Soybean Growth Stages

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Soybean Growth Stages

Determining Vegetative Stages

This publication defines soybean vegetative growth stages using the **Fehr and Caviness Method** (1977), which is recognized by the scientific community. A **Hybrid Method**, which evolved from Fehr and Caviness, is sometimes used in the field. Although both methods result in the same conclusion, it is important to note that each method counts the plant parts differently for vegetative growth stage determination.

Fehr and Caviness Method

1. Count the number of nodes on the main stem that have or had a **fully developed** leaf beginning with the unifoliate leaf node (1st leaf node).
2. A leaf is **fully developed** when the trifoliate at the node immediately above it is unrolled so the two edges of each leaflet are not touching.

Hybrid Method (P. Pedersen)

Count the number of trifoliate leaves on the main stem that are unrolled so the two edges of each leaflet are not touching to determine veg. growth stages.

For example, three trifoliate leaves originating from the main stem that are completely unrolled represents a V3 soybean plant.

Comparison of when trifoliate leaflets are considered touching (above) and not touching (below)

Soybean Growth Stages

Determining Stages for a Whole Field

1. Locate approximately 5 representative areas within the field
2. Determine the percent of plants within each area that have reached a certain growth stage
3. To claim the whole field to be at the succeeding growth stage, greater than 50% of the plants examined within each area must be in that growth stage

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Germination

- Germination begins with the soybean seed absorbing 50% of its weight in water.
- The radical (or primary root) grows from the swollen seed
- The radical elongates downward
- The hypocotyl begins elongation upward toward the soil surface, pulling the cotyledons along

Soybean Growth Stages

VE

Vegetative Stage Emergence
Cotyledons above the soil surface

- VE stage occurs approximately 5-14 days after planting depending upon the planting date.
- Emergence Factors:
  - Soil moisture – seed imbibes same amount as corn
  - Soil temperature – must be ≥48°F for imbibition
  - Planting depth – b/t 0.75 and 1.5 inches

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VC

Vegetative Stage Cotyledon
Unifoliate leaves unrolled sufficiently so the leaf edges are not touching

- Unifoliate leaves are the 1st leaf node
- Leaves are simple and opposite on the stem
- All of the nodes to follow are singular and alternate on the stem

Soybean Growth Stages

Leaf Scars

Locating the unifoliate node even if the unifoliate leaves are damaged or lost:

The cotyledons leave two opposite scars on the stem. Above these are a second set of opposite scars that mark the 1st leaf node. All of the scars above the 1st node are singular and opposite on the stem.

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Above ground parts

- axillary bud
- growing point
- petiole
- cotyledons
- unifoliate leaf
- trifoliate leaf
- leaflets

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Below ground parts

- hypocotyl
- N fixing nodules
- tap root
- lateral roots

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Growing point

The growing point or apical meristem's behavior differs with the two types of soybean growth habits:

- **Determinate – ceases** new vegetative growth soon after flowering begins
- **Indeterminate – continues** new vegetative growth even after flowering begins until approximately the R5

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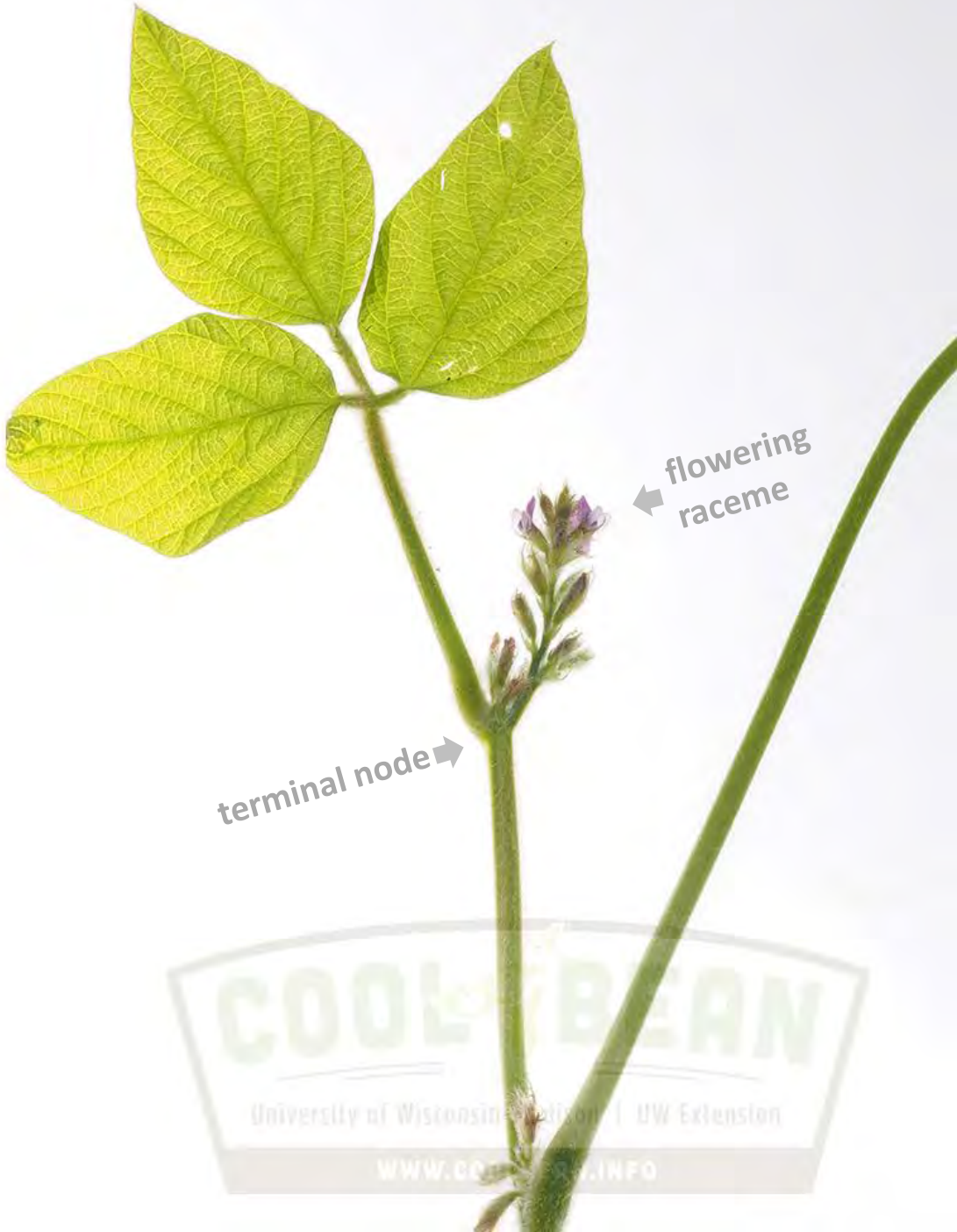
Determinate

