NebGuide
University of Nebraska–Lincoln Extension, Institute of Agriculture and Natural Resources
Know how. Know now.

G1713
(Revised April 2013)

Fertilizer Management for Dry Edible Beans

Gary W. Hergert, Nutrient Management and Soil Quality Specialist
James A. Schild, Extension Educator

Soil sampling and proper N fertilization of dry beans will help producers obtain consistent top yields.

Excellent yields of high quality dry beans can be obtained in western Nebraska. Traditional growing areas include the Panhandle and southwest Nebraska, western Wyoming, and eastern Colorado. High bean yields are produced on disease-free fertile soils. Dry beans respond to fertilizer if soil tests show nutrient levels in the low- to medium-fertility range.

Soil samples representative of the field should be taken preplant from the tillage layer (usually 0-8") for pH, phosphorus, potassium, zinc, iron, and salinity and to a depth of 30 inches for nitrate-nitrogen. Information from these tests allows the producer to make informed decisions on fertilizer needs and to determine the potential for any soil pH or salinity problems.

Nitrogen Recommendations

Dry beans are a member of the legume family and symbiotically fix nitrogen from the air. The nodules on the roots contain bacteria that fix nitrogen for plant use *(Figure 1)*. Inoculum containing the Rhizobium bacteria can be purchased and applied with the seed or to the soil in the seed furrow.

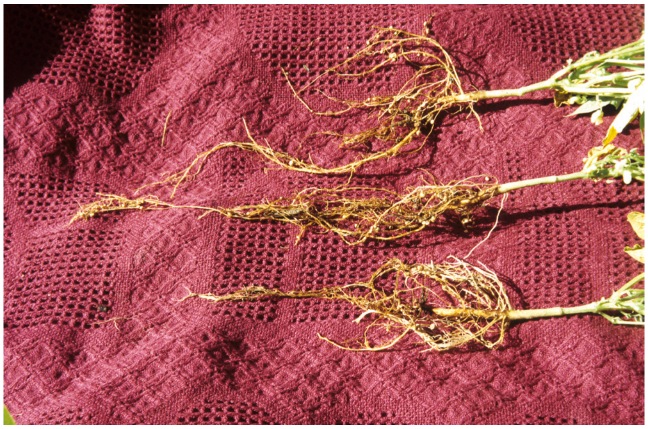

Figure 1. Nodules on dry bean roots.

If there is no history of dry bean production on the field, inoculation of the beans at planting time is essential. If dry beans recently were grown on the land and the beans were well-nodulated, inoculation is unnecessary.

Research in the Nebraska Panhandle has shown adding nitrogen fertilizer can increase seed yield if soil nitrate-N levels are low. Dry beans need 100 to 125 pounds of N per acre for top yields, in addition to N fixed by the plant. This additional N can be residual soil nitrogen, fertilizer nitrogen, nitrogen in irrigation water, nitrogen in manure, or a combination of these sources.

N rates based on residual nitrate-N are shown in *Table I.*

Table I. Nitrogen fertilizer suggestions for irrigate dry bean (2500-3000 lb/ac) yield.

Lb NO_3-N in 30 inches	*ppm NO_3-N in 30 inches*	*Fertilizer N - lb/acre*
0-20	0-2.2	100
21-40	2.3-4.4	80
41-60	4.5-6.7	60
61-80	6.8-8.9	40
81-100	9.0-11.1	20
>100	>11.1	0

Nitrogen rates can be reduced if the irrigation water has a high nitrate level. The pounds of nitrogen applied per acre foot of irrigation water is calculated by multiplying the parts per million nitrate-N in the irrigation water times the factor 2.72.

Surface irrigation water nitrate levels fluctuate over time but normally will be relatively low. During the irrigation season, nitrate levels in the North Platte River in western Nebraska range from 1.5 to 5.0 ppm nitrate-N. The median level was 3 ppm or 8 lb N/acre foot. Well waters show considerable difference in nitrate-N, so well water testing is recommended.

