SOYBEAN CHEAT SHEET

SOYBEAN FARMING SYSTEMS RESEARCH AND EXTENSION

Variety Testing Program
University of Missouri

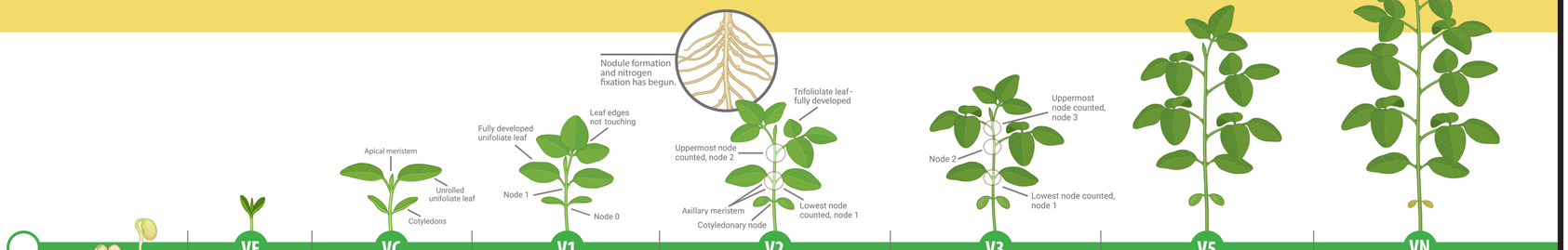
MISSOURI SOYBEANS

VEGETATIVE DEVELOPMENT

V

Count the number of nodes on the main stem, starting with the unifoliolate node (instead the cotyledonary node), and include all subsequent nodes that have fully developed leaves. A leaf is considered fully developed when the leaf at the node immediately above has expanded sufficiently so that its leaflets no longer touch. The vegetative stage corresponds to this node count. A plant with three nodes is classified as being in the V3 stage.

Fehr et al., 1971; Fehr & Caviness, 1977



GERMINATION

VE — EMERGENCE
Cotyledons above soil surface

VC — COTYLEDON
Unifoliolate leaves edges not touching

V1 — FIRST NODE
Fully developed leaves at unifoliolate nodes

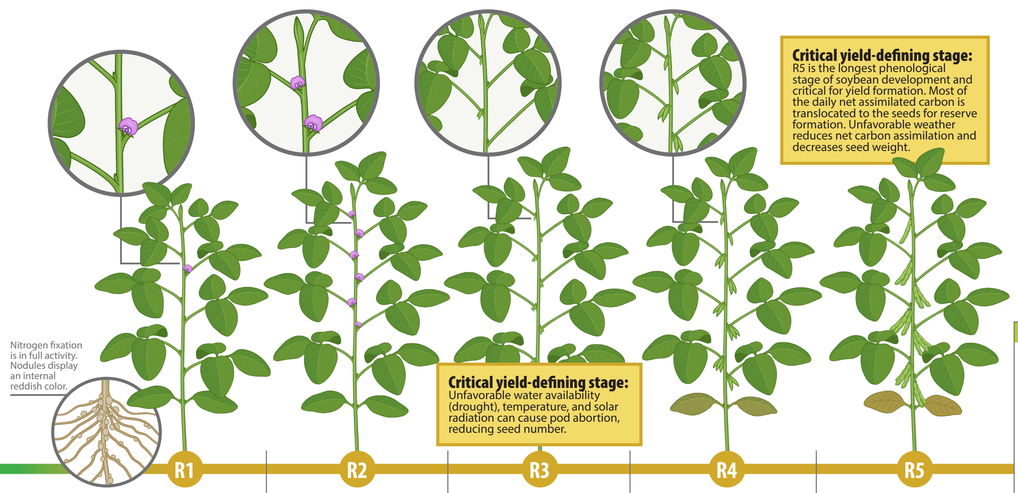
V2 — SECOND NODE
Fully developed trifoliolate leaf at node above the unifoliolate node

V3 — THIRD NODE
Three nodes on the main stem with fully developed leaves

V5 — FIFTH NODE
Five nodes on the main stem with fully developed leaves

VN — *N*TH NODE
N nodes on the main stem with fully developed leaves

STAND ESTABLISHMENT
DISEASE & PEST MANAGEMENT
CRITICAL ROOT DEVELOPMENT
CRITICAL WEED COMPETITION

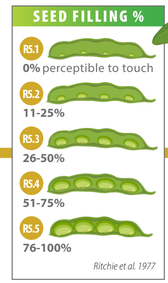


Critical yield-defining stage:
Unfavorable water availability (drought), temperature, and solar radiation can cause pod abortion, reducing seed number.

