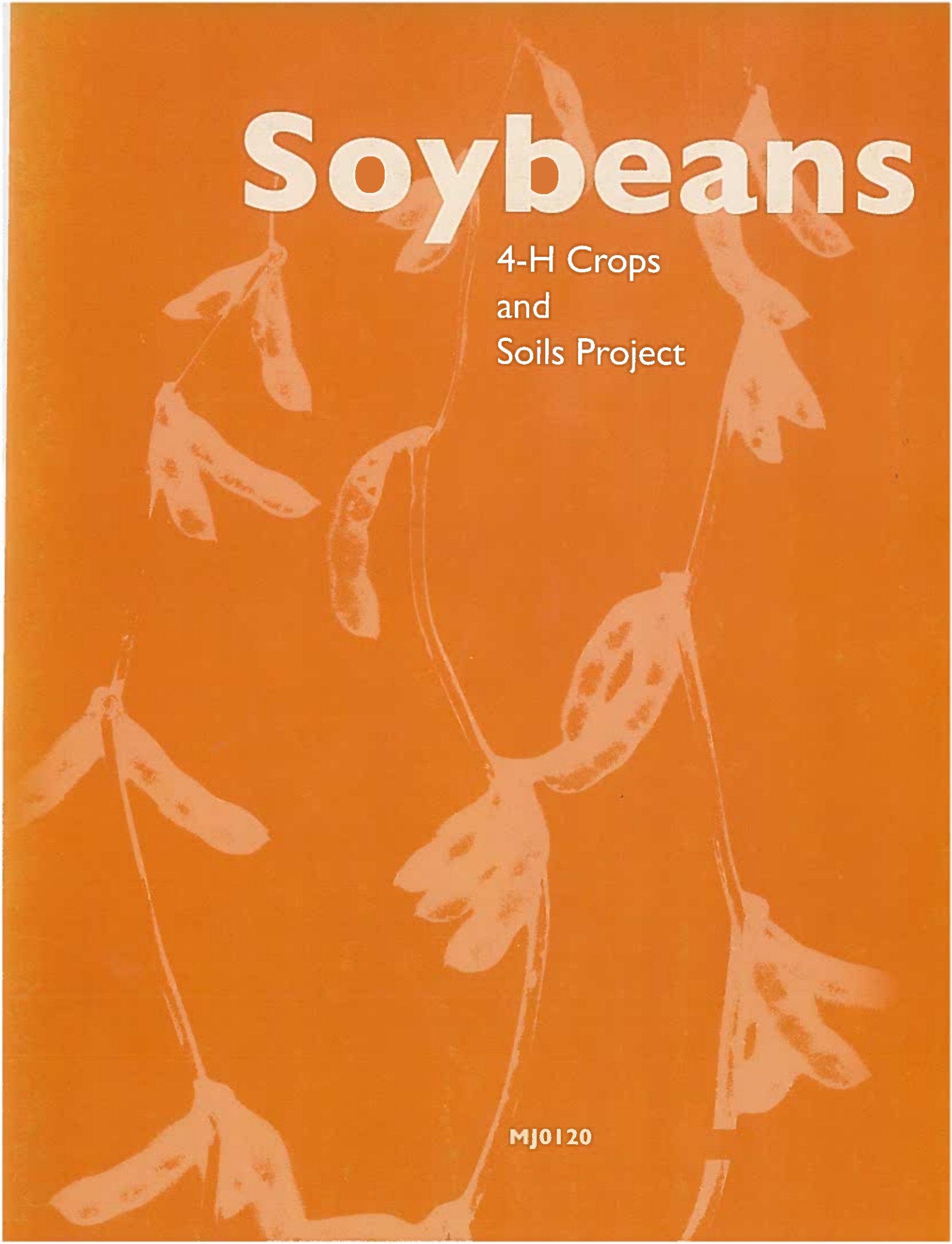


Soybeans

4-H Crops and Soils Project

MJ0120

Contents

To the Member

This book is intended to help you learn how to grow soybeans. It includes sections on soybean growth, variety selection, planting, plant nutrients, crop protection, harvesting, marketing, soybean use, and careers related to crops. Each section is accompanied by exercises that will help you understand and apply the information in that section.

