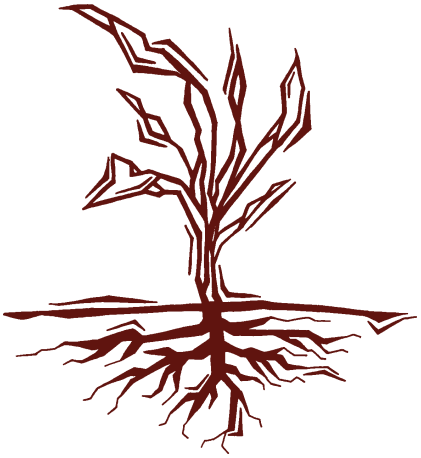

SOIL

Fertilizing Potatoes no. 0.541

by J.J. Mortvedt, P.N. Soltanpour, R.T. Zink and R.D. Davidson [1]

Adequate soil fertility is one of the requirements for profitable potato production. Potatoes are mainly grown on sandy soils, and nitrogen (N) is the most yield-limiting nutrient. Phosphorus (P) is the next most limiting nutrient, while zinc (Zn) and occasionally iron (Fe) also may be deficient in some Colorado soils.

Use cultivar-specific management practices whenever possible because potato cultivars vary significantly in root density, maturity, and their response to timing of N applications and environmental conditions. Optimum yield and quality should result from using such practices.

Quick Facts...

Proper nitrogen management is one of the most important practices for high-yielding, high-quality potato production.

Apply nitrogen fertilizers at rates based on expected crop yields minus credits for residual soil nitrates, nitrogen mineralized from soil organic matter, previous legume crop residues and manure, and nitrate-nitrogen present in irrigation water.

Apply phosphate fertilizers at rates based on soil test results.

Most Colorado soils contain sufficient potassium for potato production.

Soil Sampling

The value of a soil test to predict nutrient availability during the growing season directly relates to how well the sample collected represents the area sampled. Take surface samples to determine available NO_3-N to a depth of 1 foot. 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.

Thoroughly air dry all soil samples within 12 hours after collection by spreading the soil on any clean surface where the soil will not be contaminated. **Do not oven dry the soil** because this can change soil test results. Place the air-dried soil in a clean sample container for shipment to the soil test laboratory. Carefully complete the 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 analysis every year for optimum N fertilization of crops. To analyze the availability of the other nutrients, pH, and organic matter content, it may be sufficient to take samples 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, 115 General Services Building, Colorado State University, Fort Collins, CO 80523; (970) 491-6198. The Colorado State University Soil, Water and Plant Testing Laboratory is in Room A319, Natural and Environmental Sciences Building, Colorado State University, Fort Collins, CO 80523; (970) 491-5061.

Nitrogen Suggestions

Base nitrogen rates for potatoes on crop use and known cultivar requirements for the expected yield on each field. Give credit for the level of available NO_3-N in the soil, as determined by soil tests. Other credits for N

Colorado State University Cooperative Extension

Table 1: Nitrogen credits for previous legume crops.

Legume crop		lb N/A credit*
Alfalfa	> 80% stand	100 - 140
	60 - 80% stand	60 - 100
	0 - 60% stand	0 - 60
Dry beans		30

*For the second year, use 1/2 of the first year N credit.

Table 2: Suggested nitrogen rates for potatoes in eastern Colorado, as related to nitrate-nitrogen in the soil (expected yield, 400 cwt/A).

ppm NO_3-N in soil*	Fertilizer rate, lb N/A
0 - 18	180
19 - 24	170
25 - 30	160
31 - 36	150
> 36	140

*Concentration of NO_3-N in the surface 0 - 1 foot sample depth.
-Subtract 30 lb of N/A for each percent soil organic matter above 1.0%.
-See Table 1 for N credits from previous legume crops.
-To adjust N rate for expected yields from 300 to 400 cwt/A, subtract 30 lb of N/A for each 50 cwt/A.

Table 3: Suggested nitrogen rates for split application to potatoes in the San Luis Valley, according to cultivar (expected yield, 400 cwt/A).

