

Soybean Inoculation

Due to recent flooding in many areas of the state, inoculation of flooded field should be a consideration.

Soybeans are big users of nitrogen, removing about four pounds of nitrogen per bushel. Soybeans that are poorly nodulated will have to take up most of the nitrogen they need from the soil. Since nitrogen fertilizer is generally not applied to soybeans, a crop that is poorly nodulated will quickly use up the available nitrogen in the soil and become chlorotic from nitrogen deficiency.

Soybean inoculant contains *Bradyrhizobium japonicum* bacteria. The Bradyrhizobium bacteria forms nodules on soybean roots and these nodules fix nitrogen from the atmosphere and supply it to the plants. For nitrogen fixation to occur, the nitrogen-fixing bacteria need to be readily available in the soil or must be applied to the seed or soil. When the seed germinates, the bacteria invade the root hairs of the seedling and begin to multiply forming nodules on soybean roots. Nodules, which house the bacteria, can be seen shortly after emergence but active nitrogen fixation does not begin until about the V2 stage. After this, the number of nodules formed and the amount of nitrogen fixed increase with time until about R5.5 (midway between R5 and R6), when they decrease sharply. There is a mutual benefit in the relationship between the *Bradyrhizobium* bacteria and the soybean plant. The plant, in turn, provides the bacteria's carbohydrate supply. A relationship such as this, where both bacteria and plant profit from the other, is called a symbiotic relationship.

If soybeans have been grown on the field in previous years, there may be enough Bradyrhizobium bacteria in the soil to nodulate the soybeans adequately. In that case, an inoculant may not benefit the crop. But if there is not enough Bradyrhizobium in the soil, the inoculant may increase yields by two bushels per acre or more on fields that have had soybeans in the recent past. On fields where soybeans have never been grown, the inoculant has been shown to increase yields by 10 bushels per acre or more.

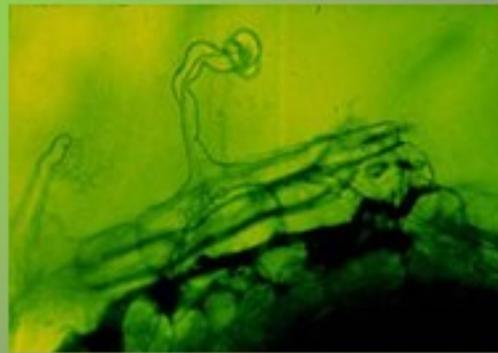
Soybeans inoculation should be considered for the following circumstances:

- Where the field has not been planted to soybeans for the past three to four years or more;
- Where the soil pH is less than 5.5 or greater than 8.5;
- Where soil organic matter levels are less than one percent; and/or
- Where there has been severe drought or **flooded conditions**.

There may be several causes of poor nodulation and inoculation failure, including: poor quality inoculant; poor storage and handling; or poor seed coverage with inoculants. Most fungicide seed treatments should not harm the inoculant if applied according to directions, but be sure to check the label of the specific fungicide seed treatment to be used. If you have questions concerning inoculation contact your local County Extension Service Agent.

Infection and Invasion

- Root hairs respond by malformation
- Essentially captures bacteria
- Bacteria divide until penetrate to root

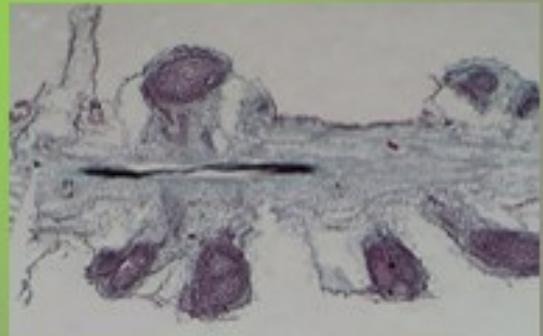


V2
Two unrolled trifoliolates,
and three nodes.
Nodules have been
established. Check for
proper nodulation.



