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Fertilizing Pinto, Navy and Other Dry Edible Bean

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North Dakota is the leading producer of dry edible bean in the USA. North Dakota has the greatest acreage of pinto bean of any state, and significant acres of navy, black and several other types of bean as well.

Beans are a warm-season crop that prefers fertile, well-drained soils. Adequate, but not excessive, moisture during the growing season and a dry harvest result in high-yielding, high-quality beans.

NITROGEN

Dryland production

Nitrogen (N) nutrition is important to dry bean production not only to sustain high yields, but also because of quality concerns. Excessive N can delay maturity and encourage excessive leaf canopy growth, which may lead to increased disease incidence and severity in some years. Maturity delays and increased disease may result in a reduced market price for growers due to reduced quality.

Dry bean growers usually do not go in and out of the business as do growers of other commodities in the state. For that reason, most growers know what N fertilization strategy works best for them in their area and their soils.

Growers have used four main N fertilization strategies effectively:

- No inoculation or supplemental N
- Inoculation using a nitrogen-fixing bacteria at seeding
- Inoculation and supplemental N
- Supplemental N only

Some soils with coarse to medium textures and higher organic matter levels (in excess of 3 percent) that have been in a dry bean rotation for many years do not require additional inoculation or supplemental N fertilization. These soils encourage natural inoculation by N-fixing bacteria from previous years' bean production.

The efficiency of the bacteria in this environment is so great that they are able to provide all the N requirements of the dry bean without additional assistance. In relation to the entire state dry bean acreage, these soils are in a minority, but for individual growers, they are important.

Inoculation is inexpensive, compared with supplemental N fertilizer. The inoculation for dry bean is *Rhizobium leguminosarum biovar phaseoli*. However, some soil and environmental conditions limit the effectiveness of the inoculants.

Hot weather and wet soils can result in nodule abortion. Therefore, in areas that tend to be hot in June, such as west of Jamestown and along the Missouri River, inoculation may not result in consistent yields, compared with supplemental N.

Likewise, if fields have significant areas of fine-textured soils, inoculation may not result in adequate yields in wet years. Therefore, inoculation is more effective in medium- to coarser-textured soils that are well-drained and in the northern half of the state. Seed for first-year dry bean fields always should be inoculated.

In the last 20 years, more than 30 site-years of trials have been conducted by various researchers in North Dakota and northwestern Minnesota. Using an N cost of 30 cents/pound of N and a dry bean price of 20 cents/pound (lb), the return to N in inoculated and noninoculated trials was determined **(Figure 1)**.

From these data, inoculated trials did not benefit from N rates greater than 40 lb N/acre, including residual soil nitrate from soil testing. Noninoculated trials peaked at about 100 lb N/acre, but N fertilization at rates in excess of 70 lb N/acre provided little additional economic advantage.

Risks of later maturity and increased incidence and severity of white mold disease would favor the 70 lb N/acre rate instead of the 100 lb N/acre rate. The most economic rate was not related to yield potential or yield goal. Therefore, no scale of yield goal is made with N rate considerations in dryland production of dry bean.

In years when environmental conditions favor higher yields, the conditions also stimulate greater mineralization of N from organic matter and crop residues, resulting in higher N availability to support higher yields.

N Recommendations for Dryland Dry Bean

Inoculated – 40 lb N/acre less STN and previous crop N credits

Noninoculated – 70 lb N/acre less STN and previous crop N credits

(STN = Soil test nitrate from 2-foot depth cores)

Irrigated Production

Most irrigation will be on well-drained, coarser-textured soils. Inoculation has not been found to be adequate to support the very high yields often experienced in these fields, especially with high-yielding cultivars such as navy bean. Therefore, supplemental N is very important to achieving the high yield potential of these irrigated fields.