Determinate – ceases new vegetative growth soon after flowering begins:

- Determinate plants have a terminal node on the main stem, indicating the end of vegetative growth from the apical meristem
- Determinate varieties are typically grown in the Southern U.S. (maturity groups IV to V and later) and in South America



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Determinate

Determinate – ceases new vegetative growth soon after flowering begins:

On determinate varieties, flowers develop around the same time throughout the plant; therefore pod and seed development are more uniform when compared to an indeterminate variety

Soybean Growth Stages

Indeterminate

Indeterminate – continues new vegetative growth even after flowering begins:

- Indeterminate plants continue vegetative growth through the early to mid reproductive phases
- Indeterminate varieties are typically grown in the Central and Northern U.S. (maturity groups 000-IV)

Indeterminate variety at reproductive stage R3

Soybean Growth Stages

Indeterminate

The following slides and images generally represent indeterminate varieties grown in Wisconsin, keep in mind the following:

- Rate of development can vary based on temperature, maturity group, soil conditions, planting date and planting patterns
- Differences may occur in time between stages, internode length, plant height, and number of leaves

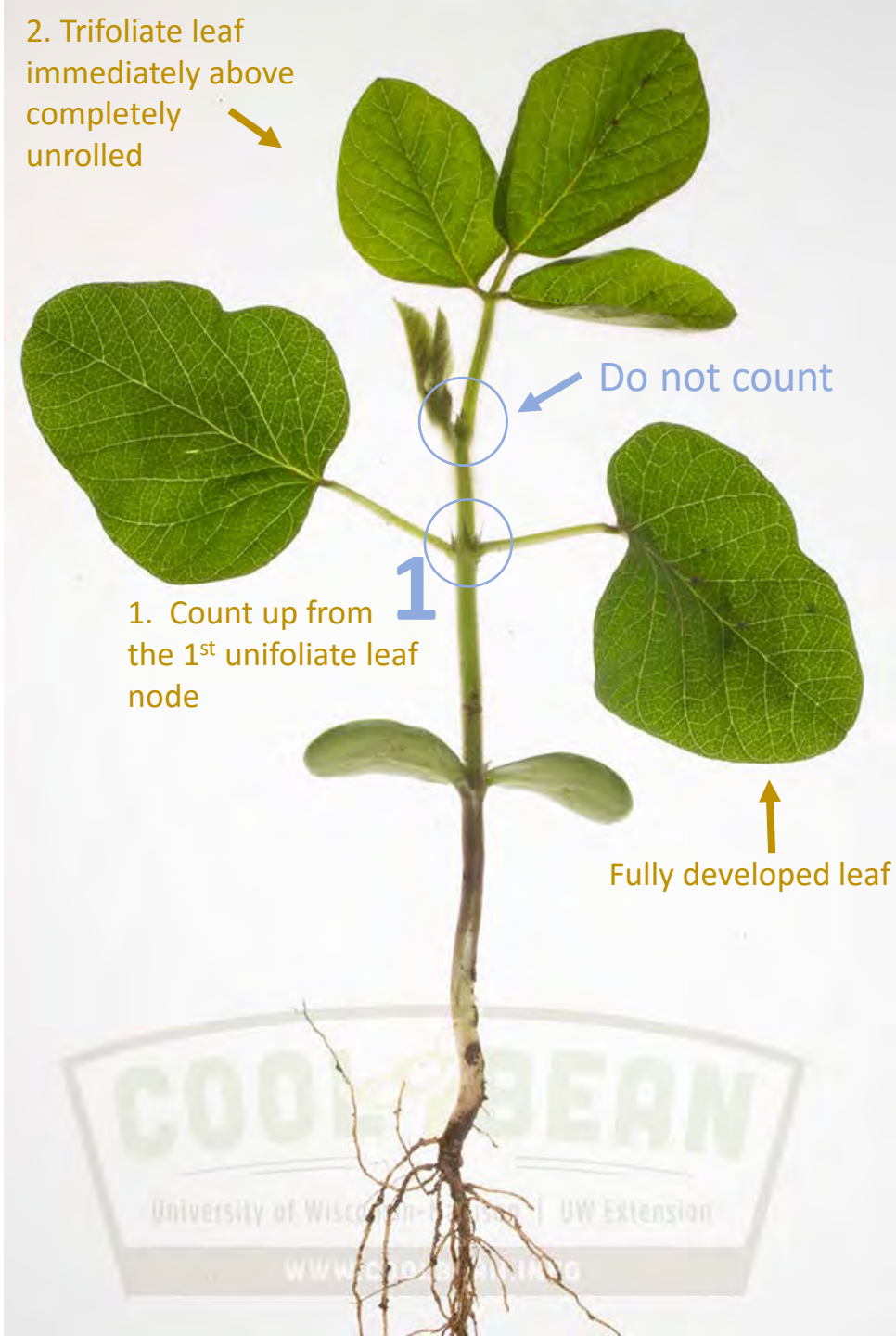
Indeterminate variety at reproductive stage R3