Critical yield-defining stage:
R5 is the longest phenological stage of soybean development and critical for yield formation. Most of the daily net assimilated carbon is translocated to the seeds for reserve formation. Unfavorable weather reduces net carbon assimilation and decreases seed weight.

At R6, many younger pods are still undergoing seed filling, especially if the crop has experienced an extended flowering period. Unfavorable weather during R6 can prevent these younger seeds from fully accumulating biomass.

SEED FILLING %



Ritchie et al. 1977

Indeterminate varieties have a stem segment or a leaf in the apical meristem at maturity, whereas determinate varieties have, or have had, a reproductive structure.

R1 — BEGINNING BLOOM
One open flower at any node on the main stem

R2 — FULL BLOOM
An open flower at the node immediately below the uppermost node with a completely unrolled leaf

R3 — BEGINNING POD
A pod with 3/16 inch (0.5 cm) long at one of the four uppermost nodes on the main stem with a fully developed leaf

R4 — FULL POD
Pod 3/4 inch (2 cm) long at one of the four uppermost nodes on the main stem with a fully developed leaf

R5 — BEGINNING SEED
Seeds inside the pods can be felt when gently squeezed at one of the four uppermost nodes on the main stem with a fully developed leaf

R6 — FULL SEED
Seeds completely filling the pod cavity at one of the four uppermost nodes on the main stem

R7 — BEGINNING MATURITY
One pod on the main stem that has reached its mature pod color, usually accompanied by the presence of yellow pods throughout the plant (Physiological maturity)

R8 — FULL MATURITY
Ninety-five percent of the pods have reached their mature pod color

Harvest maturity:
Dry weather is required after the R8 stage to allow soybeans to reach a moisture content suitable for pod threshing and seed separation.

DISEASE & PEST MANAGEMENT
CRITICAL WEED COMPETITION
DROUGHT & HEAT STRESS
CRITICAL ROOT DEVELOPMENT
DROUGHT & HEAT STRESS

Physiological maturity denotes the complete separation of the mature seed from the pod, ending seed biomass accumulation. This change is not visible to the naked eye, so we look for visual cues such as pod color. By the time pods change color, the seed has already reached physiological maturity. If the seed has separated from the pod but the pod wall is still green, this stage is also called R6.5.

REPRODUCTIVE DEVELOPMENT

R

R1 & R2 based on flowering,
R3 & R4 based on pod development,
R5 & R6 based on seed development,
R7 & R8 based on pod color (as indicator of maturity)

Reproductive stages based on the development at the upper portion of the main stem only (use uppermost FOUR nodes from R3 to R6).

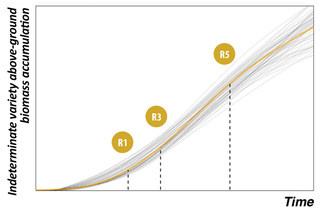
Fehr et al., 1971; Fehr & Caviness, 1977

DIGITAL CANOPY MODELS

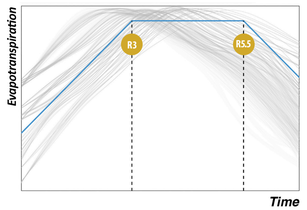
Digital model shows a 30-inch row spacing, that typically does not reach full canopy coverage before R2. Weed management may therefore need to continue beyond this stage. With 15-inch row spacing or narrower, full canopy closure occurs earlier, favoring weed suppression. However, narrower spacing can also increase water use due to higher transpiration from earlier canopy closure.

GROWTH & WATER MODELS

Modern indeterminate soybean varieties accumulate less than a third of total biomass before R1. Most vegetative biomass accumulation occurs from R1 to R5, when the crop growth rate is at its maximum. During seed filling, biomass acquisition is predominantly in the form of seed reserves. In determinate growth habit, vegetative biomass accumulates primarily prior to the onset of the reproductive phase, with minimal additional vegetative growth after flowering.



Evapotranspiration (ET), or daily water use, is driven by atmospheric demand, crop leaf area index (LAI), and soil water content. It varies throughout the growing season with the accumulation and senescence of leaf surface area. The greater the LAI, the greater the crop's capacity to move water from the soil to the atmosphere. ET is typically modeled as increasing linearly from early development until full canopy closure. Beyond that point, daily water use remains stable until LAI begins to decline with senescence. If the soil–plant continuum cannot supply enough water to meet atmospheric demand, stomatal closure will occur, reducing water consumption and biomass accumulation.