Other resources on soybean production are referred to throughout this publication and are listed on the inside of the back cover with instructions on obtaining them.

Being in a 4-H project carries with it certain responsibilities. Check with your 4-H club to find out what is expected of a 4-H member. As you work through this project on crops and soils, keep in mind the following suggestions:

- Complete three or more of the exercises in your division.
- Plan your project with your parents and the project leader working with the 4-H Crops and Soils Project. Consult the first page of the 4-H Crops and Soils Record Sheet (RJ0101) for guidance in planning.
- Help your project leader decide how many meetings your group should have and be sure to attend all the meetings.
- Assist your 4-H project leader and the 4-H project group in carrying out their plans.
- Present a talk or demonstration.
- Make an exhibit about your project.
- Complete the 4-H Crops and Soils Record Sheet (RJ0101). If you raise one or more acres of soybeans, complete pages 1 through 4. If you raise less than one acre, you need only complete page 1; you may fill in pages 2 through 4 if you want to.
- Discuss your progress in the project with your parents, project leaders, and friends.

The Importance of Soybeans

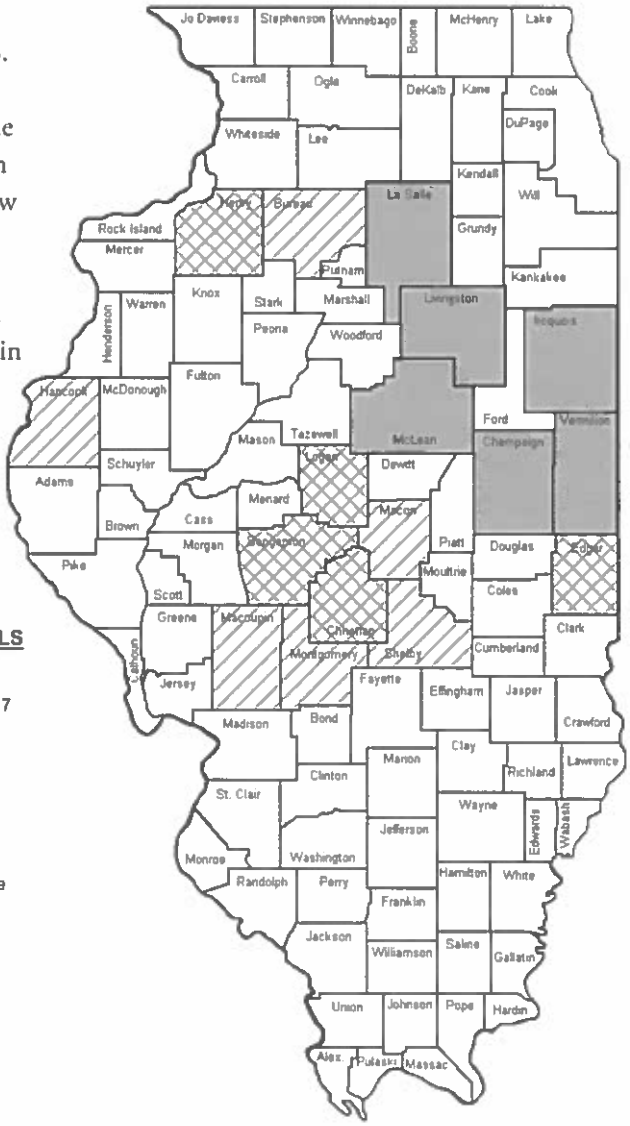
For 3,000 years, soybeans have been used for food by people in the Orient. In recent years, people in other parts of the world have become interested in the crop. Because soybeans are high in protein and calories, they have great potential as a food source for the growing human population (now at 6+ billion).

In the United States, only part of the soybean crop is widely used directly for human food (the edible oil). Soybeans benefit us in other ways such as being used in important industrial products or to feed livestock, whose meat or other products we consume.

