning and full maturity

- Problems to watch for:

- Green stem
- Stem diseases (pod and stem blight, charcoal rot, Anthracnose)
- Seed diseases (Phomopsis, white mold, purple seed stain, etc.)
- Grasshoppers, bean leaf beetles, stink bugs
- Lodging



Problems to watch for:

- Green stem (page 54, Soybean Field Guide 2<sup>nd</sup> Edition)
- Stem diseases: pod and stem blight, charcoal rot, Anthracnose (pages 31 and 30, Soybean Field Guide 2<sup>nd</sup> Edition)
- Seed diseases: Phomopsis, white mold, purple seed stain, etc. (pages 33 and 34, Soybean Field Guide 2<sup>nd</sup> Edition)
- Grasshoppers, bean leaf beetles, stink bugs (pages 47 and 46, Soybean Field Guide 2<sup>nd</sup> Edition)
- Lodging

[soybean plants with green stem]

## Conclusions

- Certain management considerations must be taken into account during the various stages of soybean growth.
- Each stage has its own set of problems.
- Many insects, diseases, and disorders are problems during multiple soybean stages.
- This knowledge can help growers to be aware of the potential problems soybeans are facing during the growing season.

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We have learned how to identify the different stages of soybean growth throughout the season. This information can help us become better soybean growers because at each of the particular growth stages of soybean, certain management considerations must be taken into account. Each stage has its own particular problems which may interfere with growth at that stage including soil temperature and crusting, weeds, insects, diseases, and other disorders. Also, many insects, diseases, and disorders are problems during multiple soybean stages. This knowledge can help growers to be aware of the potential problems soybeans are up against throughout the growing season.

Much of the information in this presentation is from: Soybean Growth and Development. PM 1945. Palle Pederson. Iowa State University Extension. Reviewed December 2009.

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