Soybean Growth Stages

V1

Vegetative Stage
Fully developed leaves at the unifoliate node

- Prior to V1 the cotyledons are the main source of nutrient and energy for early season growth.
- N fixing root nodules begin to form on the roots through infection of *Bradyrhizobium japonicum* bacteria



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V2

Vegetative Stage
Fully developed trifoliate leaf at node immediately above the unifoliate node

- At V2, lateral roots are growing rapidly
- Active N-fixation of the root nodules has most likely began by V2

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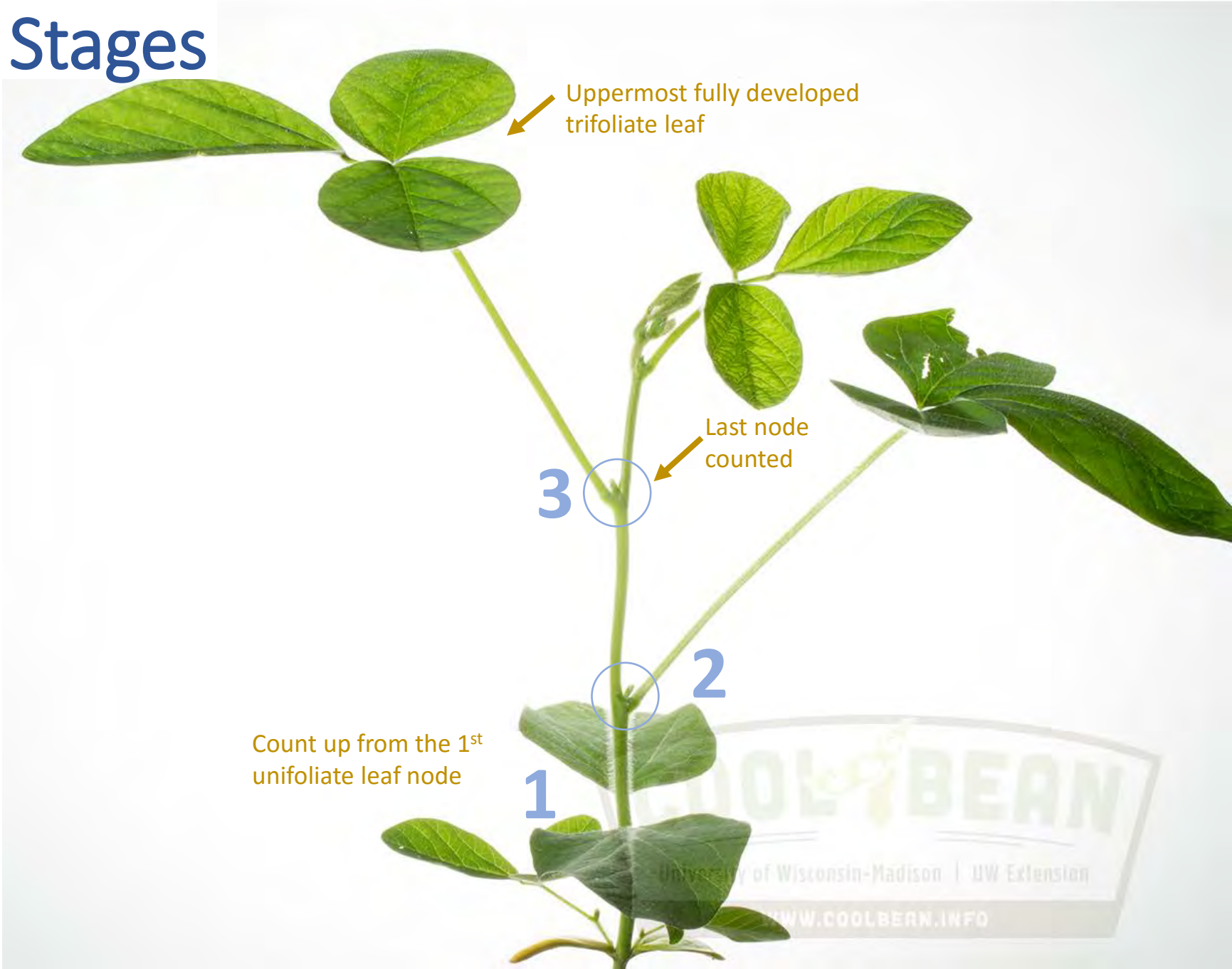
V3