Soybeans were first grown in the U.S. in 1852 as a forage for livestock and as a green manure crop to increase the productivity of the soil. Even as late as 1935, more acres of soybeans were grown for hay and soil improvement than for grain. Since that time, the acreage cultivated for grain has greatly increased. The invention of the combine in the mid-1920's allowed soybeans to be harvested as a grain crop. Now, very few soybeans are grown for hay. Instead, over 10 million acres in Illinois and over 70 million acres in the U.S. are utilized for grain. The top 10 states that produce the most soybeans are shown on the U.S. map (Illinois and Iowa are the top producers).

Major soybean producing counties in Illinois are summarized by the map shown to the right.

As soybean production has increased, so has soybean yield—in Illinois from about 17 bushels per acre in 1930 to nearly 51 bushels per acre in 2004. U.S. yields have increased by a slightly lower amount over the same period. The main reason for this increase is that we now have improved varieties and better cultural practices. The increases in acres planted and yield produced have resulted in soybean crops of tremendous size in recent years.



MILLION BUSHELS

- Less than 7
- 7 to 7.9
- 8 to 9.9
- 10 or more

Soybean production in 2004.

The 10 States that produced the most soybeans in 2004.

Soybean Growth

The Seed

Each year's soybean crop develops from soybean seed. The seed contains an *embryo* (young plant) and food to support its early growth. Soybean seed for planting must be handled carefully to avoid damaging the seedling or breaking the bond between it and its food supply. Excessively dry soybeans are most prone to damage resulting from rough handling.

The main parts of the soybean seed are illustrated in the drawings below. You should become familiar with the parts and learn their definitions.

Hilum-part of the seed where it was once attached to the pod. The hilum is often black or brown but is yellow on some varieties.

Seed coat-a thin covering that protects the seed.

Cotyledon-the part of the seed in which food for the seedling is stored. Each bean seed has a pair of cotyledons forming a protective shield around the seedling.

Epicotyl-the uppermost part of the seedling. It has two leaves that are *unifoliate* (containing only one leaflet). These are the first true leaves to develop on the plant.

Hypocotyl-the lower portion of the seedling's stem between the cotyledons and top of the root.

Radicle-the main root of the seedling. It takes up water and nutrients from the soil to nourish the seedling.

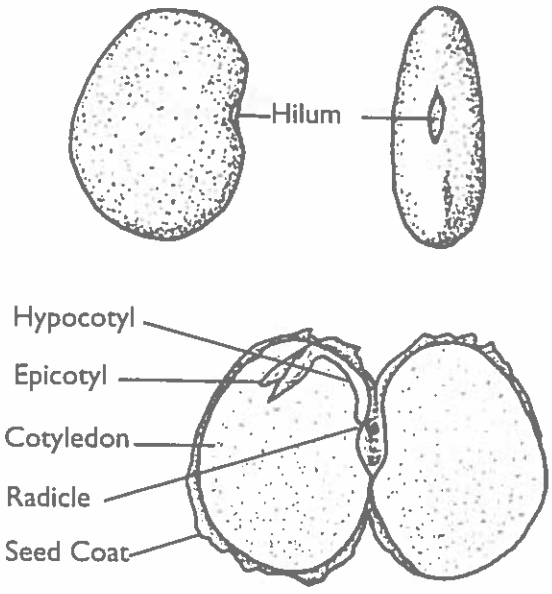
The Seedling

The drawings below show how the seedling develops, and the one on page 3 shows the seedling's main parts. The first step in its growth is *germination* (sprouting of the seedling from the seed). During germination, the radicle grows downward into the soil. It becomes the main root, or *tap root*, of the plant's root system. Many other roots branch out from this main root.

