TECHNICAL NOTES

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NATURAL RESOURCES CONSERVATION SERVICE

IOWA STATE OFFICE
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Subject: LEGUME INOCULATION

This technical note provides basic information on legume inoculation, including expected yield response, inoculation procedure and types of inoculum.

Legumes are unique plants which have the ability to work with certain strains of bacteria (Rhizobia) to gather atmospheric (N_2) nitrogen from the soil atmosphere and convert it to useable ammonia (NH_3) nitrogen. Nitrogen produced by this symbiotic relationship is virtually free and results in not only improved soil fertility but higher protein and forage production in the legume host plant.

The introduction of specific bacteria into the soil is necessary because they are not always present in sufficient numbers to insure adequate inoculation. The process of providing the legume crop with the specific bacteria adapted to it is called inoculation. Inoculation compensates for possible soil deficiencies by sticking millions of bacteria to the seed before planting. As the legume seed germinates, nitrogen fixing bacteria infect the root hairs producing a gall like structure called a nodule. It is here the bacteria fixes the nitrogen (N_2) and converts it to a plant useable form (NH_3).

Benefits of Inoculation

1. Increase yield

   Through inoculation large increases in crop yields are generally obtained on soils low in available nitrogen. Soils with higher levels of available N show less dramatic increases. Yield increases range from 10 – 100% depending on specific soil conditions. On soils with average fertility, increases in yield usually vary between 15-25%.

2. Improved protein content

   In tests over the upper Midwest, alfalfa protein quality was increased an average of 3.5% from 16.1% to 19.6%. Legumes have an obvious advantage over non-leguminous plants because of their ability to produce nitrogen which is a major building block in protein.

3. Increases soil nitrogen for future crops

Many factors influence the amount of nitrogen fixed by properly inoculated legumes. Generally the amount of nitrogen fixed by the plant will be about 75% of the total nitrogen used in the growth of the plant. Thus for every 100 pounds of nitrogen used in the growth of the legume crop, about 75 pounds are taken from the air. Nitrogen fixed by legumes will also vary depending upon species, suitable bacterium population, soil nitrogen content, soil fertility, moisture and temperature.

Average amounts of nitrogen fixed per acre by some common legumes are shown in the table below. These values may also reflect non-nitrogen rotation effects. These factors include: reduced disease, insect and weed infestations, elimination of phytotoxic substances and improved soil properties.

Legume	Nitrogen fixed per acre/yr (lbs.)
Alfalfa	140 - 200
Ladino clover	130 – 185
Sweetclover	70 – 125
Alsike clover	70 – 125
Red clover	62 – 119
Vetch	50 – 90
Soybeans	80 – 128
Birdsfoot trefoil	44 - 100

Types of inoculation Procedures

Commercial legume inoculants are available in three basic forms:

1. Solid (peat or clay based)
2. Liquid
3. Freeze dried

Generally, the solid or peat based inoculums have resulted in the best survival for rhizobia bacteria and thus have produced the best field inoculation results. Fungicides are sometimes added to inoculants to prevent damping off. Some fungicides can kill rhizobia bacteria. Manufacturer's recommendations should be followed carefully to insure successful inoculation.

Inoculum can be applied by one of the following methods:

Planter box inoculation

1. Slurry Method

The inoculant is mixed with the seed in the hopper. A water slurry should be made from the peat inoculant to insure better adherence to the seed. Various stickers are also available and can be used with the slurry method to facilitate better sticking of bacteria to the seed. This method is generally considered the most effective of all planter box inoculation procedures.

2. Sprinkle Method

   Dry inoculant is mixed with pre-moistened seed. This method is not considered as good as the slurry method but can be adequate under good planting conditions.

3. Dry Method

   Dry inoculum is mixed with dry seed. This is the most common and least effective method of adhering bacteria to the seed.

4. Pre-Inoculation

   Inoculum is pre-applied to the seed prior to sale to the grower. This method is most often used with small seeded legumes such as alfalfa. Seed inoculated in this manner must be stored under cool conditions to insure viability of the bacteria.

   A new method of pre-inoculation involves application of a peat based inoculum with a sticker producing a pelleted seed. Other products such as fungicides are often included in this mix to help prevent seedling damping off of small seeded legumes. The pelleting process can be done locally insuring viability of the rhizobia bacteria and optimum legume inoculation.

TYPES OF INOCULUM

All legume seeds need to be inoculated with specific strains of rhizobia bacteria for effective root nodulation and nitrogen fixation. In the case of small seeded legumes, many types of rhizobia are present in the soil, but often not in sufficient population of specific strains to provide optimum nitrogen fixation for maximum forage production.

Inoculants can be prepared for virtually any leguminous species. A list of available inoculants developed by Iowa State University is attached. 1/

Inoculants are perishable. They should be stored in a cool dry place and never used past the date recommended by the manufacturer.

SUMMARY

1. Inoculants and the rhizobia bacteria they transport are important to guarantee maximum production and benefits from legume plantings.

2. They are a cheap form of insurance against low rhizobia populations in the soil, especially for small seeded legumes.

3. All inoculants should be stored and used according to the manufacturer's recommendations.

4. It is important to recognize that different plant species require different strains of rhizobia bacteria.