

Soybean Plant Curriculum



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Soybean Plant Curriculum

The Soybean Plant Model is used to teach about the different stages of soybean plant growth and the general anatomy of the plant.

Curriculum Structure

The Soybean Plant Curriculum is composed of the following lessons. Approximate lesson times are included.

Lesson	Title	Approximate Time
One	Soybean Plant Anatomy	1 hour
Two	Soybean Plant Growth Stages	1 hour
	Total	2 hours

Lesson Structure

Each lesson begins with a Lesson Overview, Lesson Objectives, and a Lesson at a Glance table that lists lesson activities, materials required, suggested preparation steps, and approximate class time.

Lesson Sections

The actual lesson follows the overview, which contains some of the sections described below.

FOCUS

Every lesson begins with a FOCUS activity intended to capture participants' attention. This may be in the form of a small or large class discussion, a game, a demonstration, or a review of previous lesson information. During this activity, participants are introduced to the topic of the lesson.

LEARN

The LEARN activity in each lesson varies in its presentation mode. It may be a slide presentation, group activity, or demonstration.

REVIEW

The majority of lessons end with a REVIEW activity intended to briefly review the lesson's key messages or main points.

Lesson One – Soybean Plant Anatomy

Lesson Overview

This lesson is designed to give learners a background on what a soybean plant is, the areas in which soybeans are grown, and to give learners an understanding of the anatomy of a soybean plant.

Lesson Objectives

After completing this lesson, participants will be able to:

- Locate where soybean plants are grown
- Understand the purpose and importance of soybean plants
- Identify the anatomy of a soybean plant

Lesson at a Glance

Activity	Materials	Preparation	Approximate class time
FOCUS	• <i>Soybean Plant Anatomy</i> slide presentation (slides 1-13)	1. Prepare <i>Soybean Plant Anatomy</i> slide presentation for viewing	20 minutes
LEARN	• <i>Soybean Plant Anatomy</i> slide presentation (slides 14-25)	1. Prepare <i>Soybean Plant Anatomy</i> slide presentation for viewing	20 minutes
REVIEW	• <i>Soybean Plant Anatomy Worksheet</i> • <i>Soybean Plant Anatomy Worksheet – Answer Key</i>	1. Print/photocopy <i>Soybean Plant Anatomy Worksheet</i> (one per participant)	20 minutes

Lesson One – Soybean Plant Anatomy

FOCUS: Soybean Plant Background Information

20 minutes

Purpose:

Create a basic level of understanding of the soybean plant, its purposes, and where it is grown within the United States.

Materials:

- *Soybean Plant Anatomy* slide presentation

Facilitation Steps:

Slide 3: Thinking Prompt—Which of the following is a soybean plant?

A: Wheat

B: Soybean

C: Corn

ANSWER: B

Slide 4: Facts taken from USDA reports. If you are looking for more specific information for your home area, search the USDA website for county- or state-specific data.

Slide 5: Other broadleaf plants for reference: clover, alfalfa, dandelion.

Three types of plants: broadleaves, grasses, sedge.

Slide 6: There are two types of root systems: TAP ROOT and FIBROUS ROOT systems.

Slide 7: Legumes are grown for food for either humans or animals. Bacteria in the nodules fix unusable nitrogen (there will be more information about this in later sections, with specifics).

Slide 8: Plants form their own reproductive parts (male and female) and are self-sustainable for reproduction, which makes it easier to form pods.

Slide 9: Review of the basics of soybeans. There will be more information on all items later in the plant anatomy section.

Slide 10: Basic information about planting soybeans in the United States.

REFERENCE: 140,000 seeds per 1 bag of soybeans. The price of soybean seed is roughly \$50-75 per bag.

Slide 11: 75% of all soybeans are grown in 13 states. Soybeans are very adaptable and can grow virtually anywhere, but these are the main producers of soybeans.

Much of this has to do with shipping soybeans, as many are shipped overseas. The proximity to the Mississippi River is important for shipping.