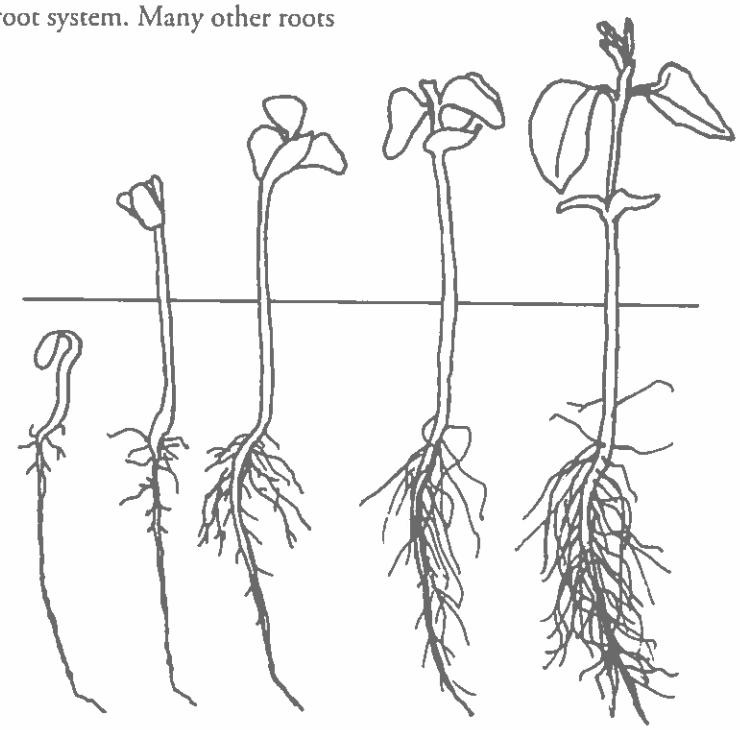
As the radicle grows downward, the hypocotyl grows upward rapidly, pulling the cotyledons with it toward the soil surface. During this process, the cotyledons protect the leaves of the epicotyl and supply the developing seedling with food.

At *emergence* (penetration of the soil surface by the seedling), the hypocotyl stops growing and the cotyledons begin to spread apart, exposing the epicotyl. The cotyledons and epicotyl, both of which are white or pale yellow in the seed, turn green when they are exposed to sunlight. The green coloring is due to formation of *chlorophyll.*

The epicotyl continues to grow upward, producing more stems and leaves. This growth takes place at the tip, or *growing point,* of the young plant. On the emerged seedling, the two unifoliate (single) leaves of the epicotyl are attached to the stem



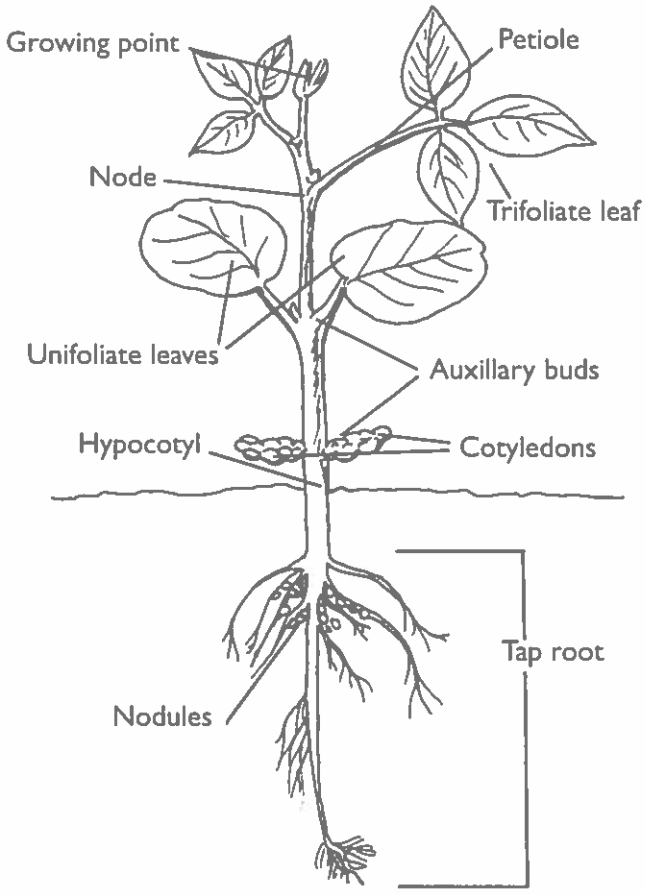
Main parts of the soybean seed.



