



Fertility Management of Soybeans

Introduction

Soybeans are an annual crop grown in New York State for grain production. The acreage planted to soybeans has more than tripled over the past 15 years. Soybeans are typically planted from early May to mid-June and are harvested in October as weather conditions allow. Nutrient management is key for optimal production and minimal environmental losses. This factsheet provides an overview of pH, nodulation, nitrogen (N), phosphorus (P), potassium (K) and sulfur (S) needs and management of soybeans in New York State.

pH

The optimal pH for soybeans is 7.0. Lime application is recommended when the soil pH in the top 8 inches of the soil profile drops below pH 6.7. This reduces the negative effects of low pH on nodulation, and increases the efficiency of fertilizer use (see Agronomy Factsheets 5-7, 48, and 54 for more information on pH management).



Figure 1: Healthy soybeans.

Nodulation

Soybeans have a symbiotic relationship with a bacterium called *Bradyrhizobium japonicum*. The bacterium has the ability to fix atmospheric N and make it available to the soybeans. The bacteria colonize in the root hairs and make small swellings called nodules. It is recommended to use seeds inoculated with the proper bacterium to ensure a healthy

population for optimal N fixation. This is especially important in fields with no prior history of soybean production. Seeds can be inoculated with a liquid, granular or powder inoculant which can be added by the seed company or done at the farm. Many factors can decrease nodulation including low pH, P or S deficiency. Proper inoculation of soybean seeds and good soil fertility are two important factors for optimizing soybean yields.

Nitrogen (N)

Nitrogen deficiency shows up on older leaves as a yellowish-brown discoloration. Symptoms may appear in the early season (V2-second trifoliolate or V3-third trifoliolate), usually in early to mid-June in New York State. An N deficiency is usually the result of poor or no nodulation, as healthy and active root nodules will supply the N needed by the soybean plants. Poor nodulation can result from several factors including wet or extremely dry soil conditions, low pH and pest issues such as root rotting fungi. Unhealthy nodules will be brown in color compared to healthy nodules which are pinkish red inside.

When nodulation is uninhibited, application of fertilizer N is not necessary. However, N can be applied at up to 20 lbs/acre without any harm to the crop or its ability to fix N at a later stage. Larger applications of N can delay nodulation and decrease N fixation. In-season foliar application of N may potentially decrease yields and is not recommended.

Phosphorus (P)

Phosphorus is very important for the growth and development of soybeans. As mentioned, N fixation can be reduced and delayed if the plant is unable to take up enough P in early growth stages. The availability of P is reduced when the soil pH is low so it is important to maintain a pH of 6.7-7.2. Phosphorus deficient soybeans are dark green to bluish-green in color and may look stunted. Soil testing before planting is the best way to determine P requirements.

Phosphorus fertilizer should be applied if the soil test indicates the potential for a response. Cornell P fertility guidelines are based on the Morgan soil test (see Agronomy Factsheet 15). If the soil test indicates that P is needed (Table 1), P fertilizer should be applied prior to (broadcast and incorporate) or at planting (as a starter). If applied as starter, place 25 lbs P₂O₅/acre in the band; the rest can be supplied as a broadcast application (or with manure). Placing fertilizer in contact with the seed (“Popup” fertilizers”) is not encouraged as it increases risk for salt injury.

Table 1: Cornell phosphorus (P) guidelines for soybeans.

Soil test P (lbs P/acre)	Recommendation (lbs P ₂ O ₅ /acre)
<1	50
1	45
2	40
3	35
4	30
5	35
6-39	20
40 or more	0

Potassium (K)

Soybeans require large amounts of K for optimal plant growth and nutritional balance. Deficiency symptoms of K occur in the oldest leaves during the early stages of growth. Symptoms begin as a yellowing around the leaf margins that turns brown with time while the veins remain green. If soil test results indicate that a K deficiency is likely, K application prior to or at planting is recommended (Table 2). Potassium chloride (“muriate of potash”) is the most common K fertilizer.

Table 2: Cornell potassium (K) guidelines for soybeans.

Soil test K (lbs K/acre)	Recommendation* (lbs K ₂ O/acre)		
	Soil management group		
	1,2	3	4,5,6
<60	40	40	60
60-79	20	40	60
80-99	20	20	60
100-149	20	20	40
150-199	0	20	20
200-269	0	0	20
>269	0	0	0

* See Agronomy Factsheet 19 for more information on Soil Management Groups.

Sulfur (S)

Sulfur deficient soybeans are pale green with the youngest leaves on top showing more yellowing. Sulfur deficient plants look stunted. These symptoms are very similar to N deficiencies but S deficiencies will occur in the youngest leaves. Sulfur availability is often dependent on the rate of mineralization of organic matter as this is a large source of S. Sulfur is less mobile in low pH soils; one more reason to manage soybeans fields for optimal pH. When a response to S is expected, S containing fertilizers (such as gypsum or ammonium sulfate), applied at planting, can help prevent a yield reduction. Crop S removal ranges from 5 to 10 lbs S/acre for yields ranging from 30 to 60 bu/acre so if an S deficiency is expected, an application of up to 20 lbs S/acre will be sufficient.

Summary

Soybeans grow best at a soil pH of 7.0 and seed inoculation should be a standard procedure on all farms regardless of field history. When nodulation is uninhibited, application of fertilizer N is not necessary. To ensure optimum yield, P, K and S should be applied when needed, at the proper time, using the right method and application rate.

Additional Resources

- o Nutrient Guidelines for Field Crops in New York: nmsp.cals.cornell.edu/guidelines/nutrientguide.html
- o Nutrient Management Spear Program Agronomy Fact Sheet Series: nmsp.cals.cornell.edu/index.html

Disclaimer

This fact sheet reflects the current (and past) authors’ best effort to interpret a complex body of scientific research, and to translate this into practical management options. Following the guidance provided in this fact sheet does not assure compliance with any applicable law, rule, regulation or standard, or the achievement of particular discharge levels from agricultural land.

For more information



Cornell University
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Nutrient Management Spear Program
<http://nmsp.cals.cornell.edu>

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2012