Slide 12: Point out the proximity to the Mississippi River and tributaries for shipping purposes.

Student Question: What crops are grown in other areas that may not grow soybeans?

Slide 13: SOYBEAN MEAL: Mainly used for animal food, but some is used for human production as well. Other beans are food grade for humans more so than soybeans.

OIL: Used in food products in many cases (frying oil, food additives, etc.)

- Some is used for biodiesel fuels for cars and trucks.
- Some is used for making paint, plastic, soaps, etc.

Lesson One – Soybean Anatomy

LEARN: Anatomy of a Soybean Plant

20 minutes

Purpose:

Understand how to identify the plant parts of a soybean plant using the Soybean Plant Model.

Materials:

- Soybean Plant Model
- *Soybean Plant Anatomy* slide presentation

Facilitation Steps:

Reference and use your Soybean Plant Model throughout the lesson to show and point out to students the various parts in conjunction with the presentation slides.

Slide 15: Parts overview. Use the plant model to point out the various parts.

Slide 16: Anchor for the plant within the soil. The root system developing depends on the plant depth when planting the crop.

Slide 17: Bacteria from the nodules fix unusable nitrogen from the atmosphere into usable nitrogen for the soybean.

FUN FACT: When root nodules are squeezed in a growing soybean plant, the nodules will excrete a pink/red fluid if the plant is actively fixing nitrogen.

Slide 18: Use examples of the human body for easy reference. The soybean stem adds structure, like our backbone, and transfers nutrients and water, like our blood vessels.

Slide 19: Cotyledon leaves provide energy to the plant until it begins the photosynthesis process. They will eventually yellow and possibly fall off during the growing season. They will be a different shape than the true trifoliate leaves.

Slide 20: Trifoliate leaves are important in determining the growth stage of the plants and are easy identifying factors.

Slide 21: Flower color is determined by seed variety.

Flower color has NO impact on plant growth.

Self-pollination occurs using the flower.

Slide 22: New leaves show up at the top of the plant. They show new growth and indicate that the plant is still vegetatively growing. They start very small and grow with time.

It is important to know the differences between new and old leaves when looking for plant nutrient deficiencies.

Slide 23: This is what we are after—the harvestable portion.

The pod acts as a blanket and protective layer for the soybean within the pod.

Pods will have 2-4 soybeans in them. Most common are 3 soybeans per pod.

When drying happens in the field, the soybeans will be loose within the pod.

FUN FACT: If soybeans are dry and nearly ready for harvest, you can shake the plant and hear the rattle of the loose soybeans inside the pods.

Slide 24: Review slide.

Lesson One – Soybean Anatomy

REVIEW: Identification of Soybean Plant Parts

20 minutes

Purpose:

Check understanding of soybean plant anatomy and the importance of each soybean plant part.

Materials:

- *Soybean Plant Anatomy Worksheet*
- *Soybean Plant Anatomy Worksheet – Answer Key*

Facilitation Steps:

Have participants spend 15-20 minutes completing the worksheet. This can be divided into two worksheets if best suited for class schedules.

