Colorado State University
Extension

Fertilizing Dry Beans

Fact Sheet No. **0.539** Crop Series | **Soil**

by J.G. Davis and M.A. Brick*

Adequate soil fertility is a requirement for profitable dry bean production. Prevention of nutrient stress during the growing season ensures optimum crop production and decreases the impacts of adverse environmental conditions. Prior to planting, test soils to measure the soil fertility status to determine the appropriate kind and level of fertilizer application.

Dry beans are sensitive to soil salinity, and yield losses can occur on soils with salinity greater than 2 decisiemens per meter (dS/m) (2 millimhos/cm). Yield losses may be severe on soils with salinity values greater than 3.5 dS/m. It is a good idea to have your soil tested for soluble salts to determine if salinity is a problem in your field. Salinity causes leaf scorching along the margins of the bean leaves.

Because dry beans fix a portion of their total nitrogen (N) needs from the atmosphere through a symbiotic relationship with *Rhizobium* bacteria in root nodules, N fertilizers are only needed on soils with low levels of residual NO_3-N. Phosphorus (P) is often limiting on soils in the High Plains. Soil pH is also important, and soils with a pH higher than 7.8 may be subject to zinc (Zn) and iron (Fe) deficiencies. For more information on fertility requirements and cultural practices for dry beans, refer to *Dry Bean Production and IPM*, Bulletin 562A. To obtain a copy, contact the University Resource Center, 115 General Services Building, Colorado State University, Fort Collins, CO 80523; (877) 692-9358; or www.ext.colostate.edu.

Soil Sampling

A valid soil analysis can be used to evaluate nutrient application needs to maintain a healthy dry bean crop. The validity of a soil test is directly related to how well the sample was collected. The soil sample must represent the area sampled; consequently, a good sample is a composite of 15 to 20 soil cores taken from an area uniform in soil type. If the soil is not uniform in the field, separate samples should be taken from each area with major differences in soil properties or management practices. Take samples down to a minimum of 1-foot deep.

Air-dry all soil samples thoroughly within 12 hours after sampling by spreading the soil on any clean surface where the soil will not be contaminated. **Do not oven-dry the soil** because soil test results can be changed. Place the air-dried soil in a clean sample container for shipment to the soil test laboratory.

Submit a carefully completed information form with the soil sample. This form provides information so fertilizer application suggestions can be tailored to your specific situation. Take soil samples for NO_3-N analyses every year for optimum fertilization of crops. Analyze soil for availability of the other nutrients, pH, and organic matter content every three to four years.

More detailed explanations of the importance of taking proper soil samples are found at The Colorado State University Soil, Water, and Plant Testing Laboratory is located in Room A319 Natural and Environmental Sciences Building, Colorado State University, Fort Collins, CO 80523 (970) 491-5061 and at www.extsoilcrop.colostate.edu/SoilLab//soillab.html.

Nitrogen Suggestions

Nitrogen fertilizer may not be needed if dry beans follow crops that have been fertilized with high amounts of N. For crops that leave large amounts of residue in the soil, higher levels of fertilizer N may be required to aid in straw decomposition. The general rule is to apply about 15 pounds N per ton

*J.G. Davis, Colorado State University Extension soil specialist and professor; and M.A. Brick, professor, soil and crop sciences. Original authors included J.J. Mortvedt, soil specialist, and R.L. Croissant, crops specialist and professor; soil and crop sciences. 4/09

Quick Facts

- Legumes, such as dry beans, fix a portion of their nitrogen needs from the atmosphere, thus nitrogen fertilizers may not be needed if soil tests indicate adequate residual nitrate-nitrogen.
- Apply nitrogen fertilizers at rates based on a valid soil test result.
- Phosphorus is often a limiting nutrient for dry beans in Colorado.
- Apply phosphate fertilizers at rates based on soil test results. Band applications at planting are more efficient than broadcast applications.

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Table 1: Suggested nitrogen rates for irrigated dry beans (expected yield*: 2,500 pounds per acre).

ppm NO_3-N in Soil	Fertilizer Rate, Pounds N Per Acre
0 - 10	65
11 - 20	45
21 - 30	25
> 30	0

NOTE: Credits for N in manure, irrigation water, or previous legumes should be subtracted from the above N rates.
*To adjust suggested N application for a different yield goal, add or subtract 2 to 3 pounds N for each CWT (100 pounds) that your yield goal differs from 25 CWT (2,500 pounds per acre).

Table 2: Suggested phosphorus rates as banded applications for irrigated and dryland dry beans.

ppm P in Soil		Relative level	Fertilizer Rate, Pounds P_2O_5 Per Acre
AB-DTPA	$NaHCO^3$		
0 - 3	0 - 6	low	40
4 - 7	7 - 14	medium	20
> 7	> 14	high	0*

* A small amount of P may be beneficial in a starter band in high testing soils.

Table 3: Suggested potassium rates for irrigated and dryland dry beans.

ppm K in Soil AB-DTPA or NH_4OAc	Relative Level	Fertilizer Rate, Pounds K2O Per Acre
0 - 60	low	40
61 - 120	medium	20
> 120	high	0

of residue up to 3 tons or 50 pounds of additional N.

Dry beans are legumes that biologically fix N through a symbiotic N fixation process. Inoculate bean seed with the specific host bacteria if dry beans have not been grown recently in a field and in fields where the presence of N-fixing bacteria in the soil is questioned due to historically poor nodulation.