Vegetative Stage
Three nodes on the main steam with fully developed leaves beginning with the unifoliate node



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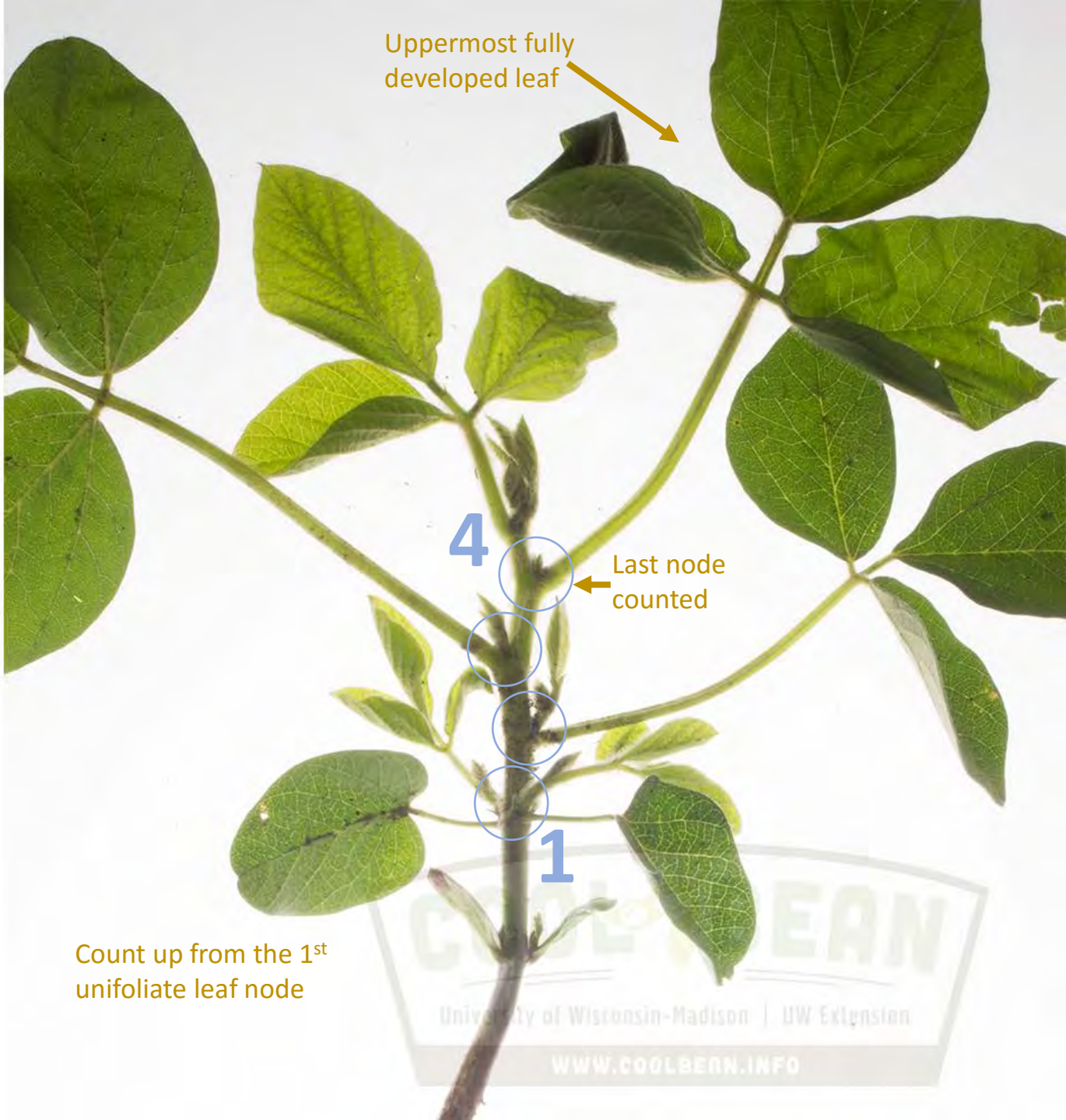
V4

Vegetative Stage
Four nodes on the main steam with fully developed leaves beginning with the unifoliate node

- For May planting dates in Wisconsin, flowers start to develop after the V4 growth stage, typically between V4-V6.



