Crop Information

This content is only available in English.

Nitrogen on Soybeans, Does it Work?

Nitrogen on Soybeans, Does it Work?

The combination of high protein and high oil content in soybeans makes the assimilation of nitrogen critical to achieve maximum yields.

When designing a fertility program for soybeans keep in mind that they use less than 50% of their Nitrogen from N2 nitrogen sources. N2 nitrogen is the form of Nitrogen that is produced by rhizobia bacteria that live in a symbiotic relationship with the plant. These bacteria form nodules on a soybean root shortly after root hairs are present. The roots secrete substances, which promote rapid growth of soil bacteria including rhizobia bacteria, therefore anything that affects or kills bacteria in the environment will reduce the amount of nodulation.

Anything that restricts oxygen at the root surface will reduce the efficiency of the rhizobia to produce N2. Flooded soils, compacted soils or soils with a low organic matter and high CEC will have a significant effect on N2 production. Dry soil around the nodules is not detrimental to the production of N2 as long as the deeper roots can pick up sufficient moisture required for plant growth. However if moisture is restricted and nodules dehydrate they will not recover once moisture is regained.

Physioligical Factors Effecting Yield

TEMPERATURE: Temperature plays a major role in soybean production. Rhizobia fixation of N2 and nutrient assimilation throughout the season is affected by day and night time temperatures of which we do not have much control. However there are a few temperatures that are important to maximize the production so that we can have some influence on.

It is important to plant soybeans as early in the season as possible so that they will have a long enough period to fill the pods. The varieties that we grow in Ontario are not as day length sensitive as varieties that are grown further South, but they are still sensitive to temperature. As long as nutrients are adequate a soybean will continue to fill pods until air temperatures at night reach 44 degrees F or 6 degrees C. This can happen in early August in some years, therefore it is important to plant as early as possible in the spring so that this pod filling time can be maximized.

Another reason for early planting is that the soybean is very sensitive to high temperatures during flowering. Daytime temperatures of 86 degrees F or 30 degrees C will cause flower abortion.

Early planting can also create early season problems, as we risk the threat of frost and the soybean seed will not germinate until the soils temperature reaches 40 degrees F or 5 degrees C. Planting in soils colder than this will subject the seed to rots that will lower plant counts reducing yield.

Seed quality also plays a role when planting in cold soils, and that is that a low moisture seed is much more prone to rot in colder soils. A seed with moisture of less than 13% is more prone to rot and will have poor germ in very cold soils. If soils are less that 5 degrees C and seed less than 13% moisture this seed may not survive.

In order to get the longest growing period for soybeans to maximize yield potential we must weigh the risks of cold soils and frost.

Fertility Requirements and Nutrient Uptake by Soybean

The following table lists the nutrients required to grow a crop of soybeans. It used to be thought that a soybean crop did not respond to added fertilizer. Understanding the physiology of the soybean and nutrient requirements combined with better varieties and management practices, fertility levels have become an important yield determining factor. Table #1 shows what an average soybean crop would remove per bu. of yield.

Table #1

Nutrients removed pounds per bu			
	N	P	K
Soybeans	4.2	0.9	1.5
Straw	1.3	0.3	0.9
Total	5.5	1.2	2.4

A 45-bu. crop of beans would therefore remove 250 pounds of N2 , (125 pounds produced by rhizobia and 125 to come from other sources), 54 pounds of P, and 108 pounds of K.

Prior to flower initiation and seed set the soybean plant will take up 60% of the total N required by the plant, 55% of the P and 60% of the K. The final grain crop contains 68% of the total N, 73% of the total P and 56% of the total K absorbed. Therefore a major source of nutrients during seed filling comes from the stem, leaves and petiole. The competition for carbohydrates during pod filling can virtually stop root growth and hence nutrient uptake by the root system. This competition for carbohydrates and the sink demand also has an effect on the rhizobia and N2 production after pod initiation drops off. Research work with foliar feeding of N and B by the University of Georgia 1988 to 1992, has shown significant response to Nitrogen at this time. (see table #2)

Table #2

Nutrients Applied	Yield, Bu/Ac	
	Bonifay	Greenville
Check	37.8	38.3
N	44.3	40.7
B	38.9	43.6
N+B	46.0	42.2
Bonifay is sand, Greenville is a sandy loam		

Foliar feeding at this time will benefit the plant by supplying nutrients to the foliage for translocation to the pod plus increasing the root activity. Field trials have shown that supplemental foliar feeding of N during rapid pod filling may help supply carbohydrates to the plant so that the sink demand does not totally restrict carbohydrates to the root and some activity will still take place. These small amounts of Nitrogen also have been shown to stimulate symbiotic fixation probably also due to the fact that some nutrients and carbohydrates are getting to the roots.

