Soybean Fertility

**KEY POINTS**

- Maximum soybean yield potential is influenced by maintaining soil fertility.
- Soil tests should be performed at least every two to three years to confirm existing nutrient levels.
- An inoculant should be seed-applied if a field has not been planted to soybean in the previous three to five years.

**What to Watch For**

Maximum soybean yield potential depends greatly on maintaining soil fertility. Realistic yield goals in conjunction with other agronomic factors and estimated nutrient removal by crops are important considerations for maintaining adequate fertility.

A soil test can indicate if a field or area of a field requires additional fertilizer to help maximize crop growth. When soil test values are below a critical level, which indicates nutrient deficiency, appropriate build-up fertilizer should be applied to increase soil nutrient levels. In addition, fertilize for the amount of nutrients removed by the crop, which is often referred to as maintenance or crop removal fertilizer applications. Soil sampling should be performed every two to three years and sampling should be done at the same time of year as previous efforts. Soil tests should include an analysis for macronutrients, micronutrients, buffer pH, organic matter, and cation exchange capacity.

**Impact On Your Crop**

**Soybean Nutrient Requirements.** Macronutrients required by soybean include nitrogen (N), phosphorus (P), and potassium (K). Each harvested soybean bushel removes approximately 3.3 lb of N, 0.73 lb of P₂O₅, and 1.2 lb of K₂O (Table 1). Additional nutrients that aid plant growth include calcium (Ca), magnesium (Mg), iron (Fe), boron (B), manganese (Mn), zinc (Zn), copper (Cu), molybdenum (Mo), and sulfur (S). Deficiency symptoms may appear if any of the essential or secondary nutrients are limited. For example, photosynthesis, N-fixation, and protein/enzyme synthesis are dependent on B, Ca, Fe, S, and Zn. As yields increase, nutrient removal rates increase (Table 2). A portion of the required nutrients for these yield levels come from soil reserves and the remainder comes from fertilizer applied prior to critical stages of plant growth.

**Soil pH.** Soil pH influences nutrient availability and should be maintained at or above 6.0 for soybean production. N and P are most available to soybean at pH levels between 5.5 and 7.0. In low pH soils, important macronutrients (N,P,K) and primary secondary nutrients (S, Ca, Mg) may become less available to growing plants (Figure 1).

Iron is necessary for nodule formation and function, and when deficient can result in reduced nitrogen fixation. Iron can become unavailable at high soil pH levels, generally above 7.0, and may result in iron deficiency chlorosis (IDC). IDC symptoms exhibit chlorosis (yellowing) between the leaf veins. Generally, the yellowing will be more pronounced on new growth because this nutrient is not mobile within the plant. High pH soils have high levels of calcium iron molecules which become tightly bound to soil particles and are not released for plant availability.

### Table 1. Nutrient Removal (lbs/bu)*

<table>
<thead>
<tr>
<th>Crop</th>
<th>N</th>
<th>P₂O₅</th>
<th>K₂O</th>
<th>S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soybean Grain</td>
<td>3.30</td>
<td>0.73</td>
<td>1.20</td>
<td>0.18</td>
</tr>
<tr>
<td>Corn Grain</td>
<td>0.67</td>
<td>0.35</td>
<td>0.25</td>
<td>0.08</td>
</tr>
</tbody>
</table>


**Figure 1.** Nutrient availability based on soil pH. The wider the “nutrient bar” indicates increased plant availability. Source: Illinois Agronomy Handbook. Permission to use granted by Dr. Emerson Nafziger, University of Illinois.
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plant uptake. Iron deficiency is difficult to correct because the soil binds any additional iron and too high of a soil application rate can become toxic to the plant. Seed product selection is the most important management option for IDC. Applying a liquid iron chelate fertilizer with the seed at planting may reduce incidence.