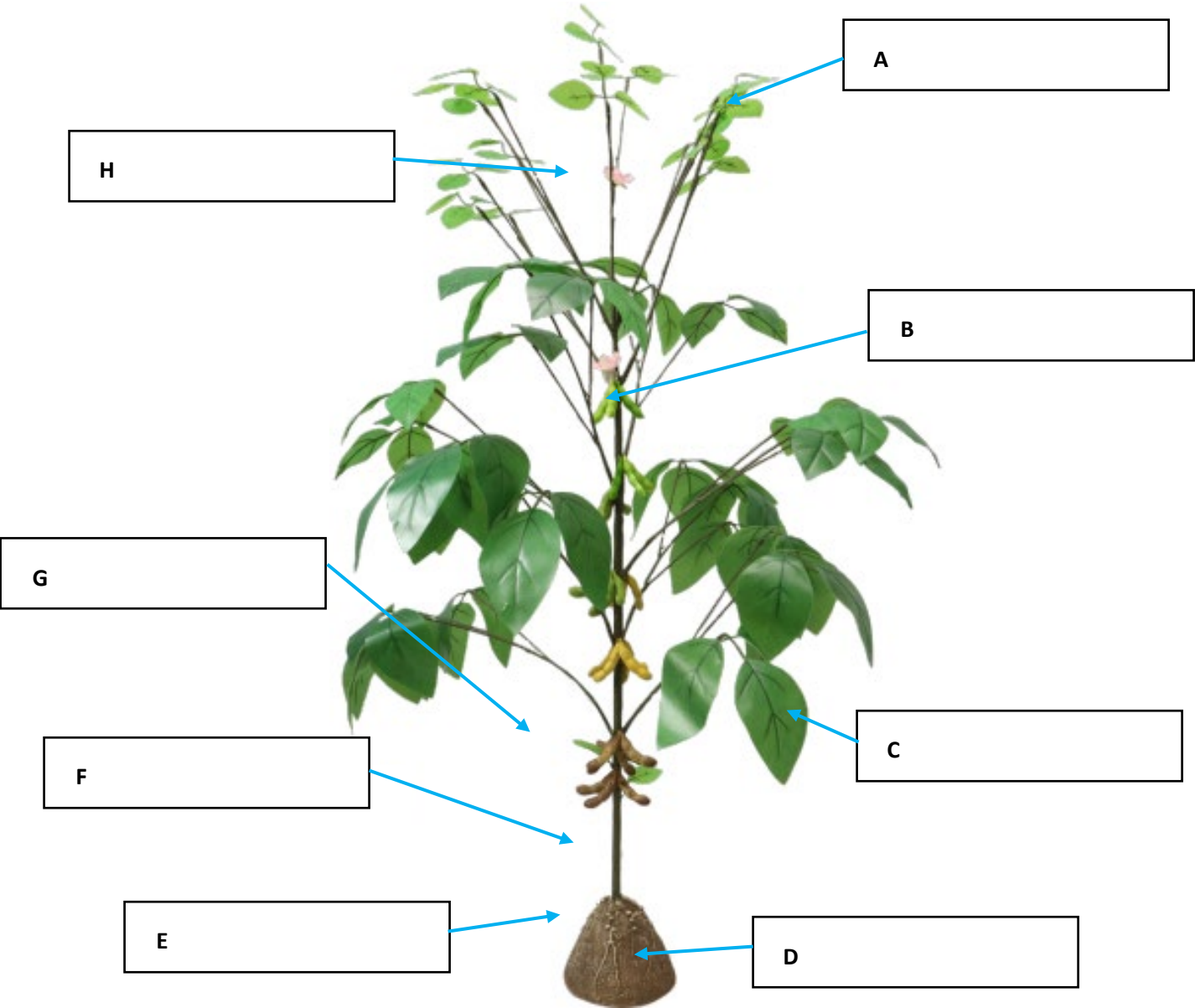
Key Terms and Definitions:

1. Fibrous Root System
2. Root Nodules
3. Soybean Stem
4. Cotyledon Leaves
5. Trifoliate Leaves
6. Flower
7. New leaves
8. Soybean pod

Name: _____ Class: _____

Soybean Plant Anatomy Worksheet Part 1

Directions: Fill in the blanks with the associated soybean plant part.