Another time when minor amounts of N are required is during nodule initiation in the early spring when N2 is minimal. During this period there is an apparent decrease in the plant growth rate, which is attributed to the carbohydrate demands for nodule initiation. This is why when planting soybeans 10 - 20 pounds per acre is usually recommended.

Research work has also shown that over application of Nitrogen prior to planting can have a negative effect on yield. This is primarily due to the fact that too much available NO3 in the soil during nodulation will actually inhibit nodulation. High levels of NO3 in and around the infection site will reduce the size and number of nodules on the root system therefore reducing the amount of fixed nitrogen.

Placement of Nitrogen below the nodules or fertilization 3 - 5 weeks after nodulation has no negative effect on nodule development or activity.

The demand by the plant from the point of flowering to that of rapid pod filling increases the efficiency of N2 fixation due to the increase in sink demand and requirements for carbohydrates by the flowers. If plant nutrient levels are good going into flowering the efficiency of the nodules to produce N2 and meet these demands will be greater.

Since the nutrient status is so critical prior to rapid pod filling it is essential that the plant nutritional condition is excellent going into this stage of growth for maximum production.

Earlier research done at the University of Guelph, Elora Research Station, also showed a response to added Nitrogen during the flowering stage. This study was designed to compensate for the demand for Nitrogen at flower initiation so that the soybean plant would not abort as many flowers and would increase yield potential.

Remembering that the soybean plant required around 250 pounds of Nitrogen to grow a 45 bu crop and that it is only capable of producing 50% we know that 125 pounds would have to come from other sources.

Application of Nitrogen up front prior to planting would only reduce to the N2 supplied Nitrogen and therefore we would still have a deficit.

In theory if we could supply Nitrogen to augment the N2 nitrogen we would be able to reduce the amount of flower abortion and supply Nitrogen to stimulate N2 during rapid pod filling and on into maturity.

The timing in this trial was to be 1 week prior to flower initiation. Mulch was also applied to see if warming the soil increased germination and early plant growth. (see table #3)

Table #3

Treatment			
	Date of Maturity	Yield	Moisture
Control	9 - 30	39.2	19.4
Urea	9 - 28	46.4	18.9
Mulch	9 - 28	42.0	20.6
Urea + Mulch		47.1	20.7

The Nitrogen source that was used was urea at 150 kgN/ha. This was banded at first flower. The timing on this trial was later than was intended. Results showed there was no significant yield response to the mulch, but the nitrogen response was significant at 19 to 20%.

Recently a number of growers have tried an application of nitrogen at this time with varied response. (See table #4)

Table #4

Treatment	Yield Response
On Farm Average	45 bu/ac
Ammonium Nitrate	55 bu/ac
Ammonium Nitrate	67 bu/ac

This grower since 1984 has applied some nitrogen to his beans and usually averages 10 bu/ac better. In one year he got 20 bu/ac more beans with this application.

Table #5

Treatment	Yield Response
On Farm Average	40 bu/ac
Ammonium Nitrate	45 bu/ac

All these trials are on field scale and reported results based on field averages.

Some growers that have tried this have not reported yields and have not measured the results. Every year more and more growers report a trial and some with success and others with no difference. The conclusion from this is that N2 is only one of the limitations.

Other environmental factors can cause yield reduction or no response to added Nitrogen. Planting late to take advantage of long pod filling or soil conditions that restrict uptake of other nutrients and Nodule performance.

Soils that are poor in nutritional levels of other nutrients such as P, K or pH may not economically benefit from this program. It is not the intent of this author to promote the fertilization of soybeans with Nitrogen, however it is the intent to stimulate progressive thought towards management practices we can put in place to increase our returns per acre.