Nitrogen Fixation. Soybean plants have a symbiotic (mutually beneficial) relationship with a specific bacteria (*Bradyrhizobium japonicum*), which allows them to produce nitrogen in root nodules. The soybean plant provides nutrients and a protective growing environment for the rhizobia. In return, the rhizobia “fix” nitrogen from the air into ammonia, which can be used by the soybean plant. Soybean plants will also utilize residual N mineralized from soil organic matter. Soybean will obtain 25 to 75 percent of needed nitrogen from the soil with the balance supplied by rhizobia nodules. *B. japonicum* is specific to soybean and will not fix nitrogen in any other legumes. Likewise, the rhizobial species that fix nitrogen for alfalfa or other legumes will not nodulate and fix nitrogen on soybean. In order for nodules to form and produce N, the soil must contain a healthy supply of rhizobia. If soybean has not been grown in a field for three to five years, an inoculant containing *B. japonicum* should be applied to the seed. Inoculated seed and inoculants must be handled with care as the living organism can be killed by desiccation, direct sunlight, heat, caustic fertilizers, and pesticides.

**Table 2. Nutrient Removal (lbs/acre) by Soybean Yield (bu/acre).**

<table>
<thead>
<tr>
<th>Soybean</th>
<th>P₂O₅</th>
<th>K₂O</th>
<th>S</th>
</tr>
</thead>
<tbody>
<tr>
<td>45 bu/acre</td>
<td>32.9</td>
<td>54.0</td>
<td>8.1</td>
</tr>
<tr>
<td>55 bu/acre</td>
<td>40.2</td>
<td>66.0</td>
<td>9.9</td>
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<tr>
<td>65 bu/acre</td>
<td>47.5</td>
<td>78.0</td>
<td>11.7</td>
</tr>
<tr>
<td>75 bu/acre</td>
<td>54.8</td>
<td>90.0</td>
<td>13.5</td>
</tr>
</tbody>
</table>

*Nutrient removal amounts may vary regionally depending on growing conditions. Use locally available data whenever possible.


Tips To Manage

Lime Application. Lime neutralizes soil acidity and adds Ca, a nutrient essential to plant growth. Soil pH indicates the level of acidity or alkalinity, while buffer pH is used to determine, if needed, the rate of lime application. Lime takes time to dissolve in the soil and neutralize acidity, so you should apply lime about 3 to 6 months before planting. Applying in the fall provides plenty of time for the lime to dissolve in the soil profile before the next growing season. Lime should be applied and incorporated a month or more before adding fertilizers, since it can interfere with the availability of other nutrients, especially P. You should pay particular attention to the different sources of liming material. Differences among products in their neutralizing efficiency (calcium carbonate equivalent and particle size) will influence optimum application rates.

Foliar Fertilization. Nutrient deficiencies that are identified during the growing season may be partially corrected by foliar nutrient application. Application should be done at lower rates and not during very warm parts of the day as plant tissue damage can occur. Some studies indicate that by spraying the soybean canopy between beginning seed (R5) and full seed (R6) growth stages; yield potential could increase. However, many on-farm trials showed that foliar fertilizer application produced inconsistent results, and even decreased yield in some areas. Iowa State University research, conducted across several locations and years, indicated there is a low probability of foliar fertilizers increasing yields. Foliar fertilization of soybean with macronutrients at early vegetative stages is likely to increase yield in 15 to 20% of the cases in Iowa. This research has shown no consistent difference between products, rates, or frequencies of application tested. However, in nutrient-limited conditions such as on sandy soils or highyielding fields that are irrigated, these products may be beneficial as the plant may not gain enough nutrients from the soil.

Sources:

9. Web sources verified 020718. 131001060140 020618TAM

Performance may vary, from location to location and from year to year, as local growing, soil and weather conditions may vary. Growers should evaluate data from multiple locations and years whenever possible and should consider the impacts of these conditions on the grower’s fields.

ALWAYS READ AND FOLLOW PESTICIDE LABEL DIRECTIONS. 131001060140 020618TAM

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