Not only is supplemental N encouraged, but splitting applications to increase efficiency and prevent nitrate leaching also is strongly recommended. The rate of

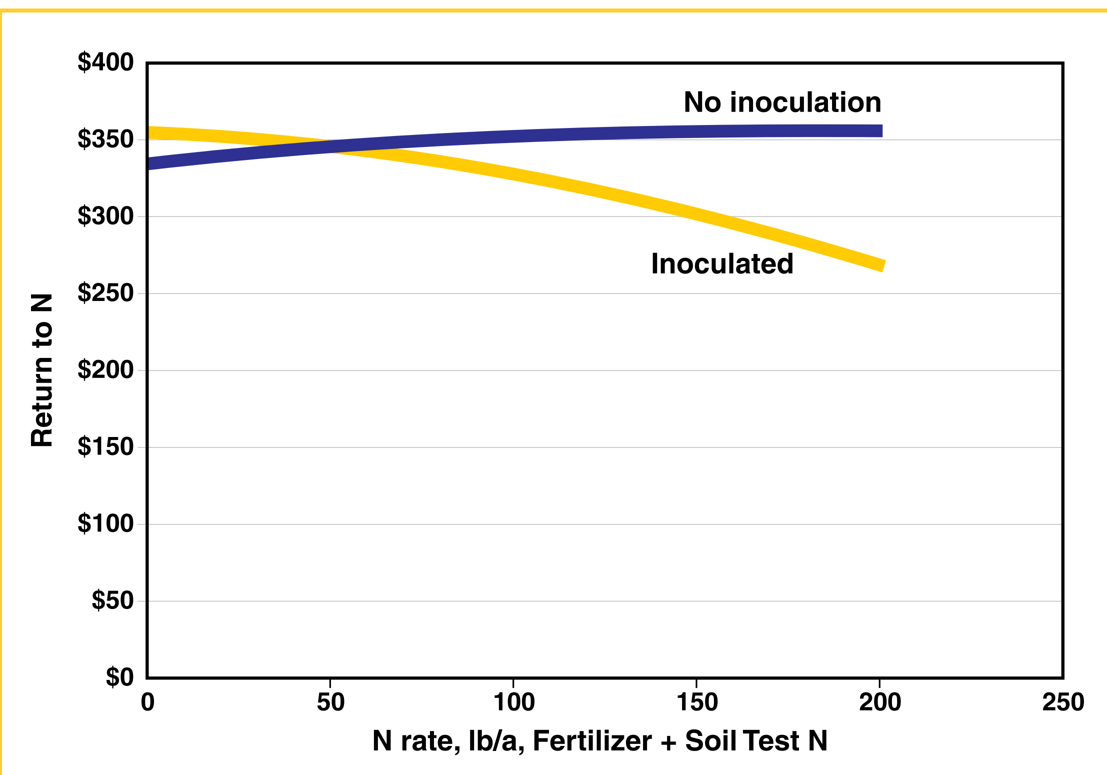

Figure 1. The economic return to supplemental N from more than 30 inoculated and noninoculated trials in North Dakota and northwestern Minnesota.

Cost of N at 30 cents/lb of N and dry bean price of 20 cents/lb.

Table 1. Previous crop credits.

Previous Crop	Credit lb N/Acre
Soybean	40
Grain legume crops (field pea, lentil, chickpea, faba bean, lupin)	40
Harvested sweet clover	40
Alfalfa that was harvested and unharvested sweet clover:	
>5 plants/sq. ft.	150
3 4 plants/sq. ft.	100
1 2 plants/sq. ft.	50
<1 plant /sq. ft.	0
Sugarbeet	
Yellow leaves	0
Yellow/green leaves	30
Dark green leaves	80

N for irrigated dry bean is 150 lb N/acre, with any supplemental N beyond the 150 lb N/acre rate directed by leaf analysis. The 150 lb N/acre rate includes preplant soil test nitrate-N and any previous crop credits. A small preplant application, usually under 40 lb N/acre, is advised.

The first supplemental N application can be side-dressed before vining. Subsequent applications can be made through the irrigation system and completed before top pod fill begins.