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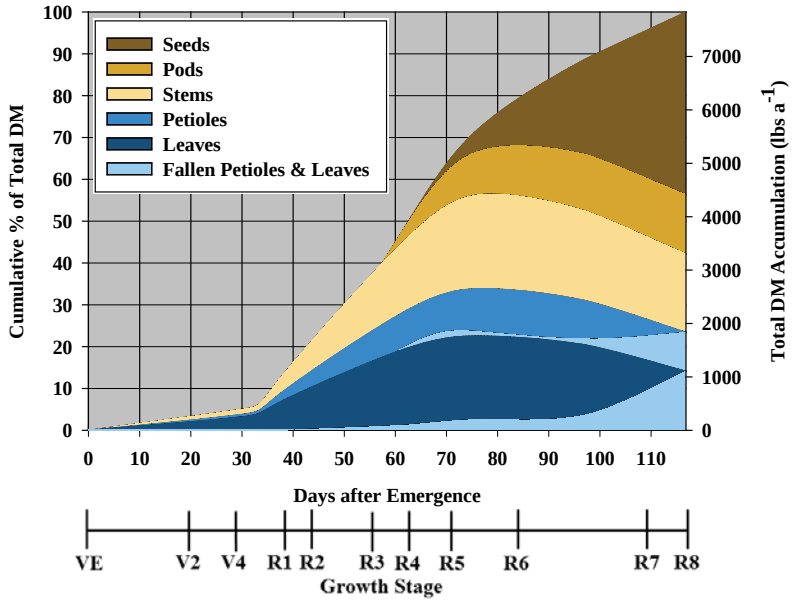
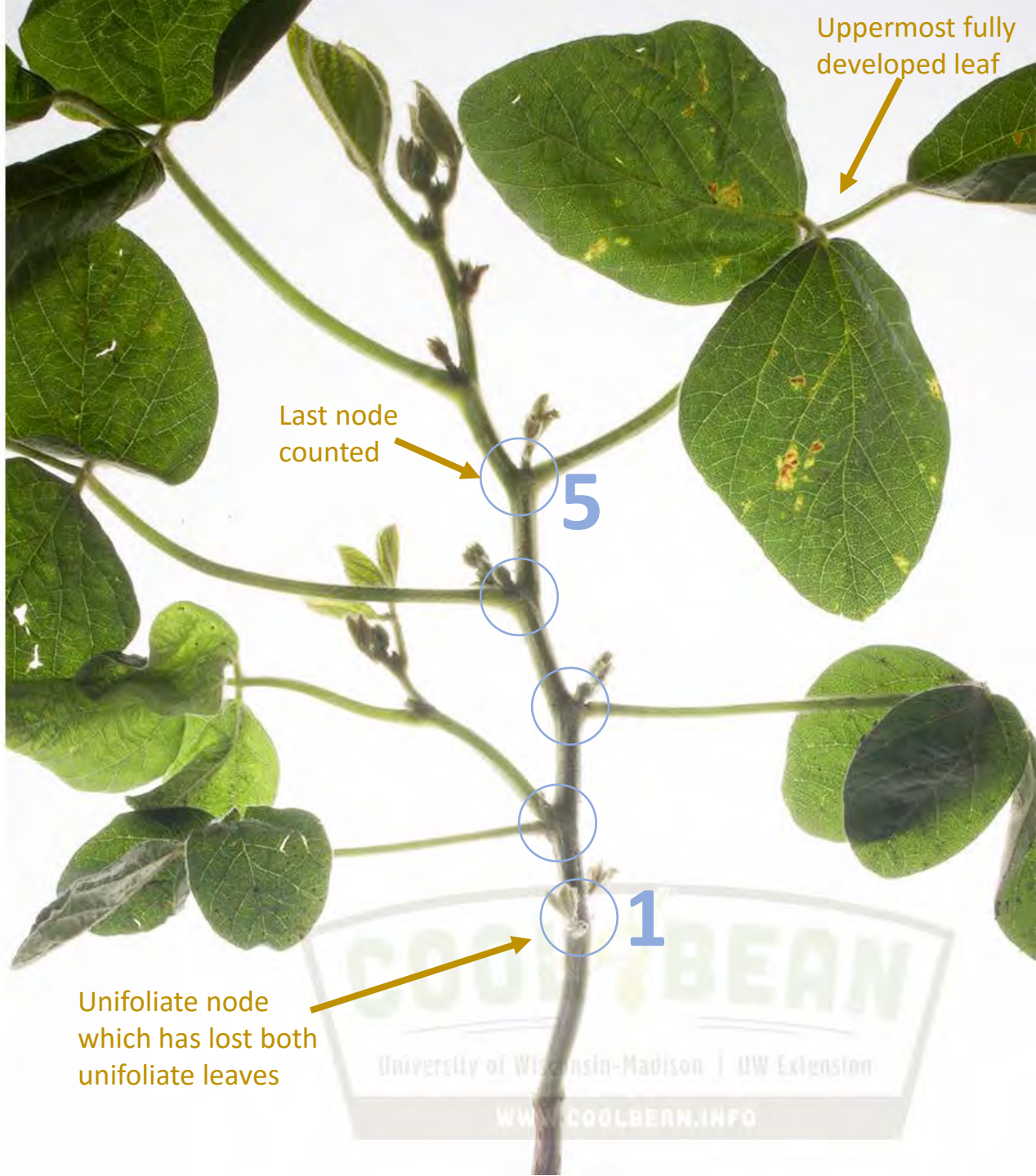
V5

Vegetative Stage
Five nodes on the main steam with fully developed leaves beginning with the unifoliate node

- Rapid and constant dry weight accumulation begins during late vegetative stages near V5





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Axillary buds

The axil is located at the upper- angle junction between the main stem and leaf petiole; each axil has an axillary bud that is capable of developing into a branch, flower cluster or can remain dormant.

- Plant density and row spacing affect auxin production, which determines if a axillary bud produces a branch, flower or nothing
- Lower planting density = greater light penetration = reduced auxin production = greater branch development

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Axillary buds

Compare these V5 plants: The apical meristem of the plant on the right has been clipped, note the plant has more branching and consequently more development of leaves, nodes, axils, axillary buds, flowers and pods.