Development of the soybean plant.

just above the cotyledons. Leaves that develop above the pair of unifoliate leaves are *trifoliate,* which means that they consist of three leaflets. These leaves are supported by a slender stalk called the *petiole.* The point at which the petiole is connected with the main stem is a *node.* An *axillary bud* is located at each node. The bud may develop into a flower, leaf, or branch.

Not all plants emerge in the way described above. For example, when a corn seedling emerges, it leaves its food supply below-ground instead of pulling it above the soil surface as the soybean seedling does. For that reason, the stored food of the corn is more likely to be attacked by insect pests or diseases and must be treated with a chemical to keep pests away. Soybean seed does not generally have to be chemically treated. When the seed is treated, it is usually with a fungicide. This chemical prevents fungi from causing plant diseases on the seed before emergence. The benefit of fungicide application to seed tends to be greatest when soybeans are planted into cold and wet soil.



Main parts of the soybean seedling

Stages of Growth

Between emergence and maturity of the soybean plant, vegetative and reproductive growth takes place. During vegetative growth, the plant becomes taller and develops leaves. When its vegetative part is large enough, it begins reproductive growth. First, it forms flowers; these develop into pods containing seed; and, finally, the plant matures.

Because not all soybeans reach the same stage of growth on the same date, it helps to have a system for describing soybean growth that will work for all soybean varieties and for all locations. This system helps farmers, professional agronomists, and other people who are involved in soybean production communicate more clearly with one another about soybean growth.

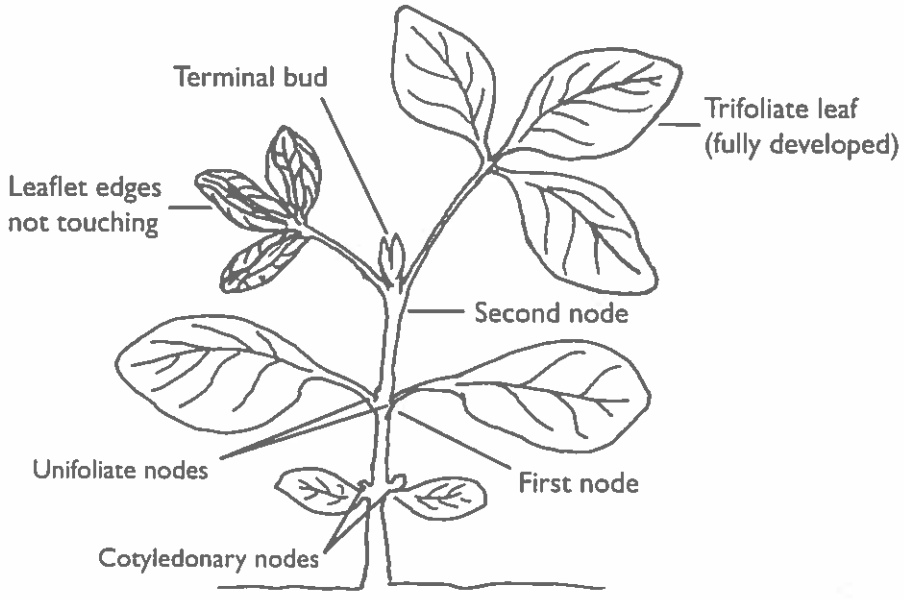
In this system, vegetative and reproductive growth are divided into carefully defined stages. The first two vegetative stages include emergence of the cotyledons and unrolling of the unifoliate leaves. The third stage (called the first-node stage) is reached when the unifoliate nodes have fully developed leaves. The plant enters later stages (second-node, third-node, and so on) as it grows new nodes with fully developed trifoliate leaves. To determine whether a trifoliate leaf is fully developed, check the growth of the leaf on the next node up. You can consider a leaf fully developed when the leaf above it has unrolled enough that the two edges of the leaf are not touching. When you count the nodes to determine what stage the plant is in, you always begin counting at the unifoliate node.

Reproductive growth is divided into eight stages. There are two stages for each of the plant's reproductive activities: flowering, podding, seed fill, and maturation.

