Soybeans: Liming & Fertilization

MISSISSIPPI STATE UNIVERSITY™ EXTENSION

Soybeans grow best on soils of medium to high fertility and with favorable soil pH. Maximum yields are possible only when producers meet plant nutritional requirements and other basic production factors. Even if you use the best soybean varieties and cultural practices, your soybeans will not reach their full potential unless soil fertility is properly managed. Adequate soil fertility helps reduce risks from weather stresses, diseases, and nematodes, allowing plants to achieve maximum potential.

Soil fertility often is overlooked in crop production. The Extension Soil Testing Laboratory at Mississippi State University consistently finds significant numbers of soil samples for soybeans that test low or very low in available phosphorous and potassium. In addition, soil acidity issues limit production. The past economic status of soybeans, the large amount of rented acreage, and the fact many growers fail to recognize lime's importance contribute to reduced yields for Mississippi soybean producers.

A frequent question is, "Should I fertilize my soybeans?" The answer is, "Yes; if they need it." Do not guess at soil fertility; have your soil tested regularly. The most economical thing available to soybean producers is a soil test; it is the original best management practice.

Lime Needs

Many Mississippi soils require lime to control soil acidity for soybean production. Lime requirements vary, and there is no way to guess the needs. Since lime is important and relatively expensive, a soil test accurately determines where and how much lime to apply.

Lime Quality and Economics

Many producers fail to lime because of the high initial cost. Lime application, however, is an investment in soil productivity and lasts about three growing seasons.

Lime particles larger than a 10-mesh size do not change the soil pH and have no function in soils. Half the limestone particles that pass a 10-mesh sieve, but not through a 50-mesh sieve, will dissolve and neutralize soil acidity in a reasonable period of time. Particles finer than 50 mesh neutralize soil acidity in relatively short amount of time.

Each quarry selling lime in Mississippi must submit samples yearly for analysis; most states have similar consumer protection laws. In Mississippi, regulation revisions in 2006 under the 1993 Agricultural Liming Materials Act required vendors of liming material to provide buyers with Relative Neutralizing Value (RNV) data as determined by the Mississippi State Chemical Laboratory.

The RNV of a lime is an index of effectiveness for neutralizing soil acidity. It is sometimes termed Effective Calcium Carbonate Equivalent (ECCE). It gives credit for one-half of the lime sized between 10 mesh and 50 mesh and all lime finer than 50 mesh reacting in agronomically significant time periods. It then adjusts the value for impurities by multiplying by the CCE value of the material

You can use the CCE and fineness information for a particular liming material in a simple calculation to estimate its effectiveness for neutralizing soil acidity. The following is an example for calculating the relative neutralizing value of a liming material:

CCE	92
Percent passing a 10-mesh screen	94
Percent passing a 650-mesh screen	50

RNV = 0.92 X x ([94 - 50]/2) + 50) = 66.2%

In this formula, half of the percentage of lime between sieve sizes 10 and 50 is added to the percentage passing the 50-mesh sieve (50 in this example). This sum is multiplied by the CCE value (0.92 for this liming material). This means about 66 percent of this sample will effectively change soil pH in an acceptable time period.

You can use relative neutralizing values to adjust liming recommendations from soil testing laboratories and to compare prices of various materials. Recommendations are normally based on materials with CCE of 100 percent, so you need to adjust application rates to reflect the material actually used.

You can calculate the economic value of different materials using RNV data. For example, compare agricultural liming materials, one at $25 per ton with a 66 percent RNV, to one with an RNV of 85 percent at $30 per ton. You can determine the actual cost by dividing the price per ton by the RNV decimal value.

$25/0.66 = $38
$30/0.85 = $35

This shows the material with the higher up-front cost actually is the more economic purchase based on its agronomic worth.

Lime sold in Mississippi, by regulation, must have a minimum RNV of 63 percent.

Fertilizer

Soil testing is critical for determining fertility needs. Soybeans require moderate amounts of plant food for high yields. A 30-bushel yield removes 24 pounds of phosphate and 42 pounds of potash in the grain per acre. Some soils can supply everything the plant needs; however, many soils require supplemental fertilization for maximum production.

Base fertilizer grade and application rate on soil and plant needs as determined by the soil test. Information and supplies for submitting soil samples are available at your county Extension office. Take soil samples at least every 3 years. If you do not apply fertilizer, test annually to determine the status of soil nutrients.

Many Mississippi Delta soils have not required P and K fertilization for soybean production. However, you need to soil test to determine lime requirements and to monitor the soil levels of P, K, and organic matter.

It is important to use soil testing for P and K management in the Hill section of Mississippi. Applying insurance levels of fertilizer without soil test recommendations is a poor investment. Phosphate not used by growing crops is attached closely to soil particles and, therefore, prone to loss by erosion.

Response to Fertilizer

The important result of a soil test report is not the absolute number provided for P or K, but rather the index, or ranking of the soil sample, on a scale from very low to very high for each nutrient. **Table 1** shows the likely yield response for each P and K index, as measured by the Soil Testing Lab at Mississippi State, and the required fertilizer to achieve maximum yield.

The yield expected without any additional fertilizer is 35–80 percent of the potential yield for a very low phosphate index. To address this potential yield loss, 120 pounds of phosphate are recommended the first year of soybean production for a soil testing very low. For this particular index, phosphate fertilizer can then be lowered to 60 pounds per acre for subsequent soybean crops in a 3-year soil test cycle. These recommendations are designed to achieve maximum economic yield potential, not average yields. When index levels are high, or very high, response to fertilizer is difficult to achieve, and fertilization is not economical. Recommendations at the medium level are designed to maintain levels of nutrients in the soil against crop removal.

