Dry Bean Fertility

Dave Franzen
NDSU Soil Science Specialist

Dry bean is responsive to fertilizer when soil levels are inadequate to support yield levels possible with existing soil moisture and growing season climatic conditions. If soil levels are less than adequate, dry bean may respond to nitrogen (N), phosphorus (P), potassium (K) and zinc (Zn) in many northern Plains soils.

Soil testing is recommended to determine the probability of crop response to fertilizer amendments. Soil test cores should be taken at 0 to 6-inch and 6- to 24-inch depths. N is analyzed on both core depths, and P, K and Zn are analyzed on the 0 to 6-inch depth. Salt levels on both depths may be analyzed if producers have a reason to suspect a salt problem. Soil pH may be determined on the surface and subsurface depth if producers anticipate iron deficiency chlorosis problems.

Phosphorus

Soil test levels indicating medium levels and lower would be expected to respond to P fertilizer. P fertilizer may be broadcast or banded. Banded rates of P in the very low or low range may be reduced by one-third from Table 9 recommendations because the broadcast recommendations also include

Table 9. Phosphorus recommendations for dry bean.

Analysis	Soil Test Phosphorus, ppm				
	VL	**L**	**M**	**H**	**VH**
Bray P1	0-5	6-10	11-15	16-20	21+
Olsen	0-3	4-7	8-11	12-15	16+
	lb P_2O_5/Acre to be applied				
	45	30	20	10	0

extra buildup fertilizer useful in long-term fertility programs. Reducing the rates will not result in long-term improvement of soil P fertility but may increase short-term profitability in the current crop year. Phosphorus should be applied as recommended in Table 9.

Banded P should not be placed in contact with the seed. In fact, **no fertilizer should be placed in contact with the seed, with the exception of 1 to 2 quarts/acre of zinc chelate or ammoniated zinc complex**. The fertilizer band should be placed with at least 1 inch of complete separation from the seed. A band 2 inches to the side and 2 inches below the seed is used very commonly.

Potassium

Potassium seldom is required in most northern Plains soils; however, soil samples should be analyzed to determine the probability of response. A medium K level or lower may respond to K fertilizer. Lower K levels may be found on sandy ridges in the region. The rate of K recommended at different K soil test levels is shown in Table 10. K fertilizer may be broadcast or banded. Banded K should not be placed with the seed. At least 1 inch of separation between seed and fertilizer is required.

Table 10. Potassium recommendations for dry bean.

Soil Test Potassium, ppm		
VL 0-40	**L** 41-80	**M** 81-120
—— lb K_2O/Acre to be applied ——		
50	20	0

Nitrogen and Inoculation

Many legumes have the ability to fix N from the air without the use of commercial fertilizers if inoculated with nitrogen-fixing bacteria. The N-fixing bacteria for dry bean are called *Rhizobium phaseolus*, and they are specific for dry bean. Inoculants used for soybean or pea are different and will not infect dry bean roots.

Unfortunately, the relationship between dry bean and *Rhizobium phaseolus* is not strong. Dry, hot weather, short periods of soil water saturation and cold weather all will result in sloughing off of nodules, so achieving high dry bean yields consistently using inoculation for an N source may be difficult.

In the last 20 years, researchers in North Dakota and Minnesota have conducted more than 30 site-years of N-rate trials on dry beans. Using an N cost of 30 cents per pound and a dry bean price of 20 cents per pound, the return to N in inoculated trials was mostly negative for N rates above 40 pounds/acre.

From these data, inoculated trials did not benefit from N rates greater than 40 pounds/acre. This included trials in which yields increased up to 100 pounds of N/acre. Fertilization at rates more than 70 pounds/acre provided little economic advantage. Risks of later maturity, and increased incidence and severity of white mold disease, would favor 70 pounds/acre rates over higher N rates.

The most economic N rate was not related to yield potential. Therefore, no scale of yield potential is made in dryland dry bean N recommendations for maximum economic production. In years when environmental conditions favored higher yields, the conditions also favored increased organic matter mineralization and more efficient uptake of N by the dry beans.

N recommendations for dryland dry edible beans:

- **Inoculated:** 40 pounds/acre less STN (soil test N to a depth of 2 feet)
- **Noninoculated:** 70 pounds/acre less STN.