Name: _____ Class: _____

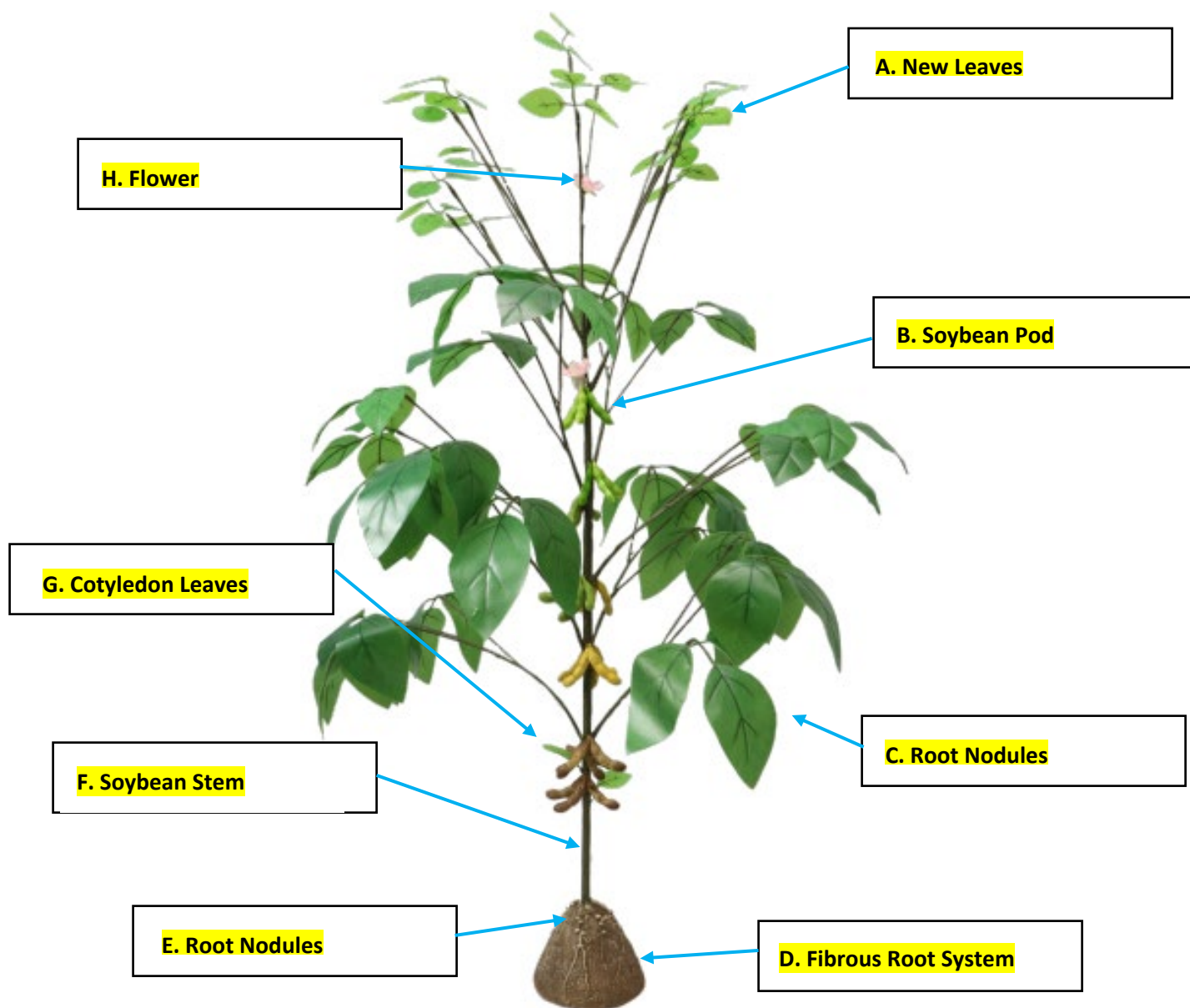
Soybean Plant Anatomy Worksheet Part 2

Directions: Answer the questions associated with the plant anatomy and the functions of each part of the soybean plant.

1. Which two human body parts does the plant stem function like? How so?
2. What is the function of root nodules in a soybean plant?
3. Where will you find new leaves on a soybean plant? Will they be as big as a formed trifoliate?
4. What colors can the flowers of a soybean plant can be?
5. What do the cotyledon leaves do? Will they stay green for the entire season like true leaves?

6. What part of the soybean plant is harvested?
7. This part is a group of three leaves and shows us that the plant has reached the next stage of growth.
8. What is the purpose of the root system in a soybean plant?