	Fertilizer rate, lb N/A		
Cultivar	Total rate	Pre-plant	Sprinkler applied
Atlantic	180	80 - 90	90 - 100
Centennial Russet	190	90 - 100	80 - 100
Century Russet	150	70 - 100	40 - 70
Chipeta	140	60 - 70	60 - 80
Crestone Russet	180	90 - 100	60 - 90
Frontier Russet	180	90 - 100	70 - 90
Ranger Russet	170	70 - 90	80 - 100
Russet Burbank	200	90 - 110	80 - 100
Russet Norkotah	210	110 - 140	40 - 70
Russet Nugget	130	60 - 80	60 - 70
Sangre	150	90 - 100	40 - 60

- Subtract 8 lb of N/A for each ppm NO_3-N above 5 ppm in soil prior to planting.
- Subtract 10 lb of N/A for each percent soil organic matter above 1.0 percent.
- See Table 1 for N credits from previous legume crops.
- To adjust N rates for expected yields from 300 to 400 cwt/A, subtract 30 lb of N/A for each 50 cwt/A.

include the amounts expected to become available during the season from mineralization of soil organic matter, previous legume crops (see Table 1), and NO_3-N in irrigation water. Subtract these credits from the total N needs to determine the suggested N fertilizer rate for the expected yield.

Other factors that affect N rates are cultivar, plant population, planting and harvesting dates, crop residues incorporated into the soil, soil type, and leaching losses from irrigation.

Irrigation water may contain NO_3-N which is available to plants. The amount of N contained in one acre-foot of irrigation water is 2.7 pounds of nitrogen for each ppm of NO_3-N. However, subtract only the NO_3-N in irrigation water applied before tuberization.

Table 2 suggests N rates for potatoes grown in eastern Colorado for an expected yield of 400 cwt/A. Fertilizer rates decrease with increasing levels of the average ppm NO_3-N in the top foot of soil. Suggested N rates in this table do not account for the other N credits listed above. Subtract these credits from the N rates in Table 2 to determine the N rate for the field.

Suggested N rates for the main cultivars of potatoes grown in the San Luis Valley are given in Table 3. This table gives the total suggested N rate at an expected yield of 400 cwt/A. The suggested N rates for preplant N and subsequent applications through sprinkler systems during the growing season also are included. Suggested N rates in this table do not account for the N credits discussed above. Subtract these credits from the N rates in Table 3 to determine the N rate for the field. The usual rate of N applied through sprinkler systems is no more than 20 pounds per acre per application.

Methods and Timing of N Applications

Proper N management and other factors, particularly irrigation, are among the most important practices needed to obtain high yields of high quality potatoes. The N supply early in the season must be adequate for vegetative growth. However, excessive levels of soil N before or at tuberization can delay tuber initiation, reduce yields and decrease specific gravity in some cultivars. In addition, excessive N in late summer and early fall can delay maturity of the tubers and result in poor skin set, which can adversely affect tuber quality and storage characteristics.

Nitrogen needs of potatoes are best met by split applications of N fertilizers during the vegetative period. This involves applying some of the N fertilizer preplant and at planting, with the remainder of the crop's N needs applied with irrigation water. However, apply all of the fertilizer before July 31 so tuber maturation is not delayed. Some N may be band applied in combination with starter fertilizers, but the rate should be less than 40 pounds of nitrogen per acre if urea or diammonium phosphate (DAP) are applied.

Anhydrous ammonia is not suggested for application to potatoes under San Luis Valley conditions. Apparently, the rate of nitrification is decreased because of cooler soil temperatures, so NH_4-N continues to be converted to NO_3-N later in the growing season.

Potato roots quickly grow into the soil between the rows. Sidedress or topdress N fertilizers early in the growing season to avoid root pruning.

Application of N fertilizers with irrigation water is a convenient method and allows split applications to improve potato yields and quality, as well as N-use efficiency. Use in-season soil or petiole analysis to determine the N status of the growing crop. If the N status is low or growing conditions appear above average, apply additional N with the next irrigation. The maximum amount of N to apply with each irrigation is 20 pounds of nitrogen per acre.

Nitrogen fertilizers may be applied through sprinkler irrigation systems. All closed irrigation systems must be equipped with backflow prevention valves if N fertilizers or other agrichemicals are applied through the system. Apply nitrogen fertilizers in furrow irrigation systems only in fields where a tailwater recovery and reuse system is in place. However, application of N fertilizers in furrow irrigation water may not result in uniform application of N, so this method is not suggested.