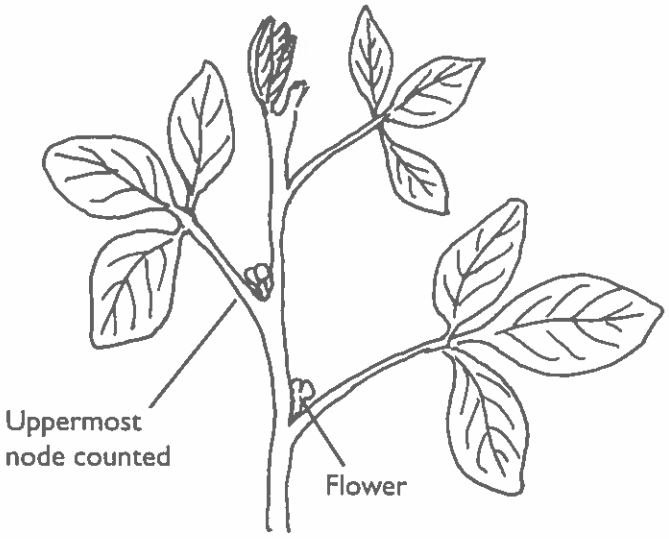
The stages of soybean growth are described in the table on page 4 and illustrated on pages 4 and 5. With the exception of the first two stages, each stage is given a letter *(V* for vegetative or *R* for reproductive) and a number that will always correspond to that stage, no matter what soybean variety you grow or where you grow it. For a more detailed explanation of this system of describing soybean development, obtain Special Report 80, *Stages of Soybean Development,* from Iowa State University. The publication can be found at: http://extension.agron.iastate.edu/soybean/production_growthstages.html.

Stages of Soybean Growth

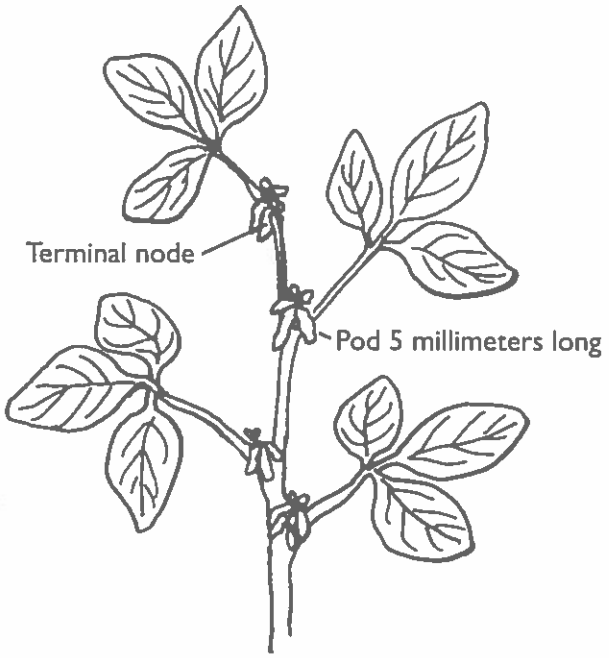
Number -	Title	Description
Vegetative		
VE	Emergence	Cotyledons above the soil surface.
VC	Cotyledon	Unifoliate leaves unrolled enough that the leaf edges are not touching.
V1	First-node	Fully developed leaves at the unifoliate nodes.
V2	Second-node	Fully developed trifoliate leaf at the node above the unifoliate nodes.
V3	Third-node	Three nodes on the main stem that have fully developed leaves.
V(n)	nth-node	*n* nodes on the main stem that have fully developed leaves (*n* can be any number). *Remember to begin counting at the unifoliate node.*
Reproductive		
R1	Beginning bloom	One open flower at any node on the main stem.
R2	Full bloom	Open flower at one of the two uppermost nodes on the main stem. *In identifying this and later stages, be sure that the node has a fully developed leaf.*
R3	Beginning pod	Pod 5 millimeters (3/16-inch) long at one of the four uppermost nodes on the main stem.
R4	Full pod	Pod 2 centimeters (¾-inch) long at one of the four uppermost nodes on the main stem.
R5	Beginning seed	Seed 3 millimeters (⅛-inch) long in a pod at one of the four uppermost nodes on the main stem.
R6	Full seed	Pod containing a green seed that fills the pod cavity at one of the four uppermost nodes on the main stem.
R7	Beginning maturity	One normal pod on the main stem that has reached its mature pod color.
R8	Full maturity	95 percent of the pods have reached their mature pod color. Five to ten days of drying weather are required after R8 before the moisture content of the soybeans is low enough for harvest.



