COATED SEEDS - STATE OF THE ART

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From the days of the Roman Empire, where growers gathered soil from fields that had been in a legume crop and spread them on fields to be sown to that same legume crop to insure nodulation, until the sophisticated seed coatings of today, is a study in matching products to needs. The Roman farmers didn't know why they got results this way, but they weren't really all that concerned because they could measure the differences easily. To a degree, growers today follow this same philosophy in many instances.

Seed coatings trace their origin back to the Pharaohs in Egypt where seeds were coated with clay to apparently achieve some of the benefits that we seek for seeds today; extra size and weight along with desired shape for easier handling, precision planting, and a degree of protection. Coating alfalfa seeds today is done for several benefits. Let's look at them in order. First, an alfalfa seedling must be assured of an adequate supply of nitrogen if it is going to establish and become a vigorous plant. Inoculating the seed with high numbers of a specific, efficient Rhizobia is the first step in achieving that goal. Results from many researchers have shown that the use of the many packaged inoculants, whether peat based or broth types, have not performed as well as expected and this led to the experimentation with coating the inoculated seeds. Coating proved to prolong the life of the Rhizobia, once inoculated and overcoated, thus leading to higher numbers reaching the seedbed, resulting in better nodulation and subsequent nitrogen production. The coating process, though much more effective than simple inoculation, was mostly a "do-it-yourself" project using gum arabic, lime, a cement mixer or some vessel to which some type of mixing action was introduced. The challenge, then, was to dry the coated seed sufficiently to sow it. If dried in the sun, ultraviolet light proved fatal to vast numbers of the Rhizobia. If dried too long and/or at too high a temperature, more Rhizobia died. If there were any toxic elements in the mixing vessel or introduced during the drying, these took their toll. Finally, if the seed wasn't planted within a few hours of pelleting, more Rhizobia were lost. Many a failure was traced to a few bags of coated seed sitting in the back of a pickup parked in the hot sun!

So, that's where we were. Today's CelPril product is the direct result of technology originally developed and refined in New Zealand by Coated Seeds Ltd., who started coating legumes, primarily, in 1962. In 1974, our management flew to New Zealand, after several years of experimentation and then commercial production of our own coating process, and came back with the U.S. (later World) rights to their process. Several improvements were made to an already fine product, i.e. better adhesives, protectants and types of coating material, to achieve that we have today.

CelPril has just completed a Rhizobia Production Facility at Manteca where we produce all our own inoculants. Under the direction of Dr. Iver Johnson, Director of Research, and Dr. Joe Marlow, our microbiologist, we've developed more specific strains of Rhizobia that are far more efficient than the strains commercially available to us before. In addition, the number of Rhizobia per gram of peat are much higher in our own product.

Besides better quality, and higher numbers of Rhizobia per seed, we have a method of protecting them from the toxic elements present on the alfalfa seed itself.

The subsequent coating with lime, adhesives and other additives constitutes the protective, ballistic and handling properties we sought.

Shelf life studies have shown that, with reasonable storage in typical dealer warehouses, plate counts of over 200 colonies per seed were achieved after 18 months! I hasten to add that we don't intend to have an 18-month expiry period! It would indicate, however, that one season is a reasonable time to expect good results.

_et's Explore the Function of Rhizobia

Wherever native legume plants occur, many strains of Rhizobia bacteria will be present in the soil, and some of these will nodulate introduced legumes. However, because nodulation occurs, it does not imply that they are efficient in converting atmospheric nitrogen into ammonia and then into protein f you are looking for effective nodulation of plants, watch for:

- Large nodules on roots near the crown of the plant When cut, they should be red inside.

- The presence of a large number of small nodules, particularly f present on the roots farther away from the crown of the plant--shows poor nodulation.

If the nodules, when cut in half, are pale or green, they are ineffective.

Some of the conditions that must be met if Rhizobia are to be effective:

- Bacteria must be able to enter the plant and form a nodule and enter into a partnership (called symbiosis) with the plant, to fix atmospheric nitrogen and convert it to forms usable by the plant.

