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Soybean seed inoculation

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Abstract
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Nitrogen fixation

For nitrogen fixation to occur, nitrogen-fixing bacteria in the genus *Rhizobium* need to be present in the soil. The first nodules form within 1 week after seedling emergence and become visible as they increase in size. Ten to 14 days later, the nodule bacteria are able to supply most of the plant's nitrogen requirements. Nitrate in the soil, however, reduces nodule formation and activity; thus, fertilizer application or carryover from a previous crop delays bacterial fixation. Active nodules have an internal pink color and remain active for 6 to 7 weeks before they begin to break down. New nodules are formed during much of the life of the plant, normally ending during pod-filling stages.

If soils do not already contain a high population of *Rhizobium*, these bacteria can be added either as a liquid or granular peat inoculant, or as a peat-based powder. The different forms can be seed-applied or used in-furrow. More specific information on forms and methods of inoculation can be obtained from the inoculant companies.

Evaluating inoculum success

When evaluating inoculum success in overall terms (i.e. yield), you must consider many factors, including the specific legume (e.g., soybean) and its appropriate *Rhizobium* (e.g., *Rhizobium japonicum*), because different *Rhizobium* species have various degrees of host specificity. Next, consider weather (e.g., rainfall and temperature) and edaphic factors (e.g., soil pH, salt content, and soil physical factors). With the number of variables to be considered, no generalizations about how often to use inoculate are possible. Most recommendations in the Midwest have been to inoculate the seed if nodulated soybean has not been grown in a field in the past 3-5 years and if soil pH has been maintained above 6.0. Fields never planted to soybean or fields with sandy soils (low organic matter soils) need to be inoculated every year. However, recent changes in our production practices (e.g., use of no-tillage and earlier planting) put stress on the legume seedling, which in turn can reduce nodulation. No-tillage conditions may leave the soil cooler and more compacted than that under conventional tillage. Soil compaction and cool soil temperatures both reduce nodulation and, therefore, make inoculation more critical to production. However, new inoculants are now available that have improved nodulation in cooler soils.

Nitrogen starter fertilizers

If soils are not suitable for planting (cool and wet soils), germination may be inhibited and emergence may take as long as 4 weeks, making the seed vulnerable to soil pathogens and insects. A starter fertilizer will not influence "Mother Nature." In general, avoid applications of nitrogen fertilizer to soybean because addition of nitrogen fertilizer is usually an unnecessary cost. The reason for this is unique. The greater the supply of readily available nitrogen in the soil, the less nitrogen that is fixed by nodules. As the nitrogen supply increases, the number of nodules declines and the bacteria become "inactive" in nodules that are present. Even though soybean does not respond with increased yield to the addition of nitrogen, plants remove a significant amount of nitrogen from the soil. Research has shown that approximately 35 percent of the nitrogen contained in the harvested portion of soybean comes from the soil. Increasing the nitrogen supply by adding fertilizer, animal manure, sludge, or a green manure crop simply substitutes nitrogen from these sources for nitrogen that would otherwise be fixed by the bacteria in nodules on the roots.

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