Second-year N Credits

Half of the N credit indicated for the first year for sweet clover and alfalfa is recommended, but no N credit is recommended after the second year for other crops.

PHOSPHORUS and POTASSIUM

At phosphorus (P) soil tests of medium and lower, and potassium (K) soil tests that are very low to low, yield increases have been found with the application of supplemental fertilizer. The degree of response was not related to yield. Therefore, the P and K in these recommendations reflect one broadcast rate for each nutrient.

Banded P or K

Dry bean is sensitive to salts and ammonium-containing fertilizers when placed too close to the seed. However, recent in-state research indicates that up to 2.5 gallons per acre of 10-34-0 based or low-salt based liquid starter fertilizer may be placed with the seed if the seedbed is moist and yield increases are very possible if soil test P is in the low to medium range. If the seedbed is dry at planting, liquid/dry starter with the seed will decrease germination and yield, so no with-seed fertilizer application is recommended in a dry seed bed. An ideal planting band application in dry seed-beds is placement in a 2-by-2 arrangement: 2 inches to the side and 2 inches at seed depth or below the seed.

With side-banded placement, P and K rates can be reduced about one-third from the recommended rate. Small rates of a product such as 10-34-0 (1 to 3 gallons/acre) have been applied successfully in some years with the seed, but in dry years, some stand injury has been reported; therefore, is not recommended as a standard practice.

Table 2. Phosphorus (P) and potassium (K) recommendations for dry bean, dryland or irrigated.

	Soil Test Phosphorus, ppm					Soil Test Potassium, ppm		
P Analysis	VL	L	M	H	VH	VL	L	M
Olsen	0-3	4-7	8-11	12-15	16+	0-40	41-80	81-120+
	------------------ lb P_2O_5 /acre ------------------					------ lb K_2O /acre ------		
Rate	45	30	20	10	0	50	20	0

ZINC

A soil test is a good guide for indicating the need for zinc (Zn). Soil tests below 1 ppm using the diethylenetriaminepentaacetic acid (DTPA) extraction method indicate a good probability of dry bean response to zinc fertilizer.

Broadcast rates of 3 to 5 lbs of actual Zn/acre as a soluble dry zinc product, such as zinc sulfate, usually are adequate to remedy a low Zn soil test. Zinc sulfate is an economic and effective zinc fertilizer, but roots avoid intact granules of zinc sulfate the first growing season, even in a band.

The first-year effectiveness of zinc sulfate can be improved by incorporating finer granules of zinc sulfate or the fall incorporation of zinc sulfate granules. If a liquid starter is applied in a 2 by 2 band, rates of zinc chelate or ammoniated zinc complex as low as 1 pint/acre have been effective in preventing zinc deficiency.

Foliar applications of zinc chelate products when the plants are small also have been used effectively. Do not apply foliar zinc products with herbicides or other plant protection products because of the chance of increased phytotoxicity to the crop or decreased efficacy to the pest.

IRON DEFICIENCY CHLOROSIS

Soils with carbonates near the surface, combined with wet soil conditions, and especially higher soluble salt levels, can result in iron deficiency chlorosis **(Figure 3)**. This condition is seen as interveinal yellowing and should not be confused with N deficiency.

Dry bean is generally more tolerant of the soil conditions that result in this problem. It usually is seen near ditch banks or edges of sloughs, where carbonates and salts are elevated.

Iron fertilizer sprays are available but have not alleviated the problem consistently. The severity usually is caused by wet soil conditions that increase soil bicarbonate levels. As soil dries, bicarbonate levels drop and affected plants usually green up. If a field has a known susceptibility to iron deficiency chlorosis, selecting varieties that have shown more tolerance to the conditions is recommended.

Figure 2.
Zinc deficiency in pinto bean.

Figure 3.
Iron deficiency chlorosis on a saline, calcareous soil near Arthur, N.D.

All photos by NDSU

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