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Inoculation of Agronomic Crop Legumes [1]

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Certain kinds of bacteria are capable of fixing atmospheric nitrogen (N) into forms usable by higher plants. The N-fixing bacteria are of two general kinds-- symbiotic and non-symbiotic. The non-symbiotic group are free-living organisms, whereas the symbiotic group cannot function without the aid of a host plant. The association between the host plant and the symbiotic bacteria is mutually beneficial in that the plant furnishes the necessary energy and the bacteria uses this energy to fix atmospheric N that can be used by the host plant.

With a few exceptions, the plants with which the symbiotic N-fixing bacteria are associated belong to the legume family. The development of nodules on the roots of a legume is evidence that the symbiotic bacteria are present. Since the symbiotic organisms are usually associated with legumes and result in the formation of nodules, they are often called "legume bacteria" or "nodule bacteria." The bacteria genes "Rhizobium" is the common "legume bacteria".

The introduction of nodule bacteria into the soil for the establishment of the mutually beneficial relationship described above is called legume inoculation.

The proper strain of nodule bacteria may be introduced into the soil in which a legume is to be planted in two different ways: 1) by spreading soil from a field in which the legume recently has become inoculated and has grown successfully, or 2) by applying a commercially prepared culture of the proper strain of bacteria to the legume seed or in the seed furrow at planting. The disadvantages of using soil outweigh the advantages to such an extent that commercial cultures are generally used.

Most commercial inoculants are in a powder form and consist of finely ground peat mixed with the N-fixing bacteria which are intended for mixing with the seed. Granular formulations of the peat-bacteria mixture have recently been introduced and are designed to be placed in the seed furrow at planting. Liquid inoculants and other non-peat-based inoculants are even more recent introductions. It has generally been noted that peat as a carrier for the bacteria provides more protection from drying and death of the bacteria than the inoculants that do not contain peat.

Several species of legumes may be inoculated by one type of bacteria. These are called cross-inoculation groups. In some cases, only one

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species of legume may be in a cross-inoculation group. Table 1 lists the legumes in various cross-inoculation groups. To purchase the proper inoculant, find the legume to be planted and then order the inoculant for that cross-inoculation group.

In using commercial inoculants, the following rules for successful inoculation should be observed:

1. Prepare a good seedbed.
2. Purchase fresh inoculant from the proper cross-inoculation group. Before completing purchase, note the expiration date printed on the container and make sure that the culture is of a strain of bacteria that will inoculate the legume to be planted. See Table 1 for legumes included in each cross-inoculation group. Do not purchase inoculant pre-mixed with molybdenum, because the bacteria may die in such pre-mixes. If needed, these materials should not be mixed with the inoculant until just prior to planting.
3. Store culture in a cool, dry place until it is to be used.
4. Inoculate if there is any doubt as to whether or not bacteria of the proper strain are present in the soil.
5. For powder inoculants, follow directions for each crop. Put a sticking compound on the seed, then add inoculant and mix well with seed. If seed becomes too wet, allow to dry on a tarp under shade. Do not allow direct sunlight to hit the inoculated seed. (Observations under Florida conditions indicate that cultures for large-seeded legumes should be applied at least twice, and those for small seedbed legumes at least four times the rates recommended by the manufacturers.) Apply granular inoculants in the seed furrow during planting at the manufacturers' recommended rates.
6. Do not allow seed to contact caustic lime or soluble fertilizers. Some seed protectant chemicals are incompatible with legume bacterial. Molybdenum may aid in nodule formation on soybeans planted on mineral soils that have not been limed to the optimum pH.
7. Plant inoculated seeds at once (within 4 hours) and cover them immediately. Pack the soil with suitable equipment, such as a corrugated roller for broadcast plantings, or a planter press-wheel for row plantings.
8. Plant when soil temperature and moisture are favorable for the survival of the bacteria.

Table 1. Cross-inoculation groups of field and forage crop legumes.[1]

ALFALFA GROUP		
Alfalfa	Buttonclover	Sourclover
Black medic	Fenugreek	Sweetclover
Bur-clover		
BEAN GROUP		
Garden bean	Pinto bean	Wax bean
Kidney bean	Scarlet runner bean	
CLOVER GROUP		
Alsike clover	Hop clovers	Strawberry clover
Arrowleaf clover[1]	Ladino clover	Sub clover
Ball clover	Persian clover	White clover
Berseem clover	Red clover	Other true clovers
Crimson clover		
COWPEA GROUP		
Aeschynomene	Guar	Partridge-pea
Alyceclover	Hoary tickclover	Peanut
Beggarweed	Indigo	Pigeonpea
Bushclover	Kudzu	Savanna Stylo
Cowpea	Lespedeza	Stylosanthes humilis
Crotalaria	Mung bean	Velvetbean
		Carpon Desmodium
LUPINE GROUP		**SOYBEAN GROUP**
Lupine	Seradella	Soybean
VETCH AND PEA GROUP		
Austrian winter pea	Horsebean	Sweet pea
Field pea	Lentil	Tangier pea
Garden pea	Rouph pea	Vetch

The following legumes appear to require specific strains of nodule bacteria for effective inoculation: *big trefoil, birdsfoot trefoil,* and *sesbania*. Special orders may be needed to locate effective bacteria.

[1] All legumes within a group can be inoculated with the same culture or kind of nodule bacteria. Some of the inoculants for clover may not be effective in N-fixation by arrowleaf clover although nodules form. Use inoculant that is specifically for arrowleaf clover.