Soybean Plant Anatomy Worksheet-Part 1 – Answer Key



Soybean Plant Anatomy Worksheet Part 2 – Answer Key

Directions: Answer the questions associated with the plant anatomy and the functions of each part of the soybean plant.

1. Which two human body parts does the plant stem functions like? How so?
 - **Backbone: for structure and strength of the plant.**
 - **Blood vessels: carries essential nutrients and water to leaves and pods.**
2. What is the function of root nodules in a soybean plant?
 - **Fix atmospheric (unusable) nitrogen into usable nitrogen for the soybean plant. This helps to cut down on fertilizer costs for the producers.**
3. Where will you find new leaves on a soybean plant? Will they be as big as a formed trifoliate?
 - **The new leaves are found at the top of the plant. The plant forms leaves at the bottom and grows upward. New leaves will start out very small and will eventually grow into larger leaves.**
4. What colors can the flowers of a soybean plant can be?
 - **Flowers can be white, pink, or purple. Seed variety determines flower color. The color of the flowers makes no difference to the growth of the plant.**
5. What do the cotyledon leaves do? Will they stay green for the entire season like true leaves?
 - **The cotyledon leaves provide energy to the plant while it germinates, comes out of the ground, and begins to form true leaves. It will produce enough energy until the plant begins to photosynthesize.**
 - **The cotyledon leaves will eventually turn yellow or brown and could even fall off during the growing season. This does no harm to the plant as they have served their purpose once the plant photosynthesizes.**
6. What part of the soybean plant is harvested?
 - **The soybean pod, or more specifically, the soybeans within the pod.**
7. This part is a group of three leaves and shows us that the plant has reached the next stage of growth.
 - **Trifoliate leaves.**
8. What is the purpose of the root system in a soybean plant?
 - **Provide an anchor for the plant to stay stable within the soil as well as bring water and nutrients from the soil to the plant stem to be distributed.**

Lesson Two – Soybean Growth Stages

Lesson Overview

This lesson is designed to walk students through the different growth stages of a soybean plant and what happens to the plant during each stage. Students will learn what happens from the time a seed is planted to the time a soybean is harvested.

Lesson Objectives

After completing this lesson, participants will be able to:

- Differentiate vegetative growth stages and reproductive growth stages
- Understand the different soybean growth stages
- Identify how plant roots and nodules impact various growth stages in soybeans

Lesson at a Glance

Activity	Materials	Preparation	Approximate class time
FOCUS	• Ample space in classroom • <i>Soybean Growth Stages Placards</i> • Soybean Plant Model	1. Print/photocopy <i>Soybean Growth Stage Placards</i> . There are 14 cards; make 2 sets for a class of 28 or more, or have students pair up.	10 minutes
LEARN	• <i>Soybean Growth Stages</i> slide presentation	1. Review curriculum notes.	35 minutes
REVIEW	• <i>Soybean Growth Stages Review Worksheet</i> • <i>Soybean Growth Stages Review Worksheet – Answer Key</i>	1. Print/Photocopy <i>Soybean Growth States Review Worksheet</i> (one per participant).	15 minutes

Lesson Two – Soybean Growth Stages

FOCUS: Introduction to Soybean Growth Stages

10 minutes

Purpose:

Familiarize students with the most basic order and steps in soybean plant development.

Materials:

- *Soybean Growth Stages Placards*
- Soybean Plant Model

Facilitation Steps:

1. Each student will receive one of the *Plant Stages Placards* and form a line in the front of the classroom in the correct order from what happens first to what happens last in soybean growth. Students must work together to put themselves in order.
2. IMPORTANT: When handing out the *Plant Stages Placards*, it is best to mix them out of order and hand them out randomly rather than in order.

Soybean Growth Stages Placards

Print the 14 placard pages that follow this page.

