Nitrogen-Fixation

by Gerhard Horn, Master Gardener

Nitrogen is one of the most important plant nutrients indispensable for good plant growth, high yield, and quality. The atmosphere around us consists of about 80% nitrogen (N_2) and thus provides for an unlimited supply. Unfortunately, N_2 is unusable by most living organisms. Therefore, the atmospheric nitrogen has to be transformed into compounds usable by plants. The first step is primarily the formation of NH_3 (ammonia). In principle, there is an abiotic (physical) and a biotic (biological) way to achieve this transformation. The most important abiotic process used today is the Haber-Bosch process by which the majority of all nitrogen fertilizers is produced. Biotic nitrogen fixation comprises a large variety of organisms in nature, like blue-green algae, lichens, and free-living soil bacteria. These organisms contribute significant amounts of NH_3 to a wide range of natural ecosystems but not to most cropping systems.

Rhizobium bacteria

In most cropping systems, including agriculture, horticulture, gardening, and landscaping, bacteria of the genus *Rhizobium* play a key role. Legumes such as peas, beans, cowpeas, alfalfa, etc. are best known for their ability to fix nitrogen by a symbiotic relationship with these bacteria. Rhizobium bacteria in the soil invade the root hairs of host plants, multiply, and stimulate formation of root nodules. Nitrogen fixation starts with the formation of nodules also called “nodulation”.

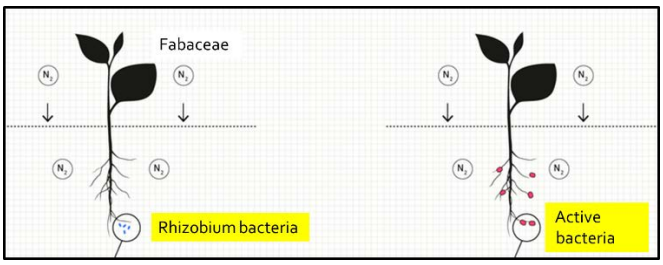
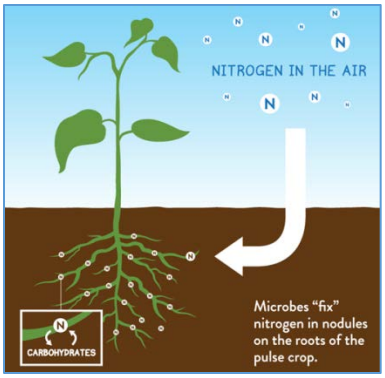


Fig. 1: Nodulation, (Ref. 1)

Fig. 2: Nodules on soybean root (Ref. 2)

As a rule of thumb: small nodules should be present on the roots 2-3 weeks after germination and can be seen with the naked eye. Just dig up a plant and wash off the soil.

Efficiency of Nitrogen Fixation



In this symbiotic relationship the plants provide all nutrients and carbohydrates to the bacteria, and the bacteria provide the plant with nitrogen. Legumes themselves cannot fix nitrogen.

Any stress affecting the plant, including temperature, water availability, and lack of nutrients like phosphorus, potassium, magnesium, etc. will reduce nitrogen fixation. A soil analysis prior to planting is strongly advised. Soil compaction, very low pH (< 5.8) and purely drained soil also adversely affect N-fixing. A high nitrogen content in the soil or extra applications of nitrogen containing fertilizers will slow down the nitrogen fixation process, too.

Inadequate nitrogen fixation often occurs in newly planted fields, or when a legume hasn't been grown for a certain period of time, or when a new plant species has been planted, as many cultivated legumes are not native to Florida. This effect can be attributed to the lack of the right strains of Rhizobium to nodulate the legume. Many soils do not contain these indispensable nitrogen fixing bacteria, so it is necessary to inoculate the legume with the proper strains of Rhizobia prior to planting the seeds.

Inoculation

Inoculation is the process of applying Rhizobium bacteria to the legume seed or directly to the soil. The document SS-AGR-154 at http://edis.ifas.ufl.edu/aa126 by D.L. Wright et al. (Ref. 3) will provide specific information about the right strains and cross-inoculation groups of field and forage crop legumes. Make sure you match the right inoculant with the legume you want to plant. A wide range of commercially relevant bacteria is available online. It is, however, important to use fresh inoculant.

N-Fixation and Florida Friendly Landscaping

Having a low-maintenance front yard is a goal for many people. If you scale back the grass area you can reduce your maintenance time and costs. Some people choose to use clover lawn instead of grass. Other examples are the partial or entire lawn replacement by Powderpuff (*Mimosa strigillosa*) (Ref. 4) or Perennial Peanut (*Arachis glabrata*) (Ref. 5). Both plant species are Florida friendly and members of the legume family that fix their nitrogen. Therefore, no additional application of nitrogen is required.

The incorporation of nitrogen fixing plants in cropping systems is not only economically viable but also a contribution to an environmentally friendly and sustainable way of doing things right.

References:

1. www.bio-wissen.org/skizzenbuecher; modified
2. www.pioneer.com/home/site/us/agronomy/library/soybean-nodulation-factors
3. Inoculation of Agronomic and Forage Crop Legumes by D. L. Wright et al., Publication #SS AGR 154 at http://edis.ifas.ufl.edu/aa126
4. Mimosa strigillosa by Stephan Brown, Lee County Extension at lee.idas.ufl.edu
5. Guide to Using Rhizomal Perennial Peanut in the Urban Landscape by R.E. Rouse et al., Publication #HS960 at http://edis.ifas.ufl.edu/ep135