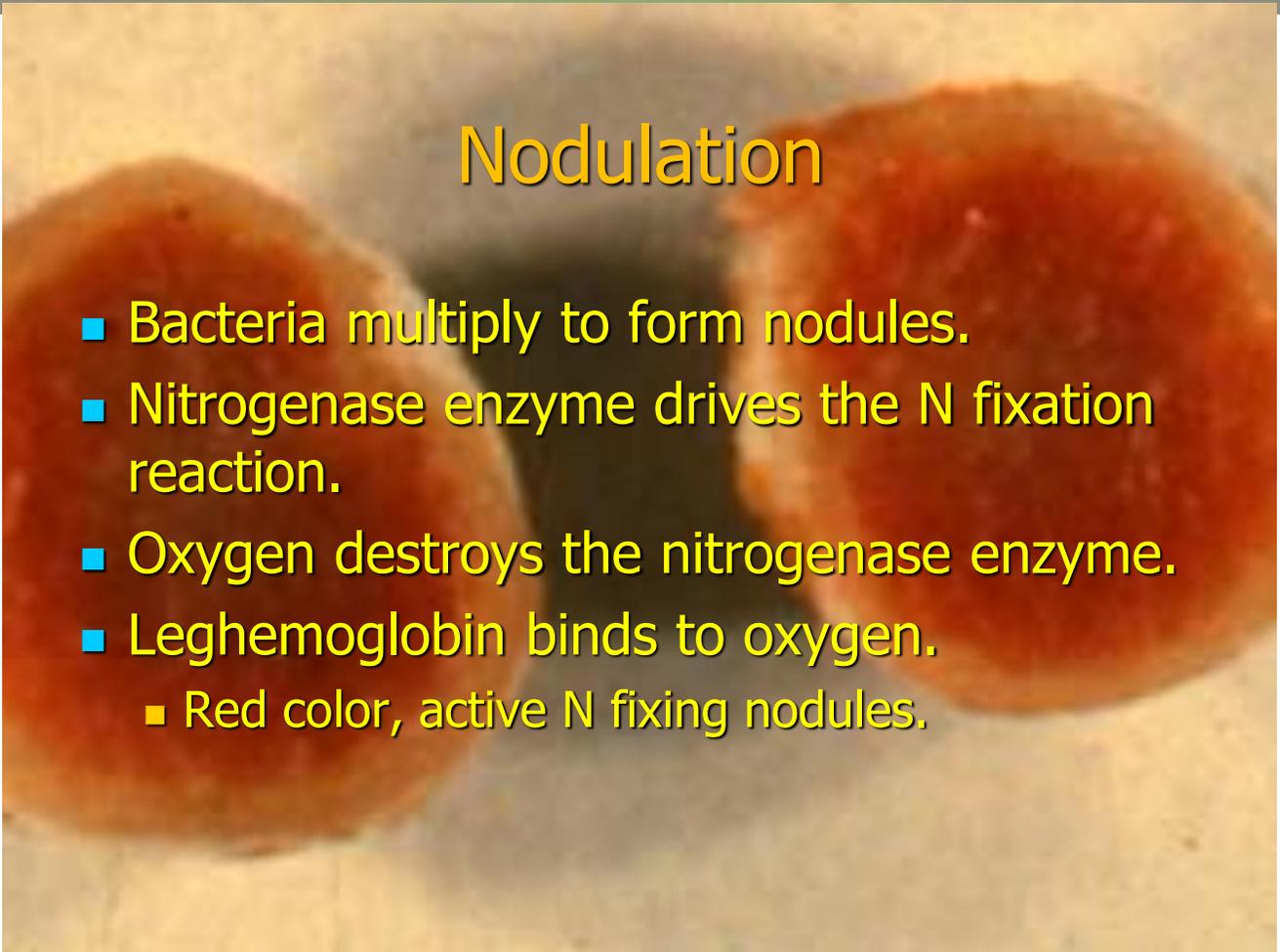
Nodule Formation

- Once bacteria are in the root, root cells divide and form a specialized structure—the nodule
- Bacteria continue to divide, causing increase in size of nodule



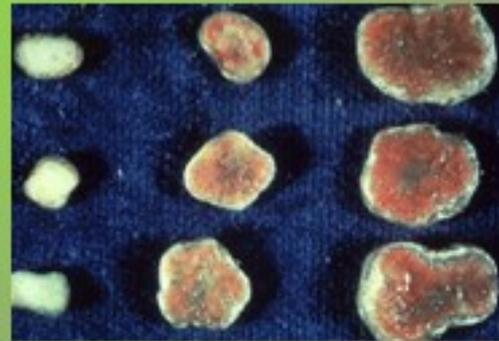
Nodulation

- Bacteria multiply to form nodules.
- Nitrogenase enzyme drives the N fixation reaction.
- Oxygen destroys the nitrogenase enzyme.
- Leghemoglobin binds to oxygen.
 - Red color, active N fixing nodules.



Nodule Function

- Plant produces leghaemoglobin to protect bacterial enzyme
- Plant provides sugars for bacteria
- Bacteria fix N_2 to form NH_3 for plant



Big Differences

Mean = 2



Nontreated

Mean = 13



Treated