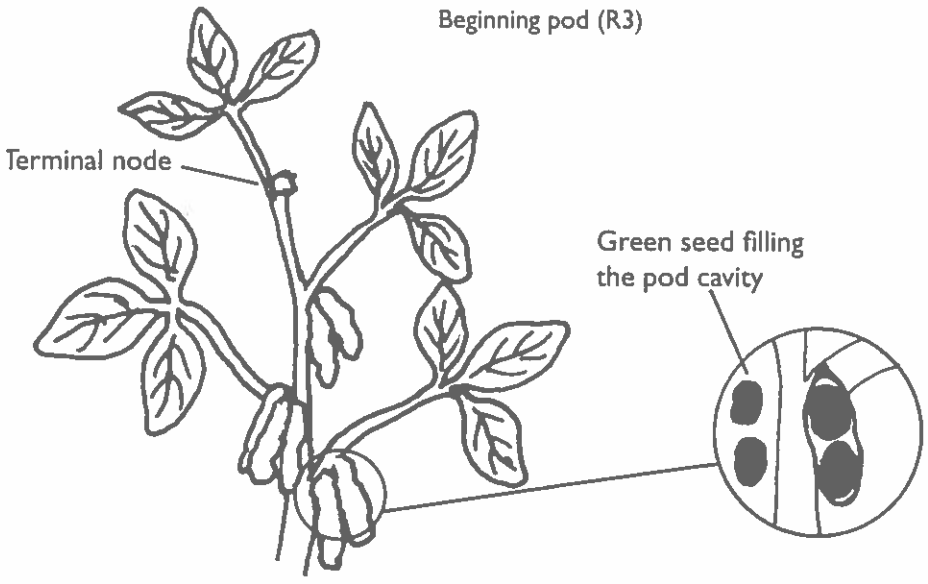
Second-node (V2) stage in vegetative growth



Full bloom (R2) stage in reproductive growth



Beginning pod (R3)



Full seed (R6)

Types of Growth

Not all soybeans develop in exactly the same way. Two major habits of growth used in soybeans are indeterminate and determinate. Virtually no determinate varieties are used in the Midwest at present, but were used by some farmers for a few years in past decades.

The indeterminate growth habit type soybean, used in the Midwest, grows leaves and stems through much of the growing season and only ceases vegetative growth when rapid seed fill activity begins in the plant (R5 stage). As a result, they are capable of developing a fairly large crop canopy if weather is favorable. If weather is too favorable, some varieties may grow excessively tall and fall over (lodge).

During the late 1970s and early 1980s, a few determinate varieties adapted to the Midwest were made available to farmers. *Determinate* varieties cease vegetative development when flowering begins, which means they stop growing stem and leaf. The size of the crop canopy is thus smaller and the plants are shorter and more resistant to lodging.

A risk involved in growing determinate varieties is that they may not yield well if growing conditions are not good early in the season before flowering begins – when they are capable of growing leaves. If water or nutrients are lacking during that time, the vegetative growth will be reduced. This reduction is especially bad for determinates, though, because leaf and stem development stops when flowering begins. The plants are unable to make up for reduced growth that occurs earlier in the season. As a result, the plants are abnormally short and may not fill the row middles well or have a large enough crop canopy to produce good yields. Along with not using sunlight fully, an abnormally small determinate soybean will allow more weeds to grow between rows, detracting from yield.

Exercise 1 The Importance of the Cotyledons

For this exercise you will need some soybean seed, potting soil or vermiculite, and containers (large tin cans will do).

Plant enough soybeans (approximately 16) to get 12 seedlings to emerge. One day after emergence, remove both cotyledons from four of the seedlings. Remove only one cotyledon from four other seedlings . Leave both cotyledons on the remaining four seedlings. These last four are your check, or control, plants.

