Water Quality

Focus Area
Nutrients and Bacterial Wastes

PUBLISHED BY UNIVERSITY EXTENSION, UNIVERSITY OF MISSOURI-COLUMBIA

– Nitrogen in the Environment –

Nitrogen Replacement Value of Legumes

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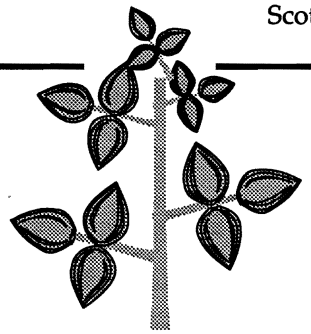

Legumes can get the nitrogen they need from three sources:

- **Atmosphere** – Nitrogen fixation (see WQ261)
- **Fertilizer** – Organic or Inorganic
- **Soil** – Mineralization (see WQ260)

Graphic by Karen DeFelice

Nitrogen is essential for all plant life. Regarding agricultural crops, a sound nitrogen management program is important in achieving high yields. For many crops, application of commercial nitrogen fertilizer is both a practical and sound method to produce top yields. The use of legumes, such as soybeans or alfalfa, can also be a valuable practice in the overall nitrogen management program of a crop rotation. Their use is valuable because they can add nitrogen to the soil for subsequent crops.

Conversion of Atmospheric Nitrogen by Legumes

The atmosphere is made up of 78 percent nitrogen in the form of a gas. But, most plants are unable to use this form. However, legumes can convert atmospheric nitrogen into a form they can use. This conversion process is actually a mutual effort, called **symbiotic nitrogen fixation**. It includes the legume plant and microorganisms that live in very small nodules attached to the plant's roots.

In a symbiotic relationship, both organisms mutually benefit. In this case, microorganisms obtain food and energy from the root of the plant while converting, or fixing, atmospheric nitrogen to a form the plant can use. The form of nitrogen fixed by legumes, is the same form of nitrogen that is found in several types of commercial nitrogen fertilizers.

When legumes are grown, farmers do not need additional inputs of nitrogen. In fact, added nitrogen will only delay, or inhibit, the nitrogen fixation ability of the legume. In a sense the legume plant is lazy, in that it will use nitrogen from the soil before it will begin to fix its own nitrogen.

How Much Nitrogen is Contributed by Legumes?

When legumes die, their residue is easily broken down by microorganisms that release nitrogen back into the soil. The result is a net increase of nitrogen in the soil system because much of the nitrogen released from the decaying plant was not obtained from existing nitrogen in the soil. Simply put, the legume took nitrogen from the air and put it into the soil.

Soybeans are one of the most common legume crops grown in Missouri. Soybeans can add 30 to 50 pounds of nitrogen to the soil. When grown in rotation with corn, grain sorghum or wheat, outside nitrogen fertilizer can be reduced. A common recommendation in Missouri for corn following soybeans is to reduce nitrogen fertilizer rates by 30 pounds.

When forage legumes are concerned, the number, or

Legume Crop	Nitrogen added (lbs. N/Acre)
Alfalfa	
80-100% stand	120-140
50-80% stand	40-60
Less than 50% stand	0-20
Sweet Clover (green manure)	100-120
Red Clover (pure stand)	40-60
Soybeans	15-60

density, of plants (stand) in the field can have a large impact on how much fixed nitrogen is added to the soil. A healthy thick stand of alfalfa can make a significant difference in the amount of nitrogen added to the soil, compared to a poor thin stand. The table lists the optimum amounts of nitrogen that can be added to the soil by various legumes.

Impact to Water Quality

Although nitrogen exists in many forms in the soil, it is the nitrate form that primarily affects water quality.

The eventual result from the death and decay of legumes is the release of nitrate into the soil. In one case, alfalfa that was plowed was found to have twice the concentration of nitrates below the root system of the crop, compared to fertilized corn. Soybeans have been found to contribute two thirds as much nitrate in drainage water as heavily fertilized corn.

The presence of nitrate in the soil is desirable because it is required by plants for growth and development. However, nitrate does not attach to soil particles, and thus easily moves with water. The results of a heavy rain can cause nitrates to move below the root zone of plants. When this happens, nitrate is unavailable for plant use. Whether nitrates continue to move downward, and leach into groundwater, depends on underlying soil and/or bedrock conditions, as well as the depth to the groundwater. If the depth to groundwater is shallow and the underlying soil is sandy, the potential for nitrates to leach into groundwater is relatively high. However, if the depth to groundwater is deep and the underlying soil is heavy clay, the potential of nitrates leaching into groundwater is very small.

Once nitrates get into the groundwater, the greatest concerns are for infants, less than one year old, and for young and pregnant animals. High levels of nitrates can be toxic to newborns causing *anoxia*, or internal suffocation. Seek alternative water sources if nitrate levels exceed the health standard of 10 ppm nitrate-N.

Do *not* boil water to eliminate nitrates. It **increases** nitrate levels, rather than decreasing them. The most common symptom of nitrate poisoning in babies is a bluish color to the skin, particularly around the baby's eyes and mouth. These symptoms of nitrate toxicity are commonly referred to as the "blue-baby" syndrome.

The initial draft was written by Karen DeFelice, former associate extension agronomist; Nyle Wollenhaupt, former state extension agronomist; and Daryl Buchholz, state extension agronomist. This material is based upon work supported by the United States Department of Agriculture, Extension Service, under special project number 89-EWQI-1-9203.

University Extension
UNIVERSITY OF MISSOURI
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■ Issued in furtherance of Cooperative Extension Work Acts of May 8 and June 30, 191. in cooperation with the United States Department of Agriculture. Gail L. Imig, Director, Cooperative Extension Service, University of Missouri and Lincoln University, Columbia, Missouri 65211. ■ An equal opportunity institution.

WQ277 New/February 1991/10M