Apical meristem intact or high plant density

Apical meristem clipped or low plant density

Soybean Growth Stages

R1

Reproductive Stage
One open flower at any node on the main stem

- Flowering begins on the third to sixth nodes on the main stem
- Flowering on the branches begins **after** those on the main stem
- Flowers can be purple or white
- Rapid and constant dry weight and accumulation begins slightly before R1.

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R2

Reproductive Stage
Open flower at one of the two uppermost nodes on the main stem

- Soybeans will continue flowering for 3-5 weeks
- 20 – 80% of flowers produced will be aborted. The first and last flush of flowers are the most likely to be aborted.
- At this stage, 50% defoliation can reduce yield by 6%.

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R3

Reproductive Stage
Pod is 3/16 inch long at one of the four uppermost nodes on the main stem

- A plant can have all of the following – developing pods, withering flowers, new open flowers and flower buds

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R4

Reproductive Stage
Pod is 3/4 inch long at one of the four uppermost nodes on the main stem

- At this stage, rapid pod growth is occurring and seeds are starting to develop
- Flowering is still present on the upper branch nodes

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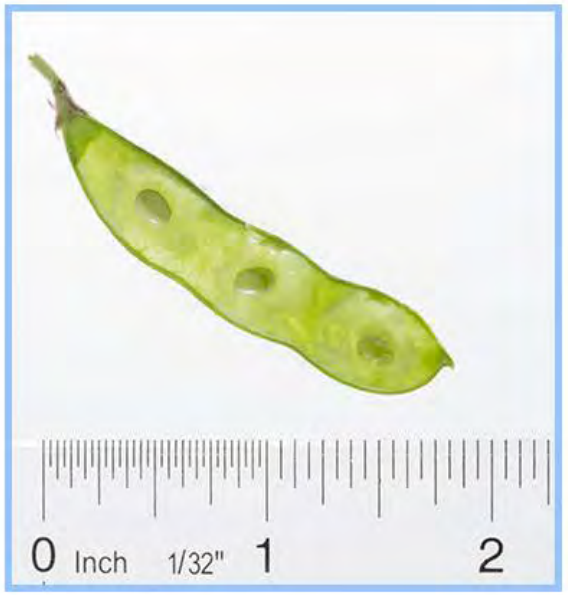
R5

Reproductive Stage
Seed is 1/8 inches long in the pod at one of the four uppermost nodes on the main stem

- Rapid seed filling begins
- Dry weight and nutrients begin redistributing through the plant to the developing seed
- Root growth is slowing



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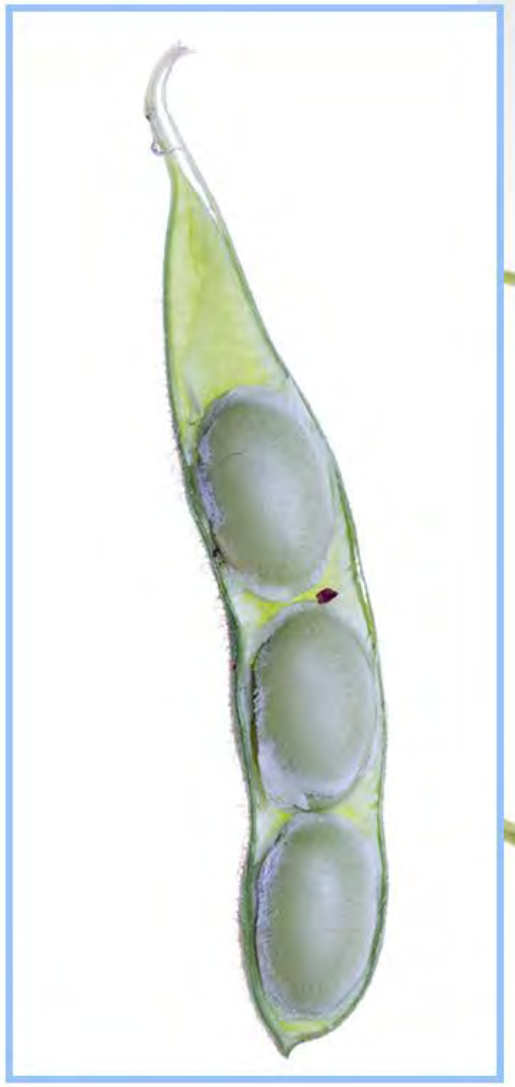
R6

Reproductive Stage
Pod containing a green seed that fills the pod cavity at one of the four uppermost nodes on the main stem

- Beans of many sizes can be found on the plant
- Large amounts of N are still being accumulated from the soil, directly to the seed



