



TIMELY INFORMATION

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INOCULATION OF FORAGE LEGUME SEED*

Legumes are important plants to livestock producers. Many different legume species produce palatable, nutritious grazing and can provide substantial quantities of forage, but they are also important because they have the ability to obtain nitrogen from the air. This may be used for growth of the legumes themselves, as well as of plants growing in association with them or planted after them. As a result of increasing nitrogen prices in recent years (and the probability of additional increases in the future) this characteristic makes legumes more and more attractive to forage producers.

The ability of legumes to obtain nitrogen is the result of a symbiotic (mutually beneficial) relationship between the legumes and a type of bacteria called Rhizobium. The bacteria infect the roots of legumes and obtain food from the plant which allows them to live and multiply. The bacteria help the plant by obtaining nitrogen from the air and “fixing” it in a form usable by plants. The nitrogen is stored in small growths called “nodules” that form on the roots.

In order to be sure this beneficial process occurs, live Rhizobium bacteria must be present on legume roots. The best way to do this is to make certain that a large number of viable bacteria are present on the legume seed when they are planted. The process of introducing bacteria is called “inoculation”. Inoculating legume seed with nodule-forming bacteria has been a standard practice since the early 1900’s.

Although legume seed inoculation may seem to be a simple matter, it is an important step in legume production, and ensuring proper inoculation can be more complex than it may initially seem to be. Many forage crop researchers believe that poor inoculation (and the resulting poor nodulation and nitrogen fixation) is a major reason why production of legumes is often difficult in the southern United States.

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The hot, dry conditions frequently encountered during the planting of legumes in this area take their toll on Rhizobium bacteria. It is important to distinguish legume inoculants from other products marketed as soil inoculants or “activators” of microbial processes. While legume inoculants are of proven practical value, inoculants or activators of other types are suspect. Therefore, all references in this paper to “inoculation” pertain to legume inoculation with Rhizobium.

COMMERCIAL COATING/INOCULATION

An ever-increasing percentage of commercially available forage crop seed is being coated prior to being marketed. The coating process involves treatment with an adhesive followed by application of some type of material that clings tightly to the seed. This coating may consist of any of several materials, often with lime as the base material, but sometimes clay or degradable plastic. Often the coating material contains a dye that gives the seed some bright color.

Much of the commercially-marketed seed of alfalfa, white clover, red clover, and some other legumes is preinoculated and thus does not require inoculation by the producer. This seed is coated using a commercial process that involves putting an adhesive on the seed, then applying the proper legume inoculants (an usually a fungicide to prevent seedling diseases), plus a lime- or clay-based coating.

Coated seed offers the advantage of higher populations of Rhizobium bacteria attached to the seed than would normally be the case with on-farm inoculation. In addition, the coating helps protect the inoculants and ensures longer bacteria survival in the soil. However, in order to ensure survival of the sensitive bacteria, coated seed must be protected from heat during transportation, by the seed dealer, and by the producer. Also, seeder calibration is essential, as coated seed flows up to 35 percent faster than uncoated seed.

The coating has volume and weight, so when producers purchase coated seed, some of the cost of the seed product purchased is actually the coating. Also, since coated seed is slightly larger, planting the same number of pounds of coated seed per acre as uncoated seed results in fewer pounds of stands obtained, there are normally no differences when planting the same weight per acre of either coated or uncoated seed.

OBTAINING AND HANDLING INOCULANTS

If forage legume seed has not been inoculated during the coating process, then the forage producer should inoculate the seed. The first step in legume inoculation is to obtain the right type of inoculum. Different strains of bacteria are effective in different species of legumes. For this reason, a producer should be sure that on the packages of inoculum he buys it is specifically stated that the inoculum can be used on the species of legume he plans to inoculate. This is very

important, since, in some cases, the wrong type of bacteria will be “antagonistic” (harmful). The proper type of inoculum for any particular legume should be sold wherever the seed of that legume are sold.

It is also important to, as far as possible, take care to obtain and use only good quality inoculum. Farm supply dealers, as well as producers, should keep inoculum stored in reasonably cool places and out of direct sunlight. When inoculum is purchased, a producer should always be sure to check the expiration date on the package and refuse to buy the inoculum if the date is already past.

It is of critical importance to inoculate when planting in areas where legumes have not been grown before. Some legume bacteria will remain in the soil for several years after a legume crop was grown in the field, but inoculum is inexpensive so inoculating seed even in areas where a legume has recently been grown is cheap “insurance” that proper nitrogen fixation will be obtained. Inoculation should always be done with fresh inoculum – not old inoculum saved from a previous year.

