AGRONOMIC Spotlight
Technology Development by MONSANTO ®

Soybean Growth & Development

Soybean yield potential is determined by the interaction of the seed's genetics and the environment in which it grows. A key to a successful soybean crop is to better understand soybean growth and development. Soybean growth and development is divided into two broad stages: vegetative (V) and reproductive (R). A soybean stage is reached when 50% or more of the soybean plants have reached or are beyond that stage.

Germination, Emergence & Early Development.

Soybean seeds begin to germinate around 50° F and accelerate in germination as soil temperature climbs to 86° F. Planting soybeans in soils less than 55° F will slow germination and often reduces seedling vigor. Given adequate moisture and favorable soil temperatures, the radicle is the first plant part to emerge from the soybean seed. Following primary root initiation, the hypocotyl begins elongation toward the soil surface, pulling its weighty cotyledons through the soil surface. This process requires a lot of energy, and for that reason, it is recommended that in most cases soybeans be planted no deeper than 1 to 1.5 inches and never deeper than 2 inches. Soybean emergence (VE) typically occurs 1 to 2 weeks after planting depending on soil moisture, soil temperature, and planting depth. Crusty surfaces can restrict emergence and result in swollen hypocotyls. Shortly after VE, the unfolding of cotyledons exposes the growing epicotyl (young leaves, stem, and growing point). The subsequent expansion and unfolding of the unifoliate leaves marks the initiation of the VC stage, which is followed by the numbered Vn stages. The cotyledons are very important to the young plant as they store all the energy reserves the plant will need to establish itself. Quickly emerging plants usually do not consume all of the food reserves and end up with thick, fleshy cotyledons at the unifoliate (V1) growth stage. Plants that require several weeks to emerge may have noticeably smaller cotyledons or may lose their cotyledons all together. These plants are at a substantial disadvantage with nearby healthy plants. Loss of both cotyledons at or soon after the VE stage may result in grain yield loss of 8 to 9%. Nitrogen-fixing nodules can be seen on the roots shortly after VE, but active nitrogen-fixation does not begin until about the V2 to V3 stages. Nodules are pink inside when actively fixing nitrogen for the plant, but are white, brown or green when nitrogen-fixation is not occurring.

Disease Potential. Seedling diseases can be a concern in some years. Seed applied fungicides can typically provide 30 days of protection from soil-borne diseases such as Phytophthora, Rhizoctonia, Pythium and Fusarium. Phytophthora damping-off is common during wet years and the fungus is active when the soil temperatures are between 70° F and 81° F. Dry spring weather favors Rhizoctonia seedling blight. Cool temperatures (less than 61° F) favor infections of Fusarium root rot and Pythium damping-off.

V3 to V6 Stages. Plants at V3 are around 7 to 9 inches tall and have four nodes with unfolded leaflets. Plants at V5 are about 10 to 12 inches tall and six nodes have leaves with unfolded leaflets. V5 is about one week from R1, or first flower. At V6, the unifoliate leaves and cotyledons may have fallen from the plant and the root system is expansive. New V stages are developing approximately every 3 days. At the V6 stage, a 50% loss of leaf area could equal an approximate 3% yield loss.

Hail or Wind Damage. Soybean plants have multiple axillary buds (growing points on the main stem) that allow a soybean plant to recover from hail or wind damage to other buds. Although the stem apex (main growing point) is dominant, damage to this growing point will direct the axillary buds lower on the plant to suddenly branch and grow. Soybeans, therefore, are capable of producing new branches and leaves after hail destroys above ground foliage, as long as at least one axillary bud remains intact. The plant will die, however, if it is broken off below the cotyledonary node because there are no axillary buds below this point.

Reproductive Stages, or R stages, begin with flowering (R1) and continue through full maturity (R8). In the northern half of the United States, where most soybeans grown are indeterminate in growth habit, vegetative and reproductive stages overlap. Descriptions of the reproductive stages are found in Table 1.

