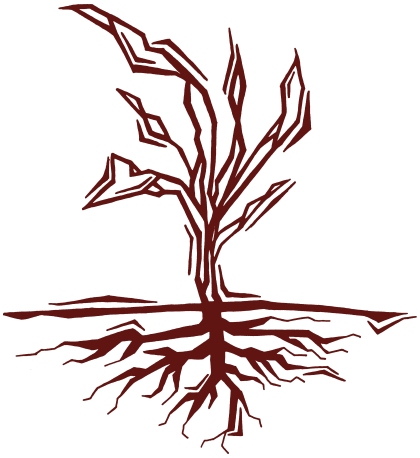

SOIL

Fertilizing Dry Beans no. 0.539

by J.G. Davis, M.A. Brick, J.J. Mortvedt and R.L. Croissant [1]

Quick Facts...

Legumes, such as dry beans, fix a portion of their total nitrogen from the atmosphere, thus nitrogen fertilizers usually are not needed, except on soils low in nitrate-nitrogen.

Apply nitrogen fertilizers at rates based on residual soil nitrates.

Phosphorus often is the most limiting nutrient for dry beans in Colorado.

Most Colorado soils contain sufficient available potassium and sulfur for bean production. Most irrigation waters contain sulfate-sulfur that helps supply the plant's sulfur needs.

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 determine the soil fertility status so appropriate fertilizers can be applied.

Beans are sensitive to soil salinity and yield losses can occur on soils with a 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. Soil compaction also can reduce yields by reducing water infiltration and root growth, and increasing the incidence of root rot.

Since dry beans fix a portion of their total nitrogen (N) from the atmosphere by *Rhizobium* species in nodules on the roots, N fertilizers may not be needed except on soils with low levels of NO_3-N. Phosphorus (P) often is the most limiting nutrient. Dry beans planted in 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 Integrated Pest Management*, Bulletin 562A. To obtain a copy, contact the Cooperative Extension Resource Center, 115 General Services Building, Colorado State University, Fort Collins, CO 80523; (970) 491-6198.

Soil Sampling

The value of a soil test to predict nutrient availability during the growing season is directly related to how well the sample collected represents the area sampled. Take surface samples from the 1-foot soil depth. A good sample is a composite of 15 to 20 soil cores taken from an area uniform in soil type. Sample separately areas with major differences in soil properties or management practices.

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 in fact sheets 0.500, *Soil Sampling*, 0.501, *Soil Testing*, and 0.502, *Soil Test Explanation*, available at your Colorado State University Cooperative Extension county office or from the Cooperative Extension Resource Center. The Colorado State University Soil, Water and Plant Testing

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Table 1: Suggested nitrogen rates for irrigated dry beans (expected yield: 2,000 lb/A).

ppm NO_3-N in soil	Fertilizer rate, lb N/A
0 - 10	50
11 - 20	30
21 - 30	10
> 30	0

NOTE: Credits for N in manure, irrigation water, or previous legumes should be subtracted from the above N rates.

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

ppm P in soil		Relative	Fertilizer rate,
AB-DTPA	$NaHCO_3$	level	lb P_2O_5/A
0 - 3	0 - 6	low	40
4 - 7	7 - 14	medium	20
> 7	> 14	high	0

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

ppm K in soil AB-DTPA or NH_4OAc	Relative level	Fertilizer rate, lb K_2O/A
0 - 60	low	40
61 - 120	medium	20
> 120	high	0

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

ppm Zn in soil	Relative	Fertilizer rate, lb Zn/A*	
AB-DTPA	level	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.

Laboratory is located in Room A319, Natural and Environmental Sciences Building, Colorado State University, Fort Collins, CO 80523; (970) 491-5061.

Nitrogen Suggestions

Nitrogen fertilizer generally is not needed if dry beans follow crops that have been properly fertilized. However, some fertilizer N may be required to aid in straw decomposition when large quantities of previous crop residues were incorporated into the soil.

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. Seed inoculation also is suggested for fields where the presence of the N-fixing bacteria in the soil is questioned.

Because legumes fix N if nodules are functioning properly, some of the N requirements of the plants are met. However, N fixation is limited in heavy clay soils. Some preplant N may be needed if residual NO_3-N levels in the soil are low. Dry beans can respond economically to N fertilizers at rates up to 50 pounds of nitrogen per acre, depending on NO_3-N levels in the soil (Table 1). Excessive N levels in the soil often inhibit nodule formation on roots, stimulate heavy vine growth, delay maturity, and provide conditions favorable to insect activity, white mold, and bacterial diseases.

Nitrogen fertilizers may be surface broadcast and incorporated or band applied in combination with phosphate fertilizers at planting (starter fertilizers). Use of planter attachments with the standard 2-inch by 2-inch placement (2 inches below and beside the seed row) is preferred for starter fertilizers, but the N rate should be less than 20 pounds of nitrogen per acre to avoid burning the seedlings.

Phosphorus Suggestions

Dry bean responses to applied P are most likely 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.

Placement of P fertilizers in the root zone is important 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 also may be surface broadcast and plowed down or tilled into the soil. Popup fertilizer placement (directly with the seed) is not suggested because seedling emergence may be decreased in dry soil, especially at higher 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 available and cost per unit of P.

Potassium Suggestions

Most Colorado soils are relatively high in extractable K, and few crop responses to K fertilizers have been reported. However, some 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), and broadcast application incorporated into the soil prior to planting is the usual method.

Zinc Suggestions

The availability of soil Zn decreases with increasing soil pH, and 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. Maturity may be delayed in dry beans grown on marginally Zn-deficient soils, so Zn applications may hasten maturity without increasing yields.

Suggested fertilizer rates in Table 4 for band 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 sprays of a 0.5 percent $ZnSO_4$ solution applied at a rate of 20 to 30 gallons per acre. However, it is difficult to prepare this solution in the field 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, some sandy soils may require S applications. Irrigation water from most surface waters and some wells often contains appreciable SO_4-S, so irrigated soils usually are adequately supplied with S. However, some deep well water may be low in S, so analyze water samples for SO_4-S if soils are low in organic matter and you suspect S deficiency.

Iron deficiencies (chlorosis) are most likely to occur on highly calcareous soils (pH higher than 7.8) or on soils leveled for irrigation where the subsoil is exposed. Iron deficiencies (yellowing of leaves) of dry beans usually appear in cool, wet spring weather in irregular areas on these high-pH soils. Iron chlorosis sometimes disappears without any Fe treatment, but yield losses can occur if chlorosis persists.

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.

There have been no confirmed deficiencies of boron (B), copper (Cu), manganese (Mn), and molybdenum (Mo) in dry beans in Colorado.

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