

Soybean Inoculation and Nitrogen Nutrition

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The soybean is a legume whose seed contains 34% to 38% protein when the grain is at 13% moisture. Seed protein contains much nitrogen in compounds called amino acids which make up the protein. Typically, a bushel of soybean grain contains between 3.5 and 4.0 pounds of nitrogen, and the crop uses about 5 pounds of nitrogen to produce each bushel of grain. About half (150-200 pounds) of the nitrogen is fixed by Rhizobium bacteria found in the nodules, and the other half is removed directly from the soil.

Most soybean crops are nitrogen deficient throughout most of the growing season with the possible exception of a short period (2-3 weeks) during the late flowering-early pod-fill stage of growth. At that time, the rate of nitrogen fixation in the nodules is greater than the plants need. Very soon after a few pods have become fully expanded, seed filling starts, and the need for nitrogen increases dramatically. At the same time there is a large increase in demand for compounds produced by photosynthesis, and the plants redirect that production to the grain. This redirection often deprives the root system of energy needed for growth and even survival.

As pods are being filled, the root system and some older leaves are often catabolized for carbohydrates and other materials. Prior to physiological maturity, the root system has been degenerated, the leaves stripped of all soluble carbohydrates and mineral nutrients, with those materials being deposited into the grain.

The most limiting input for larger yields is water. A close second factor is nitrogen supply followed by sunlight used to produce carbohydrates which are converted into protein, oil, and other seed storage compounds. Increasing the supply of any one of these three will increase yield. If all three can be increased, then grain yields increase dramatically. However, we have no control over sunlight and very limited control of water availability. Yield increases from adding nitrogen have been small and uneconomical, probably due to the demise of the root system during pod fill when the need for nitrogen is greatest. The most practical solution for this dilemma is to increase the amount of nitrogen fixed by the bacteria in the nodules. The bacteria used in the newer inoculants infect the root system more extensively and fix more nitrogen more efficiently. Some of the newer strains survive longer in the soil than older strains. More productive strains are being developed using recently developed gene transfer technology and will enter the market in about two years. In the meantime, we should use the improved (sterile) inoculants currently available as a means of increasing profits. The sterile inoculants such as GRIP, HI-STICK, PULSAR, POWER PAK, SOW-FAST, SOY-SELECT, and CELL-TECH 2000 typically have six to 10 times more bacteria per gram than the non-sterile inoculants. In trials at the University of Guelph in Ontario, Canada, the sterile inoculants have produced about 1.3 Bu/Ac more yield than non-sterile materials.

The chart on this page presents the results of three years of inoculate evaluation in Ohio fields where inoculation would not be expected to increase yields. The test fields were in a soybean-corn rotation, had good fertility, appropriate pH values, and were very productive. For those 16 trials with three products (48 tests), the yield increase has been more than 1.5 bushels per acre.

Since inoculation costs less than \$2.00 per acre, seed inoculation is a very profitable activity. Most producers can expect larger yield increases than these in some of their fields. Following label instructions carefully will improve the results.

Soybean Inoculation Study, 1995-1997		
1995 (Five Locations) Mean Yield: 50.1 bu/A	New USDA Humus	+1.6
	New USDA Liquid	+1.6
	HiStick	+1.6
1996 (Five Locations) Mean Yield: 50.9 bu/A	Regular Humus	+0.6
	New USDA Humus	+1.1
	New USDA Liquid	+1.6
	HiStick	+2.4
1997 (Six Locations) Mean Yield: 52.4 bu/A	New USDA Humus	+1.5
	USDA Frozen in Furrow	+1.0
	HiStick	+1.6
	Cell Tech	+1.3

For 16 Tests Over Three Years	
HiStick	+ 1.85 Bu/Ac
USDA Humus	+ 1.40 Bu/Ac
USDA Liquid	+ 1.40 Bu/Ac

Soybean inoculation increased:

Yield 1.55 Bu/ac

Profit by \$10.10/Acre