R1 Stage. R1 in soybean is initiated when the flowers first appear on the 3rd to 6th node of the main stem. Branches begin flowering a few days later than the main stem.

R2 Stage. An open flower at one of the two uppermost nodes on the main stem initiates R2 in soybean. This stage marks the beginning of rapid and constant daily dry matter and nutrient accumulation by the plant and will continue until shortly after the R6 stage. Peak nodulation occurs at R2.

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R3 Stage. A developed pod is 3/16 inches long at one of the top 4 nodes on the main stem at R3. Pods develop first on lower nodes where flowering began. Soybean yield is divided into the following three components: total number of pods per plant, seeds per pod, and weight per seed. Yield increases are generally due to higher pod numbers per plant compared to the other yield components.

R4 Stage. A developed pod is 3/4 inches long at one of the top 4 nodes on the main stem at R4. This stage is characterized by rapid pod growth and by beginning seed development. This stage also marks the beginning of the most critical period of yield determination. Stress , including lack of moisture, nutrient deficiencies, lodging, and defoliation, occurring anytime from R4 to shortly after R6 can reduce yields more than the same stress at any other period of development. The period between R4 and R5 is particularly critical because plants cannot compensate as flowering ends, and young pods are more likely to abort under stress than older pods. Yield reduction at this time results from fewer pods per plant. Compensation by increasing seed size can occur, but is limited.

R5 Stage. Seed is 1/8 inches long on one of the top 4 nodes on the main stem at R5. This stage is characterized by rapid seed growth or seed filling. Demand for water and nutrients is high through this period. Stressful conditions from late R5 stage into the R6 stage may also cause large yield reductions due to fewer pods per plant and fewer beans per pod.

R6 Stage. A green seed fills the pod cavity on one of the top 4 nodes on the main stem at R6. The R6 bean or "green bean" is characterized by being as wide as its pod cavity; however, wide variation in bean size may be found on the plant at this time. Total plant pod weight peaks and leaf maturation and senescence begins shortly after R6.

R7 Stage. Beginning maturity marks the R7 stage, with one pod on the main stem reaching its mature, brown or tan pod color, depending on the variety. Dry weight accumulation has essentially ceased. Stress occurring at R7 or thereafter has basically no effect on yield.

R8 Stage. Full maturity marks the R8 stage, with 95% of the pods reaching their mature pod color. After R8, 5 to 10 days of favorable drying weather are required before the soybean reaches less than 15% moisture.

Sources: OMAFRA Staff. 2002. Soybeans: growth stages. Excerpt from Agronomy Field Guide for Field Crops (Chapter 4).; S. Ritchie and others. 1997. How a soybean plant develops. Iowa State University of Science and Technology Cooperative Extension Service Special Report 53.; Pedersen, Palle. 2009. Soybean growth and development. Iowa State University Extension.

Table 1. Reproductive Growth Stages in Soybeans

R Stage	Growth Stage	Description
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 with a fully developed trifoliolate leaf node.
R3	Beginning Pod	Pod is 5mm (3/16 inches) long at one of the four uppermost nodes on the main stem with a fully developed trifoliolate leaf node.
R4	Full Pod	Pods 2 cm (3/4 inches) long at one of the four uppermost nodes on the main stem with a fully developed trifoliolate leaf node.
R5	Beginning Seed	Seed is 3 mm (1/8 inches) long in the pod at one of the four uppermost nodes on the main stem with a fully developed trifoliolate leaf node.
R6	Full Seed	Pod containing a green seed that fills the pod cavity at one of the four uppermost nodes on the main stem with a fully developed trifoliolate leaf node.
R7	Beginning Maturity	One normal pod on the main stem that has reached its mature pod color, normally brown or tan, depending on the variety.
R8	Full Maturity	95% of the pods have reached their mature pod color. Five to 10 days of drying weather are required after R8, before the soybean contains less than 15% moisture.

Source: Pedersen, Palle. 2009. Soybean growth and development. Iowa State University Extension.