SOIL TEST INFORMATION SHEET NO. C-170

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Soybeans

1. In soybean production, applying agricultural limestone is recommended when the soil pH falls below 6.2 to 6.3. This practice helps maximize nutrient availability. However, when soybeans are grown in rotation with rice, it's important not to raise the soil pH above 6.2, as higher pH levels can potentially lead to zinc deficiency in the rice crop.

2. The effectiveness of limestone depends on the particle size of the liming material (fineness factor) and its Calcium Carbonate Equivalent (CCE). Lime recommendations typically assume a CCE of 100. Agricultural lime (Ag lime), primarily Calcite Lime ($CaCO_3$), is the most common liming material. If the soil's magnesium content is medium or low, dolomitic limestone [$CaMg(CO_3)_2$] should be applied. Ideally, incorporate liming materials into the soil 3 to 6 months before planting. It's also important to consider the soil's buffer pH and avoid overliming, as this can induce deficiencies in micronutrients and phosphorus.

3. For consistent results, soil samples should be collected every two to three years, ideally at the same time of year and submitted to the same laboratory. Collecting multiple soil samples per field or grid using a soil probe is the preferred method. In Louisiana, it is common practice to take 0–6 inch core samples and send them to a lab that utilizes the Mehlich-3 extraction method. The LSU AgCenter fertilizer recommendations are specifically based on analyses of 0–6 inch core samples using the Mehlich-3 extraction method.

4. Generally, a yield response to fertilizer application is anticipated when soil-test nutrient concentrations fall below critical levels. The likelihood and extent of yield increase from fertilization are inversely related to how far the soil-test nutrient concentration is below this critical threshold. Research has established reliable critical concentrations for soil test levels of phosphorus (P), potassium (K), sulfur (S), and zinc (Zn). It's important to note that these critical nutrient concentrations and the corresponding application rate recommendations may be slightly adjusted based on ongoing research and should be considered approximate. For phosphorus (P), the critical level ranges from 25 to 35 ppm P (equivalent to 50 to 70 lbs P per acre), with a recommended application rate of 40 to 90 lbs P_2O_5 per acre. For potassium (K), the critical level is between 100 and 130 ppm K (200 to 260 lbs K per acre), and the recommended application rate is 60 to 120 lbs K_2O per acre. The critical level for sulfur (S) is 10 to 15 ppm S (20 to 30 lbs S per acre), with a recommendation of 10 to 20 lbs S per acre. For zinc (Zn), the critical concentration is 1.5 to 2.5 ppm Zn (3 to 5 lbs Zn per acre), and the recommended application rate is 5 to 10 lbs Zn per acre.

5. Micronutrient application recommendations are generally highly dependent on soil pH. Soils with high pH (above 7.0 – 7.5) may require applications of most micronutrients, except for molybdenum. Molybdenum application is recommended for soils with a pH below 6.0-6.2. Recommended critical concentrations for some micronutrients include 0.5 ppm (equivalent to 1 lb per acre) for both boron and copper, 25 ppm (50 lb per acre) for manganese, and 50 ppm (100 lb per acre) for iron.

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6. In soils with a pH below 6.2, it is recommended to apply the micronutrient molybdenum, which is essential for the nitrogen fixation process in soybeans. Molybdenum deficiency can be addressed through soil application (2 oz/acre as a band within seven days of planting) or foliar application (0.25 oz/acre at the R1 growth stage). If a *Bradyrhizobia japonicum* inoculant is planned, apply the molybdenum to the soil or as a foliar spray separately from the *Bradyrhizobia japonicum*. Applying molybdenum directly to the seed in conjunction with the inoculum can reduce the viability of the bacteria. Additionally, sulfate (SO_4^{2-}) fertilizer application can potentially decrease molybdenum uptake by the plant.

7. While not always strictly necessary, annual inoculation with a viable *Bradyrhizobia japonicum* bacteria inoculum is generally recommended. It is especially important to inoculate soybean seed if soybeans have not been cultivated in the field for three or more years.

8. Soybean plants require macronutrients nitrogen (N), phosphorus (P), and potassium (K) in substantial amounts. Typically, nitrogen fertilization is not needed due to the plant's ability to fix atmospheric nitrogen. The total phosphorus uptake (as P_2O_5) ranges from approximately 0.9 to 1.0 lbs per bushel, with 0.74 to 0.80 lbs of P_2O_5 being removed in the harvested grain. For potassium (as K_2O), the total uptake is about 2.3 to 2.5 pounds per bushel, with 1.17 to 1.5 lbs of K_2O removed in the grain. Therefore, a 50 bushel per acre soybean crop will utilize approximately 45 to 50 pounds of P_2O_5 (with 37 to 40 pounds removed at harvest) and 115 to 125 lbs of K_2O (with 59 to 75 pounds removed at harvest). A 100 bushel soybean crop would require and remove roughly double these amounts. To at least maintain soil nutrient levels, fertilizer should be applied annually at the rate of nutrient removal. Given the significant quantities of macro and secondary macronutrients needed by soybeans, addressing soil content deficiencies is generally more effectively done through soil-applied fertilizers.

9. Soybean plants utilize and remove the secondary macronutrients sulfur (0.21 lbs used and 0.16 lbs removed), magnesium (0.51 lbs used and 0.16 lbs removed), and calcium (0.96 lbs used and 0.12 lbs removed) per bushel, at lower rates compared to nitrogen, phosphorus, and potassium. While deficiencies in these nutrients are less common, sulfur deficiency is becoming an increasing concern in some areas.

10. Soybean plants utilize and remove significantly smaller amounts of micronutrients (ranging from 0.001 to 0.006 lbs per bushel used and 0.001 to 0.002 lbs per bushel removed). Due to the relatively small quantities required, plant deficiencies in micronutrients can often be corrected more readily than deficiencies in macro and secondary macronutrients. Furthermore, soil deficiencies in certain micronutrients can frequently be resolved by adjusting the soil pH to the optimal range.

11. Prior research suggests that spring applications of phosphorus and potassium, when incorporated and followed by rehipping, can enhance yield potential compared to fall applications. This is particularly true for soils susceptible to nutrient losses through runoff, leaching, erosion, and fixation. However, research has shown no significant yield difference between spring and fall applications when spring applications are not incorporated and rehipped. In soils with chloride toxicity issues, it is advisable to apply potassium fertilizer (which may contain chloride) in the fall. This allows winter rainfall to leach and reduce the chloride concentration in the soil. Furthermore, if soil chloride levels are consistently high, selecting soybean varieties known to be tolerant to chloride is recommended.

12. Contact your county agent for additional information and help in your fertilization program. The agent also receives a copy of this report for the parish office files.