The use of nitrogen fertilizer for dry beans does have some limitations. Excessive N rates can delay maturity. The same effect is seen when planting dry beans in a newly plowed alfalfa field. Planting dates and/or varieties should be adjusted

Figure 2. **Dry beans on the right received 80 lb N per acre. Beans on the left received no N. Additional N promotes foliage growth which can enhance vulnerability to white mold.**

to compensate for the delayed maturity. Nitrogen fertilizer also will increase the amount of foliage produced *(Figure 2)*. This can be a serious problem in fields with histories of white mold. The incidence of white mold damage, when present, can be increased as much as 30 percent with nitrogen fertilization.

Phosphorus Recommendations

Dry beans respond to phosphorus fertilizer when soil test levels are low. Banding phosphorus is more efficient than broadcasting, consequently the application rate for banded P is one-half the broadcast rate. Banding improves P availability in cool, wet, or compacted soils. P fertilizers have relatively low salt indices, but contact between the fertilizer band and the seed should be avoided.

Different soil extractants are now being used by commercial soil testing laboratories to determine available P. Most research has been conducted on calibrating Bray-1 P with yield response. The following equations can be used to convert other extractants results to a "Bray-1 P equivalent."

For Mehlich 2: Bray-1 = 0.9 * Mehlich 2
For Mehlich 3: Bray-1 = 0.85 * Mehlich 3
For Olsen-P: Bray-1 = 1.5 * Olsen-P

Because most soils in the dry bean growing regions of the state are higher pH or are calcareous, the Olsen-P test is often used by growers. Phosphorus recommendations are given as an equation to more accurately accommodate computer controlled and GPS guided variable rate applications. This equation provides values similar to older tabular (stair step) values, is comparable to other High Plains (Colorado, Wyoming, Montana) dry bean P recommendations, and gives a better approximation of fertilizer needs over a wide range of soil test levels.

The following equation for phosphorus recommendations is suggested for dry beans:

P rate (pounds per acre) = 7 * (10 - Olsen-P test value).

A summary of average fertilizer recommendations for phosphorus based on the equation are shown in *Table II*.

Table II. Phosphorus recommendations for dry beans.

Phosphorus soil test method and critical levels			*lb P_2O_5/acre*	
Olsen-P	*Bray P-1*	*Mehlich 3*	*Banded P*	*Broadcast P*
0-3	0-5	0-6	30	60
4-6	6-10	7-12	20	40
7-9	11-15	13-18	10	20
≥10	≥16	≥19	0	0

Potassium Recommendations

In western Nebraska, where dry beans traditionally are grown, soils are very high in potassium. Dry beans have not shown a response to potassium fertilization on soils testing over 125 ppm K. Potassium recommendations are shown in *Table III*.

Table III. Potassium recommendations for dry beans.

Potassium Soil Test ppm K	*Potassium to Apply lb of K_2O/A*
0 to 40	60
41 to 74	40
75 to 124	20
>125	0

Zinc Recommendations

Zinc is the most common micronutrient deficiency of dry beans in Nebraska. Zinc deficiency can occur when the topsoil has been removed by leveling or erosion. Soils low in organic matter, compacted soils, sandy soils, and/or soils with a pH greater than 7.3 may exhibit zinc deficiency. It also can be a problem when beans follow sugar beets.

As with P, banding is more efficient than broadcasting and half as much zinc is recommended for banding. Zinc does not revert to insoluble forms as rapidly as other micronutrients, so broadcast application provides residual effects for several years. Soluble sources of zinc (zinc sulfates, zinc chelates, or zinc-ammonia complexes) are preferable to zinc oxide-based materials.

Zinc recommendations are shown in *Table IV.*

Table IV. Zinc recommendations.

DTPA Soil Test Zn -ppm	*pH less than 7.5*		*pH more than 7.5*	
	# Banded Zn	*# Broadcast*	*# Banded Zn*	*# Broadcast*
0-0.5	3	6	5	10
0.51-1.0	2	4	4	8
1.01-1.5	1	2	2	4
>1.5	0	0	0	0

Iron Recommendations

Dry beans are sensitive to iron deficiency chlorosis (IDC). IDC can occur on soils with pH values greater than 7.5 that contain free calcium carbonate and have low organic matter *(Figure 3)*. In addition, cool, wet springs increase the probability of iron chlorosis. As these soils warm or lose moisture, IDC symptoms often disappear without any iron treatment. If chlorosis persists, yield losses can occur.

