

Fertilizing Pinto, Navy and Other Dry Edible Beans

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North Dakota is the leading producer of dry edible beans in the United States, with the greatest acreage of pinto beans of any state, and significant acres of navy, black and several other types of beans 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 yield and quality.

NITROGEN

Dryland production

Nitrogen (N) nutrition is important to dry bean production, not only to sustain high yields, but also because of the 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 reduced market price for growers due to reduced quality.

Dry bean growers usually do not go into 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 in their soils. Growers effectively have used four main N fertilization strategies:

1. No inoculation or supplemental N
2. Inoculation with a nitrogen-fixing bacteria at seeding
3. Inoculation and supplemental N
4. Supplemental N only

Some soils with coarse to medium textures and higher organic matter levels (more than 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 the 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. 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. Inoculation is, therefore, 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, various researchers in North Dakota and northwestern Minnesota have conducted more than 30 site-years of trials. Using an N cost of 30 cents/pound and a dry bean price of 20 cents/pound, 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 pounds of N/acre, including residual soil nitrate from soil testing. Noninoculated trials peaked at about 100 pounds of N/acre, but N fertilization at rates more than 70 pounds of N/acre provided little additional economic advantage. Risks of later maturity, and increased incidence and severity of white mold disease, would favor the 70-pound N rate over the 100-pound 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 beans. 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 beans

Inoculated – 40 pounds N/acre less STN

Noninoculated – 70 pounds N/acre less STN

(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 beans. Therefore, supplemental N is very important to achieving high yield potential of these irrigated fields. Not only is supplemental N encouraged, but split applications to increase efficiency and prevent nitrate leaching also are strongly recommended.

The formula for N recommendations under irrigation is:

$$N \text{ rec} = YP \times 0.05 - STN - PCC$$

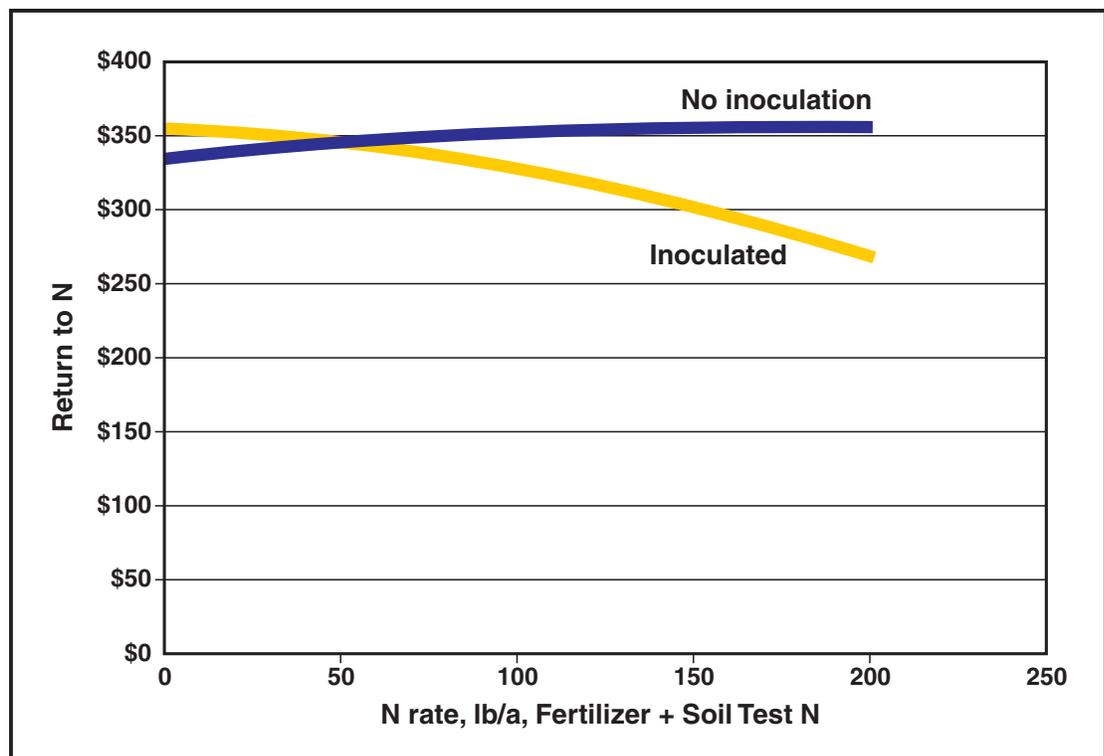
Where N rec is the total supplemental N recommended through the growing season

YP is yield potential based on historic yield in the field

STN is available soil test nitrate from preplant soil test

PCC is previous crop credit/previous rotational crop or crops

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/pound, dry bean price of 20 cents/pound.



A small preplant application is advised, usually under 40 pounds of N/acre.

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.

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 beans are sensitive to salts and ammonium-containing fertilizers when placed too close to the seed. The general recommendation is fertilizer should not be placed with the seed. An ideal planting band application is placement in a 2-by-2 arrangement: 2 inches to the side and 2 inches below the seed. With 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 successfully applied in some years with the seed, but in dry years, some stand injury has been reported, and therefore is not recommended as a standard practice.

ZINC

A soil test is a good guide for indicating the need for zinc (Zn). Soil tests below 1 part per million (ppm) suggest a good probability of dry bean response to zinc fertilizer. Broadcast rates of 3 to 5 pounds 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 intact granules of zinc sulfate are avoided by roots the first growing season, even in a band.

The first-year effectiveness of zinc sulfate can be improved by incorporation of finer granules of zinc sulfate, or 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 to 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.



Figure 2.
Zinc deficiency
in pinto beans.

P and K recommendations for dry bean, dryland or irrigated.

Analysis	Soil test phosphorus, ppm					Soil test potassium, ppm		
	VL	L	M	H	VH	VL	L	M
Bray P1	0-5	6-10	11-15	16-20	21+	0-40	41-80	81-120+
Olsen	0-3	4-7	8-11	12-15	16+			
Rate	lb P ₂ O ₅ /acre					lb K ₂ O /acre		
	45	30	20	10	0	50	20	0

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 beans generally are 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 3.
Iron deficiency chlorosis on a saline, calcareous soil near Arthur, N.D.

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