For additional information on managing nutrients for soybean production, refer to Mississippi State University Extension Service Publication 2647 *Nutrient Management Guidelines for Agronomic Crops Grown in Mississippi*.

Table 1. Expected response of soybeans to phosphorus and potash at various soil testing levels.

	Yield expected without fertilizer		Required fertilizer	
Level	Phosphate	Potash	Phosphate	Potash
	%		lb/a	
very low	35–80	50–80	120*	120
low	75–96	75–96	60	60
medium	92–100	92–100	30	60
high	100	100	0	0
very high	100	100	0	0

*After first year, reduce to 60 lb/a.

Sulfur

Sulfur deficiencies in soybeans are seldom found in Mississippi. However, sulfur deficiencies are becoming more common in some crops because of fewer complete fertilizers that contain sulfur, lower sulfur emissions from automobiles, improved smokestack-scrubber technology, and the sandy nature of many Mississippi soils. Soybeans may respond to sulfur on sandy soils or soils low in organic matter.

Molybdenum

The minor element molybdenum generally is deficient in acid soils. The chance of a soybean yield response to molybdenum increases as soil pH decreases.

Molybdenum is especially important where no lime will be used in the non-Delta region, on the Delta foothills, and on the sandy and silt loam soils of the Delta with pH less than 6.2. When soil acidity is below 5.5, however, apply lime and molybdenum to achieve maximum yield potential. Molybdenum, however, has been found not to be needed on the heavy clay soils of the Delta, even at pH levels below 5.6. Molybdenum is not a substitute for lime but may help offset acidity problems.

Molybdenum Rates and Methods of Application

Seed treatment is the most common and practical method of application. Use a material that provides half an ounce of sodium molybdate per bushel of seed. Uniform coating of each seed is important. Liquids applied at the processing plant or in the hopper provide better coverage than do dry powders. You might also use a material that is combined with a fungicide if it is needed.

Foliar treatments also are effective when applied before bloom. For foliar sprays, use 1 ounce of sodium molybdate per acre in 10–20 gallons of water. Before mixing any pesticides, read the label for instructions.

Yield Increases from Lime

Yield increases depend on several factors. For maximum benefit the first year, apply finely ground lime several months in advance of planting. (You may get some benefit from application just before planting.) Response to lime depends on intrinsic soil properties that govern the rate of reaction.

Other Secondary and Micronutrients

Generally, there is no need to apply secondary nutrients (for example, magnesium) or micronutrients (for example, boron, zinc, or cobalt) to soybeans in Mississippi. Producers regularly see temporary iron deficiency symptoms (yellow leaves with green veins) in the high pH soils of the Black Belt region, but soybeans generally outgrow this condition.

Treatments have failed to increase yield, and work is needed to address varietal tolerances. Manganese deficiencies occasionally occur in the Flatwood region of the Gulf Coast and a few other locations. This deficiency also shows yellow leaves with green veins. Soil and plant analyses are beneficial in diagnosing these and other isolated cases of unusual deficiencies.

Nitrogen and Inoculation

Research found no general need for nitrogen fertilizer when soybean roots are well nodulated. To ensure nodulation, inoculate the seed with a fresh source of commercial inoculant when planting on land not previously planted in soybeans or on land where soybeans have not been planted for 3–5 years.

Inoculant applied dry in the hopper or prepackaged with molybdenum or fungicides may be ineffective. The best procedure is to buy the inoculant, molybdenum, and fungicide separately, as needed, and apply to the seed before placing in the hopper. Another option is to apply a granular inoculant directly in the furrow. Inoculants are live bacteria, so if you don't use all the seeds by the end of the day, re-inoculate them before planting the next day.

Double-Cropping Fertilization

If you double-crop soybeans with small grains or ryegrass, you can apply all the recommended phosphate and potash for both crops combined or to either crop. Generally, it is more practical to apply all of the fertilizer during seedbed preparation for the small grain or ryegrass so you can plant soybeans with minimum delay. Extension Publication 1380 *Double Cropping Soybeans* can provide more detailed information.

When and How to Fertilize

Fall or spring applications of fertilizer are satisfactory on most soils. Restrict fall applications of potash to soils with a CEC of 8.0 or above to avoid excessive leaching.

Banded application of fertilizer places nutrients in the immediate root zone and improves fertilizer efficiency. When banding, be sure to offset the fertilizer several inches to the side and below the seed depth to prevent salt injury.

Broadcast application is common, convenient, and satisfactory if spreading is uniform. On very acid, low-testing soils, shallow incorporation and the use of low rates may reduce the effectiveness of broadcast fertilization. Banding is a better alternative in this particular situation.

Solid or Liquid Fertilizer

When used properly and at equivalent rates of nutrients, dry- or liquid-mixed fertilizers are equally effective; therefore, base your choice on cost, ease of handling, and labor and equipment requirements.

Information Sheet 873 (POD-08-15)

Revised by **Dr. Larry Oldham**, Extension Professor, and **Dr. Keith Crouse**, retired Associate Extension Professor, Plant and Soil Sciences.

Produced by Agricultural Communications.

Extension Service of Mississippi State University, cooperating with U.S. Department of Agriculture. Published in furtherance of Acts of Congress, May 8 and June 30, 1914. GARY B. JACKSON, Director