Follow this answer key for proper order:

1. Seed
2. Vegetative Cotyledon
3. Vegetative Emergence
4. First Trifoliate
5. Vegetative Growth: Multiple Trifoliates
6. Beginning Bloom
7. Full Bloom
8. Beginning Pod
9. Full Pod
10. Beginning Seed
11. Full Seed
12. Beginning Maturity
13. Full Maturity
14. Harvest

Seed

I am what the farmer/producer puts into the ground in the spring. There's nothing fancy about me. I'm just a seed ready to grow!

Vegetative Cotyledon

I'm in the ground, I've absorbed some water, and I'm starting to develop some roots. I haven't broken through the ground yet, though.

Vegetative Emergence

Hello, world! I've come above the ground to see what's happening. I only have a couple of leaves and can't photosynthesize yet, but I will be able to soon.

First Trifoliate

I have some leaves and three of them have paired into a trifoliate. I am photosynthesizing now, but I'm only a couple of inches tall.

Vegetative Growth: Multiple Trifoliate

I have multiple pods of leaves called trifoliate that have formed, and I am growing very tall at this point. My roots are strong and providing me nutrients that I need to survive.

Beginning Bloom

I've grown a flower at this stage. I likely won't get much taller, but changes are happening to me. My flower is purple.

Full Bloom

I've grown all kinds of flowers. They're all purple in color and I look amazing.

Beginning Pod

I've started to grow a pod. There's nothing in the pod yet, but I've pollinated myself and have started to grow a pod to fill later.

Full Pod

My pod has grown to its full size. I am getting ready to fill that pod with soybeans soon.

Beginning Seed

My pod is starting to get a little tighter. The soybeans are forming. They're still pretty small, but I'm trying my best to fill them.

Full Seed

Jeez, it's tight in this pod. My soybeans have gotten pretty big. In fact, this is the biggest my soybeans will be. I'm full!

Beginning Maturity

I feel older, and more mature! My beans are filled in my pod and I am getting close to being ready to harvest.

Full Maturity

I'm losing my leaves like crazy, my pods are turning from yellow to brown, and I'm losing moisture awfully quick.

Harvest

I hear a loud noise coming through the field and this big machine is picking all of my friends and separating the soybeans from the pod. See you next year!

Lesson Two – Soybean Growth Stages

LEARN: Soybean Growth Stages

35 minutes

Purpose:

Familiarize students with the soybean growth stages and how the soybean plant grows.

Materials:

- *Soybean Growth Stages* slide presentation

Facilitation Steps:

Use the *Soybean Growth Stages* slides, the notes below, as well as the Soybean Plant Model to facilitate that lesson. Use the model to point out various stages and parts throughout the lesson.

Slide 3: The picture shows soybean growth stages from start to finish. This will be used as reference throughout the presentation and as a review at the end. This picture shows most stages and color differences in the soybean.

Slide 4: Two main growth stages are vegetative growth and reproductive growth.

Vegetative Growth: The soybean plant is actively growing, addition trifoliolate leaves, and will continue to get taller. No seed, flowers, or any other reproduction happen during these stages.

Reproductive Growth: The soybean plant is self-pollinating, and it reproduces in steps. We will get to the details later. The main point is that the soybean has switched gears from growing taller to producing a pod and seed during these stages. The plant is very sensitive to stress during these stages.

Slide 5: Plant stages have names as well as symbols. The students should know that anything with a “V” is vegetative growth stage and anything with an “R” is reproductive growth stage.

Slide 6: Important Terms:

Emergence: The plant coming out of the soil and becoming an above ground plant

Node: Critical areas on the soybean plant that branches and flowers will grow from.

Cotyledons: Seed leaves that first appear on a soybean plant and provide energy until the plant starts photosynthesis.

Axillary Buds: Additional buds that are formed between nodes, that may or may not flower and produce a pod with soybeans.

Radicle: The primary or first-developed root that all roots will then branch off from.

Slide 7: The seed takes time to adjust to the soil temperature and does so by soaking up water. Once water is absorbed, it will develop a radicle and begin the growth process. Germination can take about 5-10 days depending on soil and weather conditions.