STAND ESTABLISHMENT

Soil temperatures above 50°F, along with water and oxygen, are essential environmental factors from the start of seed germination through plant establishment.

Plants emerge best when seeds are placed 1.0 to 1.5 inches deep. Early in the season, emergence can take up to 15 days, so plant shallow on early planting dates or in heavy soils. Under dry conditions, plant deeper—but never below 2.5 inches. Late in the season, high temperatures reduce emergence time to as little as 4–5 days.

Poor stands are often associated with low seed vigor or germination, saturated soils, prolonged drought after initial seed imbibition, soil crusting caused by heavy rain after planting, and biotic stresses such as insects or diseases.

When deciding whether to replant, compare the yield loss from the current stand with the yield loss associated with a later planting date. Often, stand uniformity is as important as stand count.

DISEASE & PEST MANAGEMENT

Soybean is susceptible to pathogens throughout the entire season. Common issues include:

SOIL-BORNE DISEASES
- Oomycetes (Phytophthora and Pythium) can lead to early-season stand losses.
- Fungal infections can occur during germination, but symptoms may not appear until the R3 growth stage or later.
- Nematode infections often lack above-ground symptoms.
- Most soil-borne pathogens can infect roots at any growth stage.

FOLIAR DISEASES
- Most are caused by fungi and bacteria, and many do not impact yield.
- For yield-impacting fungal diseases, a fungicide application is a recommended management practice.
- The optimal time for most fungicide applications is at the R3 growth stage.

INSECT PESTS
- Early-season insect pests feeding on seeds and seedlings can lead to stand loss, stunted growth, or delayed emergence.
- Common early-season pests include seedcorn maggot, bean leaf beetle, white grubs, and cutworms.
- Late-season insect pests primarily feed on foliage, flowers, pods, and seeds, which can reduce yield and seed quality.
- Common late-season pests include bean leaf beetle, grasshoppers, green cloverworm, podworms, and stink bugs.

CRITICAL WEED COMPETITION

The critical period of weed competition varies based on weed species and density, environment, soybean row spacing, and a variety of other factors. As a rule of thumb, soybeans should be kept free from weed competition from V2 to R2 or full canopy coverage.

Early-season weed competition can often be more detrimental to soybean yield than sporadic weed escapes that may occur later in the season. Therefore, it is important to apply an effective pre-emergence, residual herbicide as close to soybean planting as possible. Depending on moisture and rainfall, pre-emergence herbicides will generally keep fields free from weed competition for three to four weeks after application, at which time post-emergence herbicide applications should be made to weed escapes that are no more than 4 inches in height.

CRITICAL ROOT DEVELOPMENT

Soybean root growth begins during seed germination to anchor the growing seedling and supply it with water and nutrients. Rapid root growth continues through pod-setting (R3). Once seed filling begins (R5), carbon partitioning increasingly shifts to seed growth and there is little to no additional root growth.

Adequate water availability and soil fertility are critical for root growth and the successful establishment of functioning nodules. Absence of physical compaction or an impediment layer, and the presence of a porous network that allows oxygen to diffuse into the soil favor root growth and development.

Excess soil moisture during vegetative or early reproductive stages, caused by heavy rainfall or a high-water table, can restrict root growth and intensify water deficit during dry spells later in the season.

DROUGHT & HEAT STRESS

FLOWERING & POD SETTING (R2-R3)
Drought and extreme heat can lead to excessive flower and pod abscission, as well as seed abortion. Seed number per plant is the most critical trait associated with soybean yield, particularly in low population scenarios.

SEED FILLING (R5–R6)
Drought reduces seed size (test weight), accelerates senescence, and shortens the growing cycle, resulting in undersized, underdeveloped beans. However, because seed filling is the longest phenological stage, soybeans have the resilience to adjust seed biomass accumulation over an extended period of time.

Management information contributed by Kevin Bradley, Mandy Bish, and Ivair Valmorbida.
Developmental stages adapted from Fehr et al., 1971; Fehr & Caviness, 1977.
Initial design and figures by Ana G. Ramser under a BioRender license. Final design by Jared Fogue.
Revised by Felix Fritschi and Mike Mulvaney.
Produced by Andre Froes de Borja Reis, MU Soybean Farming Systems, University of Missouri, 2025.

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