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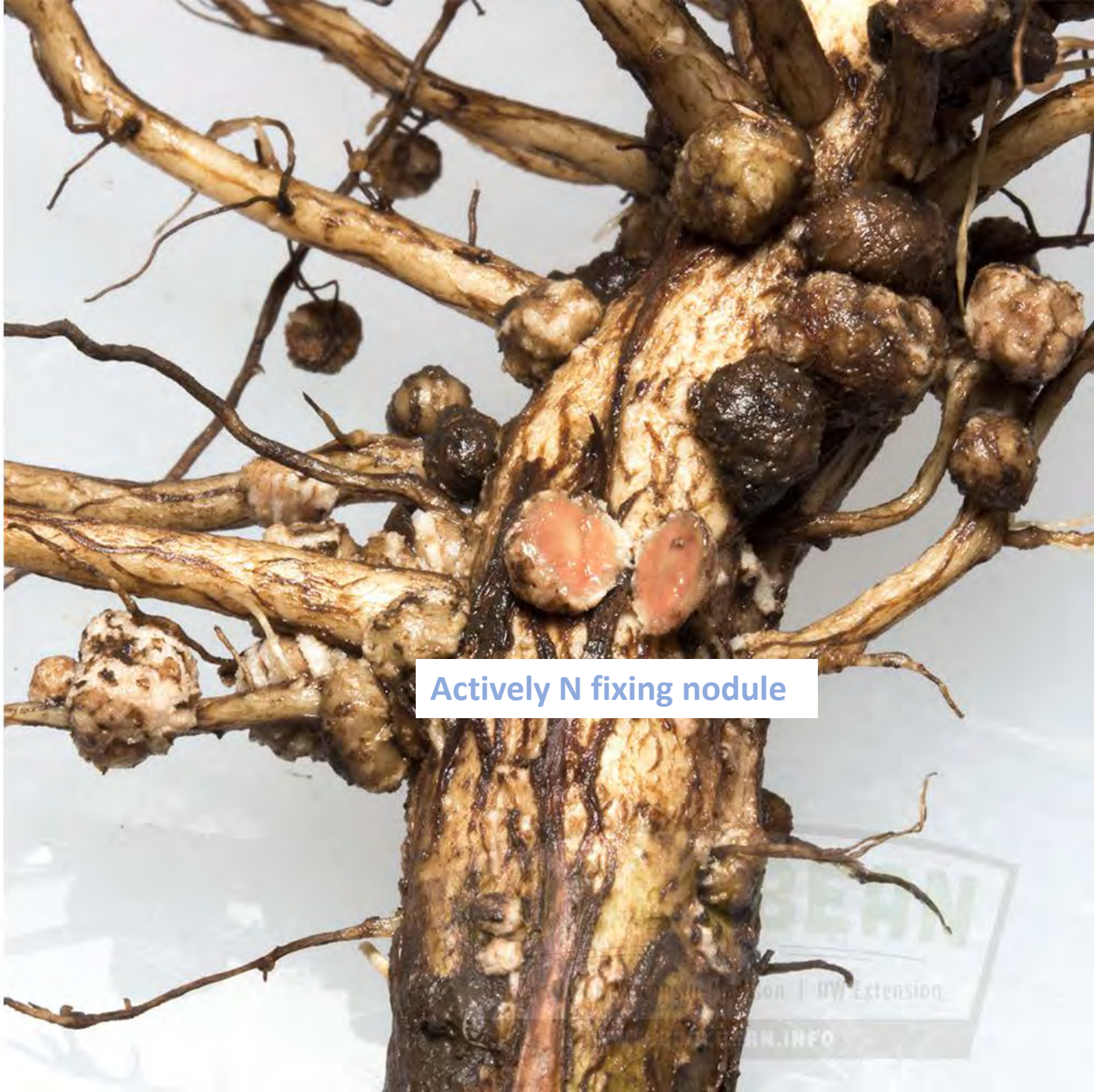
Root Nodules

- N fixation continues all the way through R6
- An actively N fixing nodule is pink in the middle when split open. Green, brown, or white internal coloration mean no N fixation is occurring
- The number of nodules is not strongly correlated to the amount of N fixed. Nodule efficiency is more important



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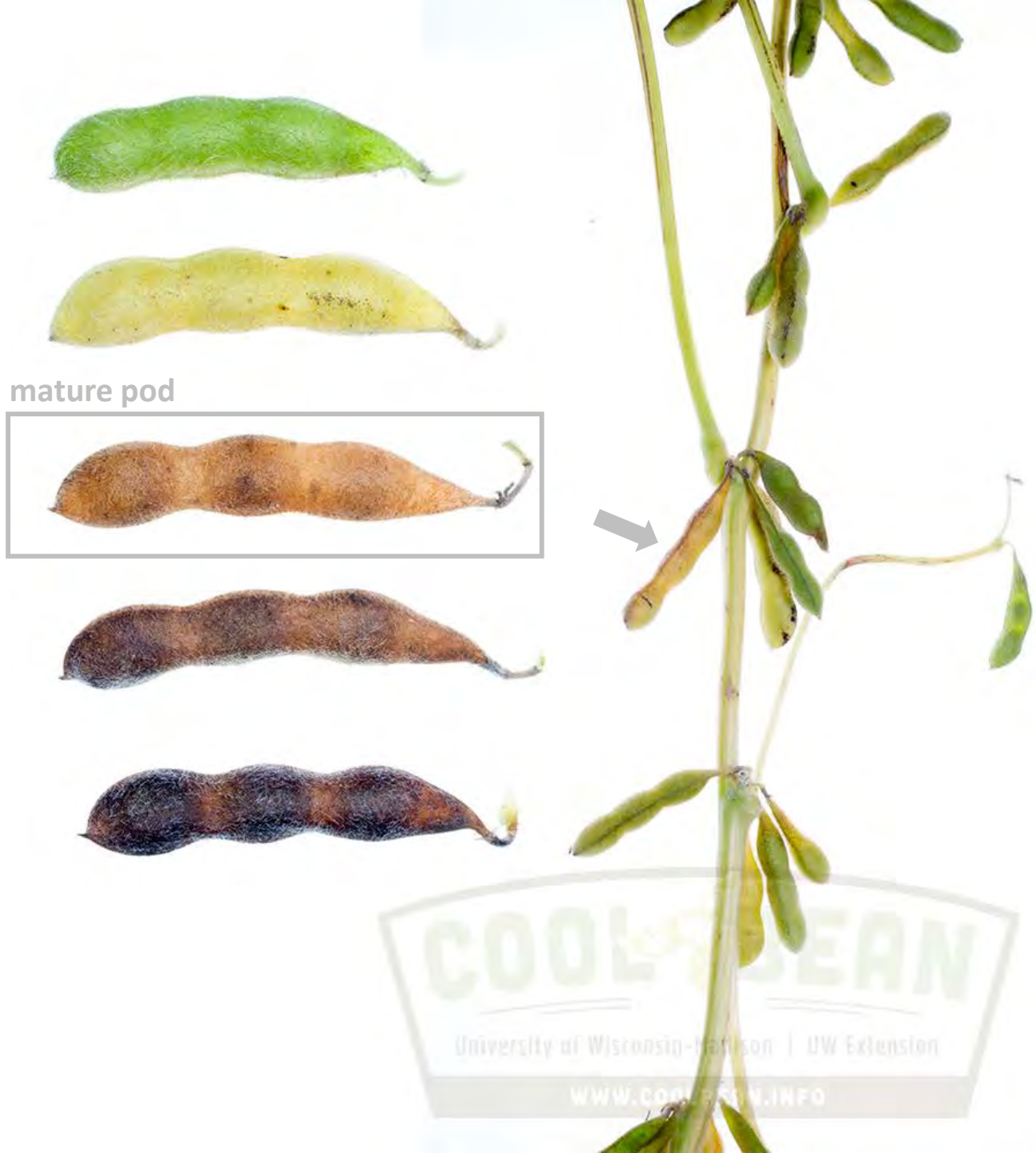
R7