- Conditions must be suitable for bacteria and plant to enable bacteria to colonize the root system (called Rhizosphere). The bacteria enter the plant through infection threads beginning at the end of the root hairs on the plant roots. The root hair curls around on itself and bacteria are able to produce a tubular structure, the infection thread, through which bacteria move into the root itself. At the end of the infection thread in the root, bacteria are liberated into the plant cells (Fig. 1). The plant cells within the root nodule are filled with bacteria (or bacterioids), and contain the red pigmented haemoglobin, its presence indicating effective nodulation. This haemoglobin is similar to that in the human blood. It is the only known case where this occurs in plants (Fig. 2).

Nitrogen is drawn from the atmosphere and converted to ammonia within the red pigmented portion of the nodule. Amino acids are formed which are the basis of protein.

The conducting tissue in the roots supply sugars, mostly in the form of ordinary sugar and carry away amino acids to other parts of the plant.

- Bacteria must be able to persist in the soil from one growing season to the next to re-inoculate legumes. Superior bacteria, introduced via inoculants, may very well nodulate roots the first year, but fail to re-inoculate the next year. Research workers have proved that, by sterilizing the soil, bacterial numbers may increase adequately for effective nodulation of legumes, suggesting that some element or toxin is responsible for bacteria mortality.

- Bacteria move slowly in soil--this being one reason by second year plants are often isolated from bacteria introduced the previous year.

- Legume roots have a limited number of sites for nodule formation. If the ineffective bacteria occupy these sites before the efficient ones do, poor nitrogen production results.

Figure 1

Nodule bacteria colonizing on the root hair and plant root.

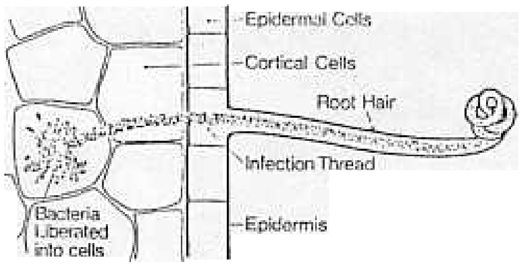
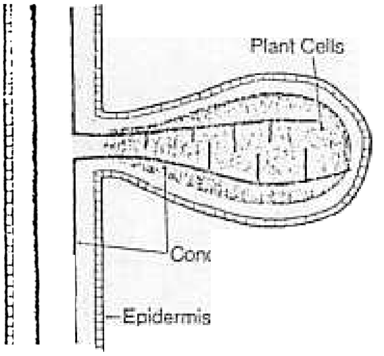


Figure 2

Root nodule containing bacte



To summarize the benefits:

1. To assure nodulation with the specific, most efficient strains of Rhizobia. This is done by starting with large numbers of these bacteria and keeping them alive much longer than previous methods could.

2. The added weight and size of the coating makes handling easier and provides ballistic improvements so seeding by air is more efficient.

3. On acid soils, CelPril-coated seed has been equivalent to 1 ton of lime per acre in neutralizing power.

4. On neutral soils, not previously sown to alfalfa, nodulation is superior to conventional inoculants and other coatings.

A recently completed test in Oregon showed conventional inoculants nodulated from 15 to 46% of the varieties, a competitive lime coated seed nodulated 9%, and our RhizoKote nodulated from 85 to 97%. (Oregon State University - Dr. Murphy.)

What are the opportunities for coated alfalfa?

1. The inclusion of more plant nutrients: major, secondary, and micro Enough to be significant, but not enough to be phytotoxic.

2. The addition of fungicides and insecticides (possibly both systemic).

3. Adding plant growth regulators--stimulatory and inhibitory, designed to achieve specific goals, i.e. delay maturity, induce early flowering, increase uptake of nutrients, water, oxygen, etc.

4. Including hydrophyllic and hydrophobic over coatings--materials that speed up and slow down absorption of water by the seed. The former speaks for itself. The latter would allow earlier planting in dry soils to await just the right level of moisture for germination or planting in the fall those crops that normally are spring seeded, but often delayed because of wet soils, cold soils, or simply not enough time to plant big acreages with limited equipment.

These are just a few of the possibilities. Time and company secrecy requirements prevent me from going on. Suffice to say, the testing programs are most exciting!