Irrigated Production

Most irrigation is sited on well-drained, coarser-textured soils. Inoculation has not been found adequate for supporting higher yields of dry beans produced under irrigation, especially with high-yielding cultivars such as navy beans.

Therefore, supplemental N is very important to achieve the high yield potential in irrigated fields. Not only is supplemental N encouraged, but split applications of N are encouraged to increase N efficiency and prevent N leaching.

The formula for N recommendations under irrigation is:

N recommendation = YP X 0.05 –STN-PCC,

Where YP is the yield potential (in lb) based on past history of the grower or field,

STN is the soil test N acquired in fall or spring to a depth of 2 feet,

PCC is the previous crop credit from a previous legume, sugarbeet tops or another N source such as a cover crop.

A small preplant application of N is advised, usually under 40 pounds of N/acre. The first supplemental N application can be a side-dressed ammonia, UAN or urea application before vining. Subsequent applications can be made through the irrigation system and completed before top pod fill begins.

Zinc

Dry bean is one of only a few crops in the region to respond regularly to zinc fertilizer in low-zinc soils. Soil test levels below 0.8 parts per million may respond to fertilizer zinc application. Zinc deficiency may be seen as bronzing, browning and death of leaf tissue, and stunting and poor vining. Zinc deficiency may be treated by foliar sprays of zinc sulfate, zinc chelate or ammoniated zinc solutions.

Zinc deficiency may be prevented with preplant or planter treatments of zinc sulfate, zinc chelates or ammoniated zinc solutions. A treatment of 3 to 5 pounds/acre actual zinc preplant incorporated as zinc sulfate may improve soil availability for several years.

Studies have shown that greater water solubility of the zinc source is important for zinc utilization by plants. A liquid starter such as a zinc chelate or ammoniated zinc complex can be applied. Rates as low as 1 pint/acre have shown effectiveness. Most grower rates range from 1 to 1.5 quarts/acre.

Application with water with the seed is preferred over the use of a liquid fertilizer. If the starter band is separated from the seed by at least an inch, the liquid Zn fertilizer may be applied with the liquid starter fertilizer, provided that a jar test shows that they are compatible when mixed together.

Iron Chlorosis

Dry bean is generally more resistant to iron deficiency chlorosis (IDC) than soybean, but IDC still can be seen in some fields under certain conditions. Iron chlorosis appears as interveinal yellowing of upper leaves in response to low available soil iron due to high levels of carbonate minerals with or without high levels of soluble salts.

Soil pH levels higher than 7.0 may be accompanied by high levels of calcium/magnesium carbonates in the soil. Carbonates dissociate in moist soils to form bicarbonate, which lowers the dry bean plant's ability to take up soil iron. Wetter soils contain higher levels of soluble bicarbonate than dry soils. Wetter soils also may contain higher levels of salts due to shallower soil water tables.

The combination of high levels of soil carbonates and salts has been shown to increase the level of iron chlorosis symptoms in soybean. A similar relationship also is likely for dry bean. Iron chlorosis may be minimized by planting cultivars showing tolerance and having a higher tolerance to salt. Iron sprays have performed inconsistently in the past but, if used, should be applied early in the season for best results. Late-season spraying after about the third true leaf would reduce effectiveness.

Iron sprays of ferrous sulfate or iron chelates have been used with limited success. Application of iron amendments with postemergence herbicides is not recommended. If a field has shown a history of IDC in dry bean, either avoid the field entirely or grow an IDC-tolerant cultivar and maybe plan to apply an ortho-ortho-EDDHA iron chelate such as Soygreen in furrow to help iron nutrition.

Salts

Dry bean is very sensitive to salt damage. Levels of salt (EC or electrical conductivity) higher than 1 millimho per centimeter as a 1-to-1 soil water extract begin to reduce yield. Salt levels are reduced by lowering water table levels. This is difficult to do in exceptionally wet years. Soil salts can be reduced through tile drainage, but in many areas of eastern North Dakota, the effect of sodium in inclusions in the field may be enhanced and certain areas rendered unproductive.

In the absence of tile drainage, lower salt levels are achieved by continuously cropping and introducing deep-rooting crops into the rotation. The use of cover crops before or after seeding in the rotation, or a roadside buffer of alfalfa strips, also may be helpful. See NDSU Extension Service publication “Managing Saline Soils in North Dakota” (SF1087) for more information.