Allow the seedlings to grow for five days. At the end of that time, compare the length of the stems on seedlings from which one or both cotyledons were removed.

How do the first two groups compare to the control plants? _____

_____

Why are cotyledons important to the early growth of the soybean plant? _____

_____

_____

Exercise 2 Re-growth of Damaged Seedlings

Soybeans have a remarkable ability to recover from damage occurring early in the growing season. If hail or wind damages soybean seedlings, re-growth can occur as long as the plant stem is not broken below the cotyledons.

At the point where each cotyledon is attached to the stem there is a bud that normally develops only if the upper part of the plant is damaged. In judging damage to soybean seedlings, check to see where the stem has been broken. If the break is above the cotyledons, re-growth is likely. If the stem is cut off below the cotyledons, re-growth is impossible for there are no buds from which growth can occur.

This exercise will demonstrate when soybeans can and cannot recover from damage. If re-growth to damaged soybeans cannot occur, the farmer must replant the crop.

In a container such as a large tin can, plant enough seed (approximately 13) to get 10 seedlings to emerge. Once the cotyledons have spread apart and the epicotyl is exposed, cut five plants just below the cotyledons. Cut the other five plants off just above the cotyledons. Note how much the two groups of plants grow during the next 7 to 10 days.

How much did the plants that were cut below the cotyledons grow? _____

_____

Describe the re-growth on plants that were cut above the cotyledons. _____

_____

_____

Exercise 3 The Effect of Light on the Hypocotyl

When a seed germinates, the hypocotyl begins to grow upward. It continues to grow as long as it is beneath the soil surface and ceases only when it reaches the surface and is exposed to light. Because the hypocotyl responds to light in this way, the soybean can emerge from various depths. Soybeans cannot emerge if planted too deep, for the weight of too much soil may prevent the hypocotyl from pushing through to the surface. There are, then, some limits to the amount the hypocotyl can elongate.

This exercise will demonstrate the striking effect of light on the hypocotyl. Plant soybeans in two small hills of soil (four seeds in each hill) in large tin cans or in a shallow, flat box. Over one hill place a tin can upside down, so that the seedlings will emerge in darkness.

Note the amount of time it takes for seedlings to emerge from the uncovered hill. Four days after emergence, remove the can placed over the other hill. Dig up three seedlings from each hill and compare the lengths of the hypocotyls.

Which hill produced the plants with the longest hypocotyls? Measure and record below the lengths of the hypocotyls for the two hills.

Uncovered hill _____
Covered hill _____

Soybeans are sometimes eaten as sprouts, although most sprouts we find on salad bars are mung beans. In order to grow sprouts, the seed is allowed to begin growth in a favorable moist and warm environment.

If you were growing sprouts from soybean or other bean crops, would you do so in the light or dark? _____

_____

Exercise 4 Testing Soybean Germination

Perform a "warm" germination test following the steps listed below.

1. Place two paper towels together and thoroughly moisten them, then squeeze out excess water. Lay the paper towels flat.
2. Put 25 soybeans on the moist towels without letting the seeds touch each other.
3. Moisten two more paper towels, and place them on top of the seeds.
4. Roll the towels up. Place the roll on end in a small container.
5. Store the towels in a warm place (75 to 80 degrees F). Put a plastic bag over the roll to prevent evaporation of water. Sprinkle towels with water occasionally to keep them damp.

UNIVERSITY OF ILLINOIS
EXTENSION

University of Illinois College of Agricultural, Consumer and Environmental Sciences • U. S. Department of Agriculture • Local Extension Councils Cooperating

Urbana-Champaign, Illinois MJ0120 December 2006

Issued in furtherance of Cooperative Extension Work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, DENNIS R. CAMPION, Director, University of Illinois Extension. University of Illinois Extension provides equal opportunities in programs and employment. The 4-H Name and Emblem are Protected Under 18 U.S.C. 707.

Illinois 4-H Youth Development acknowledges the Illinois Soybean Association for their financial support of this 4-H project book.