Reproductive Stage
One pod on the main stem has reached a mature pod color of brown or tan

- Yellow pods are moving toward maturity
- Tan or brown pods signal physiological maturity
- Seeds at the R7 growth stage pods are at approximately 60% moisture



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R8

Reproductive Stage
95% of pods have reached mature pod color

- Mature pod color does not necessarily indicate that beans are ready to harvest
- 5-10 days of drying weather are typically required after R8 for soybean moisture to be <15%

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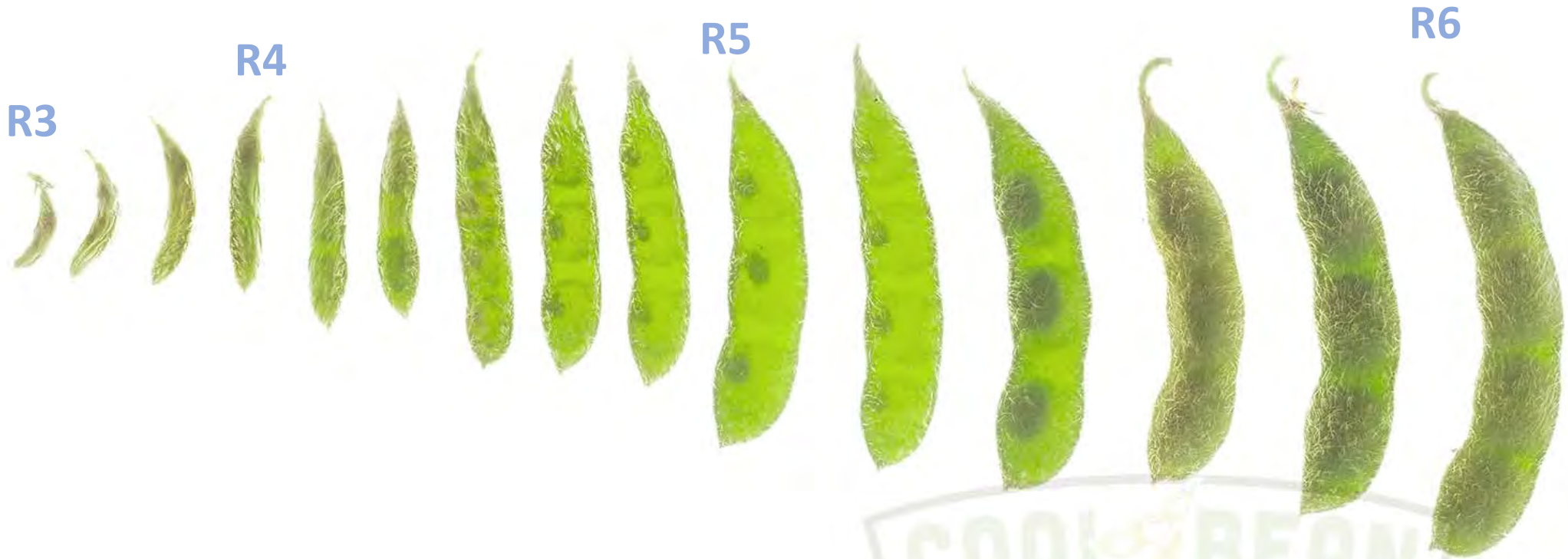
Early pod development



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Seed development

Green (R6) pod

Developing seeds in pods

Soybean Growth Stages

Pod development

Green (R6) pod

Bean fills pod cavity

Yellow pod

Not physiological mature

Pod reaches mature color - brown, tan or tawny

Physiological maturity

Harvestable