Figure 3. Iron chlorotic (yellow) dry bean next to a normal plant.

Soil application of inorganic iron sources is generally ineffective. Recently, renewed interest in FeEDDHA (ortho-ortho formulation) chelate for IDC correction has shown promise. Research at PHREC has shown the potential for economical yield increases with low rates of banded FeEDDHA (ortho-ortho). The material can either be seed-applied alone in a water solution to avoid salt damage or can be mixed with N-P liquid fertilizers and banded beside the seed. The research shows that for severely chlorotic areas, 1.0 to 1.5 pounds of ortho-ortho FeEDDHA is required. On areas with more moderate IDC, 0.75 to 1.0 pounds of the chelate is sufficient. Yield increases for these rates can range from 250 to 450 pounds of seed per acre when IDC is severe. If there is no IDC expressed, yields will not be increased. Soil test values of DTPA-extractable iron do not consistently predict the need for iron applications. Generally responses will be seen when soil test values are below 2.5 ppm, but many soils where IDC occurs may have values greater than this.

One of the most effective ways to economically correct IDC is to map fields with aerial photography in combination with yield maps to define the different areas or zones of IDC severity in fields. These areas are always present, however, the degree of IDC severity does change with yearly weather conditions. The creation of IDC severity zones allows variable rate application of different Fe (iron) chelate rates based on potential IDC.

Responses to foliar solutions of iron sulfate have increased yields but have not been adopted as common practice. Deficiencies can be corrected by spraying the crop with a 1 to 1.5 percent ferrous (iron) sulfate solution at the rate of 20 to 25 gallons per acre. Foliar sprays may reduce IDC but usually are detected late enough that full yield potential is not realized. Multiple sprays may also be required. Aerial application usually does not provide sufficient foliage coverage because of gallonage limitations.

Other Micronutrients and Sulfur

Other nutrient deficiencies (boron, chlorine, copper, manganese, molybdenum) have not been observed in the High Plains dry bean growing region. Documented responses to sulfur applications are rare. The most likely need for sulfur would occur on sandy soils with low organic matter, and soils irrigated with water low in sulfate-sulfur (< 6 ppm SO_4-S). If sulfur is required, 10 lb S from a sulfate source is recommended.

Salinity

Dry beans are one of the most sensitive crops grown in Nebraska to soluble salts. A saline/alkali soil test should be run on soils suspected of having a salt problem. Salinity levels testing over 2 dS/m (mmhos/cm) normally cause some injury and reduce yields. Salt sensitivity of several crops is shown in *Table V*.

Table V. Salt sensitivity to crops.

	Relative yield decrease in yield - percent			
Crop	*0*	*10*	*25*	*50*
	dS/m salinity level causing yield reductions above			
Dry Bean	1.0	1.5	2.3	3.6
Corn	1.7	2.5	3.8	5.9
Wheat	5.0	7.4	9.5	13.0
Sugar Beet	7.7	8.7	11.0	15.0
Barley	8.0	10.0	13.0	18.0

The most common effect of salts is on the plant's ability to absorb water. The symptoms of salt injury on the bean plant are stunting, smaller, thicker, darker green leaves, or in some cases, burning around the leaf margins *(Figure 4)*. The effects of salts can't be separated from water stress since salts contribute to moisture stress in the plant. The bean plant is most sensitive to salt effects during germination and early growth.

Figure 4. Salt damage to dry bean (Photo courtesy of R.G. Wilson).

Most soils normally don't have salt concentrations high enough to cause injury to beans, but under drought and high temperatures, salts may accumulate near the soil surface and injure the developing seedling. The same conditions of high temperatures and low soil moisture also can affect preplant herbicide performance, which may lead to herbicide injury. The possibility exists for all these factors to interact and dramatically reduce bean yield. The best strategy to counteract the salt stress problem is to irrigate the crop early and leach salts out of the soil zone where the crop is germinating and beginning development *(Figure 5)*.

Figure 5. Dry beans showing no salt damage (foreground) and dry beans in an area with salinity above 2 dS/m (Photo courtesy of R.G. Wilson).

This publication has been peer reviewed.

UNL Extension publications are available online at *http://extension.unl.edu/publications*.

Index: Field Crops
Miscellaneous Crops
2007, Revised April 2013