Slide 8: Emergence usually happens within approximately 5-14 days of planting soybeans, but it depends on soil temperature and moisture levels. During the VE stage, the cotyledon leaves are providing all of the energy for the plant.

Slide 9: During VC – Vegetative Cotyledon stage, the plant has already emerged and the cotyledon leaves are providing the energy to the plant. Later in life the cotyledon leaves will eventually fall off of the plant and yellow.

During this stage, two unifoliolate leaves will form. These are the first true leaves on a soybean plant.

Slide 10: During V1 – First Trifoliolate stage, the plant has its first trifoliolate or set of three leaves from one branch.

Slide 11: As trifoliate leaves continue to form, each one will grow in size to maximize the surface area for photosynthesis. A new trifoliolate is formed only when all three leaves have formed together

Slide 12: During V3-V5 growth stages, the plant only grows taller and gets more leaves. With each trifoliolate forming a new growth stage has been reached. With proper weather conditions, the plant will rapidly go through V3-V5 or more.

In many soybean varieties, reproduction happens after V5 or V6. This is impacted by the maturity of the soybean seed.

Slide 13: As the soybean gets close to reproductive stages, it may form additional buds that may or may

not flower. These buds have the ability to form pods and produce soybeans, but not all will.

Auxiliary buds are typically seen as the soybean begins the reproductive stages. They will be found in other areas aside from the nodes, like normal flowers.

Slide 14: Review the vegetative growth stages before moving forward to reproduction.

Slide 15: Ask the students the question on the slide.

Answer: Everything that happens during vegetative growth is to prepare the plant for reproduction. The entire goal of the soybean plant is to produce a pod full of seeds for harvest.

Slide 16: R1 – Beginning Bloom stage is when you first see flowers appear on the soybean. Note that not all soybeans will have flowers at this stage.

Flowers can be white, purple, or pink in color. That is variety- and brand-dependent. Flowers will appear at the nodes of the plant and will eventually form pods near the same area.

Slide 17: R2 – Full Bloom stage. The soybean will be loaded with flowers at this point. Pollination is actively taking place during this stage.

The plant roots are actively fixing nitrogen and providing water and nutrients to the plant.

Slide 18: R3 – Beginning pod stage. The soybean has been pollinated at this point and is forming its first pods. Pods are very small in size and not every flower has developed a pod. It is difficult to see the pods without closely looking at the plant, as they are only ¼” long in some cases.

Slide 19: R4 – Full Pod stage. Pods have grown and soybeans are just starting to form within the pods.

This is an important stage because the pod is going to act as a layer of armor for the soybeans that are about to form within the pod.

Slide 20: At stage R5, a tiny soybean (or multiple soybeans) have begun to develop within the pods. The pods may look as though they have formed separate “compartments” for each seed to be in.

During this stage, nitrogen fixation is still actively happening from the plant roots. This is VERY important for “filling out” the soybeans.

Slide 21: R6 – Full Seed stage. At this stage, soybeans will be the largest that they will ever be.

They are loaded with water/moisture and are still putting on “weight,” an important step for growing quality soybeans.

Weather is crucial during this stage.

Nitrogen fixation is still happening and an important part to seed development; it will slow or even stop after this growth stage.

The pod is a bright green color at this stage, and one can see the beans filling the pods.

Slide 22: After the R6 stage, the root nodules have served their purpose and will stop producing and providing the plant nitrogen.

Prior to the R6 stage, if someone digs a plant up and squeezes or cuts a nodule in the middle, it will produce a pink/red liquid. That means that the plant is actively fixing nitrogen and feeding it to the soybean plant.

Slide 23: R7 – Beginning Maturity. At this stage there will be some of the most drastic changes to the plant, visible with the naked eye from a distance. The soybean plant itself will start to change from green to yellow to brown. The leaves from the soybean will begin to defoliate and fall off from the plant.

The pods will turn from bright green to yellow, indicating that the seed development and active growth of the plant are complete.

Slide 24: R8 – Full Maturity stage. The plant has now defoliated many or all of its leaves, and the pods have turned from yellow to brown.