Research at Auburn University indicates that there can be great differences in the performance of inoculants produced by different companies. This may partially be due to differences in the way the inoculum is handled after it is produced, but it also influenced by the population density of Rhizobium bacteria in the inoculum as well as by what strains of bacteria are present in the inoculum. Therefore, if possible, it is highly advisable for producers to buy inoculum which they know has performed well in the past, or about which they have some assurance of effectiveness. The total amount of nitrogen fixed per acre will be affected by many factors, but as indicated by figures presented in Table 1, the species of legume is an important influencing factor.

Table 1. Estimated Average Amounts of Nitrogen Fixed Per Acre By Various Legume Species.*

<u>Legume Species</u>	<u>Nitrogen/Acre</u>	<u>Legume Species</u>	<u>Nitrogen/Acre</u>
Ladino Clover	200	Soybeans	51
Alfalfa	185	Peanuts	42
Blue Lupine	151	Bur Clover	107
Red Clover	132	Crimson Clover	85
Sweetclover	125	Vetch	82

*Figures presented in USDA Farmer’s Bulletin No. 2003, revised August, 1967, and titled, “Legume Inoculation: What It Is – What it Does.”

HOW TO INOCULATE SEED

Legume seed should be inoculated just prior to planting. The inoculum package will provide instructions as to what quantity of seed can be inoculated with a package of inoculum (usually, one 8-ounce package of inoculum is recommended for use in inoculating 50 pounds of seed).

The traditional method of seed inoculation is as follows. The seed should first be placed in a tub or other open-topped metal or wooden container. It is best to then slightly dampen the seed and mix them thoroughly prior to inoculation. The seed may be dampened with a small quantity of water, but a soft drink, a mixture of table syrup and water or other liquids which will cause the seed to be sticky (without harming the inoculum or the seed) will likely be better than plain water. The proper quantity of inoculum should then be applied to the seed and mixed in thoroughly. The inoculated seed should be protected from the sun and heat as much as possible and should be planted soon after inoculation. If the seed cannot be planted the day they are first inoculated, it is advisable to re-inoculate.

ON-FARM LIME PELLETING OF SEED

Producers who wish to do so can “pellet” their legume seed with lime, which helps protect the Rhizobium bacteria. The following is a “seed pelleting recipe” that has been used successfully by a number of Alabama forage producers.

1. Thoroughly mix 1 quart of syrup with 1 quart of water.
2. Take 1 pint of this mixture and slowly mix with 50 pounds of seed (pour and mix; pour and mix).
3. Add the amount of inoculum needed to inoculate 50 pounds of seed (for most legumes this will be one 8-ounce package: for arrowleaf clover, two 8-ounce packages should be used). Thoroughly mix the inoculum and seed.
4. Then take about 1 pound (about a double handful) of finely ground agriculture lime, add it to the seed, and thoroughly mix. If needed, add small additional amounts of finely ground lime until the seed are no longer sticky.
5. If possible, spread seed out in a shaded area and allow them to dry for a few minutes.

PLANTING INOCULATED SEED

The bacteria used to inoculate legume seed will be most likely to survive if the seed are planted in slightly moist soil or if planted just prior to a rain. Although great care should be taken to avoid covering small-seeded legumes with more than 1/4 to 1/2 inch of soil, a light or

partial soil covering, such as might be accomplished with a cultipacker, will help protect the bacteria. Inoculated legume seed should never be mixed with fertilizer, as fertilizers can quickly kill Rhizobium bacteria.

HOW TO EVALUATE NODULATION

After legume plants are 3-4 weeks old, tiny nodules should first begin to be visible along the tap root. As the plants become older, the number, size, and color of the nodules present will indicate the extent of nitrogen fixation. In older plants that have been properly inoculated, some nodules should form on secondary roots, the size of the nodules should increase, and the interior of healthy, effective nodules will be pink to dark red in color. White or green nodules indicate inefficiency.

In situations in which very little or no nitrogen fixation is occurring, the plants may begin to indicate nitrogen deficiency by stunted growth and a yellowing of leaves (especially the bottom leaves). In cases in which inoculation failed, it is sometimes possible to increase nodulation by applying inoculum to sand and broadcasting it over the legume field just prior to a rain. Small applications of nitrogen fertilizer will improve the growth of nitrogen deficient legumes, but application of nitrogen to vigorous, well-inoculated legumes can result in decreased nitrogen fixation and should therefore be avoided.