Because legumes can fix N if nodules function properly, some of the N requirements of the plants are met. However, N fixation is limited in heavy clay soils or compacted soils due to poor soil aeration. If residual NO_3-N levels in the soil are low, apply N fertilizer (Table 1). Avoid excessive N levels because they inhibit nodule formation, stimulate heavy vine growth, delay maturity, provide conditions favorable to insect activity, and enhance white mold and bacterial diseases. When residual soil NO_3-N levels are high (greater than 30 ppm), consider planting varieties that mature early to compensate for potentially delayed maturity.

Nitrogen fertilizers may be surface broadcast then incorporated, or band-applied. Band application can be accomplished with the use of planter attachments that place the fertilizer band 2 inches below and 2 inches beside the seed row. If band application is utilized, the N rate should be less than 20 pounds of nitrogen per acre to avoid burning the seedlings.

Phosphorus Suggestions

Dry beans respond to applied phosphorus (P) on soils with low or medium levels of extractable P. Suggested fertilizer P rates (Table 2) are for band applications related to soil test levels. The main soil tests for extractable P in Colorado soils are the AB-DTPA and sodium bicarbonate ($NaHCO_3$) tests. Values for both tests are in Table 2.

Place phosphorus fertilizers in the root zone because P is not mobile in soil. Band application at planting is the most efficient placement method for P, and suggested rates for band application (Table 2) are about half those for broadcast application. Phosphate fertilizers may be surface broadcast and tilled into the soil. Fertilizers applied directly to the seed, or "popup" fertilizer placement is not suggested for beans because they may injure the seedlings in dry soil, especially at high fertilizer rates. Monoammonium phosphate (MAP, 11-52-0), diammonium phosphate (DAP, 18-46-0), and ammonium polyphosphate (10-34-0) are equally effective per unit of P if properly applied. Base your choice of fertilizer on availability, equipment, and cost per unit of P.

Potassium (K) Suggestions

Most Colorado soils are relatively high in extractable K, and few crop responses to K fertilizers have been reported. However, some sandy soils or highly eroded soils with exposed subsoils may be low in extractable K. Suggested K rates related to soil test values (AB-DTPA or NH_4OAc) are given in Table 3. The main K fertilizer is KCl (muriate of potash). Broadcast application followed by incorporation into the soil prior to planting is the usual method.

Zinc (Zn) Suggestions

The availability of soil Zn decreases as soil pH increases; consequently, most Zn deficiencies are reported on soils with pH levels higher than 7.0. Zinc deficiencies also are found on soils leveled for irrigation where the subsoil is exposed, on soils with high levels of free lime, sandy soils, or soils low in organic matter.

Suggested fertilizer rates in Table 4 for applications of Zn are based on use of $ZnSO_4$. Effective Zn chelates, such as ZnEDTA, may be applied at about one-third of the Zn rates shown in Table 4. Band application of all Zn fertilizers with starter fertilizers is more effective than broadcast application. Soil test values for extractable Zn using the DTPA soil test are similar to those by the AB-DTPA soil test shown in Table 4.

Zinc deficiencies also may be corrected by foliar spray using 0.5 percent $ZnSO_4$ solution applied at a rate of 20 to 30 gallons per acre. However, it is difficult to prepare

Table 4: Suggested zinc rates for irrigated and dryland dry beans.

ppm Zn in Soil, AB-DTPA	Relative Level	Fertilizer Rate, Pounds Zn Per Acre*	
		Banded	Broadcast
0 - 0.9	low	5	10
1.0 - 1.5	marginal	2	5
> 1.5	high	0	0
*Rates are based on zinc sulfate applications.			

this solution in the field due to its low solubility, so ZnEDTA or other soluble Zn sources can be used. A surfactant (wetting agent) increases plant absorption of the applied Zn.

Other Nutrients

Most Colorado soils contain adequate levels of available sulfur (S), thus soil tests for available S are not routinely performed. However, light or sandy soils may require S applications of 10 to 20 pounds SO_4-S per acre. Irrigation water may contain appreciable SO_4-S, so irrigated soils usually are adequately supplied with S. However, some deep well water may be low in SO_4-S (less than 5 ppm), so analyze water samples for SO_4-S if you suspect S deficiency.

Symptoms of iron (Fe) deficiency (interveinal chlorosis) occur most often on highly calcareous soils (pH higher than 7.8) and eroded or leveled soils where the subsoil is exposed. Iron deficiencies of dry beans usually appear in cool, wet spring weather in irregular areas on these high-pH soils. Iron chlorosis sometimes disappears when soil temperatures warm without Fe application, but yield losses can occur if chlorosis persists. Some varieties are more tolerant of iron (Fe) deficient soils. In general, small-seeded types such as black and navy beans are more sensitive than medium-seeded pinto, great northern, small red, or pink beans.

Foliar spray applications of a 2 percent $FeSO_4$ solution at a rate of 20 to 30 gallons per acre are not always completely effective in correcting chlorosis and several applications may be necessary. However, $FeSO_4$ solutions are difficult to prepare in the field, and other Fe sources may be used. Soil applications of most Fe fertilizers generally are not effective, but applications of manure will provide available Fe for dry beans.

Deficiencies of boron (B), copper (Cu), manganese (Mn), or molybdenum (Mo) are rare in dry beans in Colorado.

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