During this stage, the soybeans will break free from the pods themselves. If someone takes a mature soybean plant that has begun to dry, they can shake it and it will sound like a baby rattle. This tells us that the soybean has separated from the pod and is actively drying within the pod.

Slide 25: The moisture levels are indicating the soybean within the pod.

Ideal soybean harvest moisture is less than 15%, however they are stored in a grain bin at 13% or less. Warm weather and wind help dry soybeans within the pods.

Slide 26: Shows the growth stages from start to finish.

Lesson Two – Soybean Growth Stages

REVIEW: Soybean Growth Stages

15 mins

Purpose:

Review the soybean plant growth stages and check student knowledge.

Materials:

- *Soybean Growth Stages Review Worksheet*
- *Soybean Growth Stages Review Worksheet – Answer Key*

Facilitation Steps:

Students will complete the worksheet to check their knowledge of soybean plant growth stages.

Name: _____

Date: _____

Soybean Growth Stages Review Worksheet

Directions: List the soybean growth stages and answer the associated questions.

VE: _____

1. How long does it usually take for the soybean to emerge from the soil?

VC: _____

2. How many cotyledon leaves will be on the soybean plant after it emerges?

V1-V5: _____

3. How do we tell that soybeans have gone from one vegetative growth stage to another?

R1: _____

4. What different colors can the soybean flower be?

R2: _____

5. How many flowers will produce a soybean pod?

R3: _____

6. How long will the pods be at this stage?

Soybean Plant Curriculum

R4: _____

7. How long will the pods be at this stage?

R5: _____

8. What is happening to the root system during the R5 growth stage?

R6: _____

9. What color are the soybean pods during the R6 growth stage?

R7: _____

10. What is happening to the soybean plant leaves during this growth stage?

R8: _____

11. At what percentage are the soybeans harvested in the field?

Soybean Growth Stages Review Worksheet – Answer Key

VE: Vegetative Emergence

1. How long does it usually take for the soybean to emerge from the soil? **Depending on weather, the soybean will usually emerge 7-14 days after planting.**

VC: Vegetative Cotyledon

2. How many cotyledon leaves will be on the soybean plant after it emerges? **There will be 2 cotyledon leaves, as soybeans are dicot plants.**

V1-V5: Vegetative Growth 1 (First Trifoliate)-Vegetative Growth 5 (Fifth Trifoliate)

3. How do we tell that soybeans have gone from one vegetative growth stage to another? **When a new trifoliate has been formed above the previous node, we know that a soybean has gone from one vegetative growth stage to the next.**

R1: Beginning Bloom

4. What different colors can the soybean flower be? **Soybean flowers can be white, purple, or pink.**

R2: Full Bloom

5. How many flowers will produce a soybean pod? **It depends, but usually half of the flowers that are formed will not form a pod.**

R3: Beginning Pod

6. How long will the pods be at this stage? **Pods at the beginning pod stage will be roughly ¼" long.**

R4: Full Pod

7. How long will the pods be at this stage? **Pods will be roughly ¾" long at this stage.**

R5: Beginning Seed

8. What is happening to the root system during the R5 growth stage? **Overall root growth is slowing significantly, but the plant roots are actively fixing nitrogen and transferring it to the plant.**

R6: Full Seed

9. What color are the soybean pods during the R6 growth stage? **Soybean pods are bright green in color during the full seed stage.**

R7: Beginning Maturity

10. What is happening to the soybean plant leaves during this growth stage? **The soybean plant leaves are turning yellow and brown, and defoliating or falling off from the plant in preparation for harvest.**

R8: Full Maturity

11. At what percentage are the soybeans harvested in the field? **Soybeans are best to harvest at less than 15% moisture and can be stored in a grain bin at 13% moisture.**

Sources

1. http://coolbean.info/library/documents/2017_Soybean_GrowthDev_Guide_FINAL.pdf
2. <https://www.dekalbasgrowdeltapine.com/en-us/agronomy/soybean-growth-stages.html>