TEN REASONS FOR NODULATION FAILURE IN LEGUMES

If your forage legumes are stunted and yellow and generally exhibit signs of nitrogen deficiency, the problem may be nodulation failure. Here are ten factors that may contribute to nodulation failure:

1. **Failure to Inoculate.** Producers often do not inoculate because they have previously grown the legume in the field they are planting. This is a risky practice that may or may not be successful due to a number of environmental factors that affect bacteria survival in the soil. Inoculation of legumes is simply a cheap insurance practice.

2. **Use of Pre-Inoculated Seed.** Pre-inoculation is a common seed industry practice but, without accompanying seed pelleting, the chances are slim that this inoculum will be viable at planting time. Pre-inoculated seed should carry a label indicating the expiration date of the inoculum, and seed should not be purchased if inoculum has expired. Use of additional inoculum on pre-inoculated seed is always a cheap insurance policy and is essential if the inoculum has expired. Seed pelleting affords some protection to the inoculum and also serves as a source of Ca and nutrition to the bacteria in the seed zone after planting. When using pelleted seed, be sure to adjust seeding rates accordingly since the pelleting process adds to individual seed weight and so reduces the number of seed per pound. A lot of seed that is pre-inoculated is also treated with fungicides to provide protection from "damping off". Since many fungicides are harmful to the Rhizobia bacteria responsible for nodulation, use of fungicide-treated, pre-inoculated seed without further inoculation is risky business.

3. **Planting in Acid Soils.** Improper liming is a major cause of nodulation failure. Low pH and calcium deficiency can interfere with the nodulation process itself. Toxicities due to manganese and aluminum can affect root growth to the point that nodules will not form. Liming is the best way to overcome these toxicities in surface soil and also improve the availability of molybdenum which is essential to N fixation.

4. **Planting in Soil with Fertility Deficiencies.** Any mineral nutrient deficiency that reduces root growth can affect nodulation. The most important nutrient in this regard is phosphorus. Soils should be fertilized according to soil test results with P at planting or before. Calcium is very important to nodulation, but requirements for Ca are met if soils are properly limed. Two micronutrients, molybdenum and cobalt, are important to nodulation and N fixation. Typically, these micronutrients are present in sufficient quantities in the soil with proper liming, but many of the seed pelleting formulations include minute amounts of these nutrients to insure their presence.

5. **Storing Bags of Inoculum on the Pickup Dashboard.** Inoculum should be refrigerated until it is used by seller and buyer. The heat stress caused by storing bags of inoculum on a dashboard or prolonged storage in a closed truck cab is sufficient to kill the bacteria.

6. **Storage of Inoculated Seed for Long Periods in the Sun.** The bacteria responsible for nodule formation are sensitive to ultraviolet radiation, in addition to heat stress and desiccation. If you have applied inoculum to seed in a bucket and then leave that bucket in the sun for a prolonged period you have defeated the purpose of inoculation. Inoculated seed should be stored in the shade in a cool, dry place until planted.

7. **Placing Inoculated Seed in a Fertilizer Spreader with P and K Fertilizer.** Prolonged contact of inoculated seed with acid, high salt fertilizers can result in death of the inoculum. Both P and K fertilizers can desiccate seed due to high salt content.
8. **Surface Seeding into a Dry, Prepared Seedbed.** Seeding inoculated legume seed into a dusty seedbed places the adhering bacteria into a situation of extreme heat and moisture stress. Prolonged periods of exposure to these conditions can result in death of the inoculum.

9. **Seeding into Water-logged Soil.** Although this also affects seedling survival, poor root hair growth under anaerobic conditions will result in poor nodulation. The nodulation process may also be affected by anoxia in water-logged conditions.

10. **Use of Wrong Inoculum Type.** Many inoculum preparations are very prolific and will form nodules on a wide range of legume species, but many of our legumes have very specific bacteria requirements. Use of the proper inoculum is very important. Do not use soybean inoculum for alfalfa just because it's inoculum.