Phosphorus Suggestions

Crop responses to applied P are most likely on soils with low or medium levels of extractable P, although lower P rates may be effective for potatoes on San Luis Valley soils high in extractable P because of cold spring soil temperatures. 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 given in Table 4. Suggested P fertilizer rates (Table 4) are for preplant application related to soil test levels. Broadcast and incorporate high P rates by tillage, with a portion band applied as starter fertilizer. Most growers in the San Luis Valley band apply most or all of the required P fertilizer to minimize P fixation in the soil.

Table 4: Suggested phosphorus rates for potatoes (expected yield, 400 cwt/A).

ppm P in soil		Relative	Fertilizer rate,
AB-DTPA	$NaHCO_3$	level	lb. P_2O_5/A
0 - 3	0 - 6	very low	240
4 - 7	7 - 14	low	180
8 - 11	15 - 22	medium	120
> 11	> 22	high	60

NOTE: High P rates should be applied broadcast preplant, with a portion band applied as a starter fertilizer.

Placement of P fertilizers in the root zone is important because P is not mobile in soil. Broadcast incorporated applications are effective on low-P soils because broadcasting provides a greater probability for roots to come in contact with P fertilizer, so absorption of fertilizer P is greater. However, broadcast P fertilizers may be fixed rapidly in high pH, high lime soils so some of the applied P quickly becomes unavailable to plants. Band application at planting (starter fertilizer) is the most efficient placement method for P. Place ammonium phosphates as starter fertilizers below and to the side of the seed piece at planting, and rates should not exceed 40 pounds of nitrogen per acre.

Table 5: Suggested potassium rates for potatoes (expected yield, 400 cwt/A).

ppm K in soil	Relative	Fertilizer rate,
AB-DTPA or $NaHCO_3$	level	lb. K_2O/A
0 - 60	low	160
61 - 120	medium	80
121 - 180	high	40
> 180	very high	0

Potassium Suggestions

Most Colorado soils are relatively high in extractable K, and few crop responses to K fertilizers have been reported. Suggested K rates related to soil test values (AB-DTPA or NH_4OAc) are given in Table 5. The main K fertilizer is KCl (potash). Broadcast application tilled into the soil prior to planting is the usual method. Use of KCl instead of K_2SO_4 may decrease specific gravity of potatoes.

Table 6: Suggested zinc rates for potatoes.

ppm Zn in soil	Relative level	Fertilizer rate, lb. Zn/A zinc sulfate	zinc EDTA
0 - 0.9	low	10	4
1.0 - 1.5	marginal	5	2
> 1.5	adequate	0	0

NOTE: Suggested Zn rates are for band application with starter fertilizers.

Table 7: Suggested iron spray applications for potatoes.

ppm Fe in soil AB-DTPA	Relative level	Spray application notes
0 - 3.0	low	Likely to be beneficial
3.1 - 5.0	marginal	May or may not be beneficial
> 5.0	adequate	Response not likely

NOTE: Soil applications of most Fe fertilizers are not effective.

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 subsoil has been exposed, on soils with very high levels of free lime, sandy soils, or soils low in organic matter.

Suggested Zn fertilizer rates in Table 6 for band applications are based on use of $ZnSO_4$. Apply effective Zn chelates, such as ZnEDTA, at about one-third of the Zn rates shown in Table 6. Band application of Zn fertilizers with starter fertilizers is more effective than broadcast application of all Zn fertilizers. Soil test values for extractable Zn by the DTPA soil test are similar to those by the AB-DTPA test shown in Table 6. Zinc fertilizers have measurable residual effects, and repeated annual applications will result in a buildup of extractable Zn. As soil test Zn increases to higher levels in soil, decrease Zn rates according to soil test results.

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, but several spray applications may be necessary. 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

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 has been exposed. The Centennial Russet cultivar is more susceptible to Fe chlorosis than other cultivars. Foliar spray applications (Table 7) of a 1 percent $FeSO_4$ solution at 20 to 30 gallons per acre are not always completely effective in correcting chlorosis, and several applications may be necessary.

Because $FeSO_4$ solutions are difficult to prepare in the field, other Fe sources may be used. Inclusion of urea and a detergent increase effectiveness of applied Fe. Soil applications of most Fe fertilizers generally are not effective.

Most Colorado soils contain adequate levels of available S, and soil tests for available S are not routinely performed. However, some sandy soils may require S applications. Irrigation water from most surface water and some wells often contains appreciable SO_4-S, so irrigated soils usually are adequately supplied with S. However, some deep well waters are low in S, so analyze water samples for SO_4-S if soils are low in organic matter and you suspect S deficiency.

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

[1]*J.J. Mortvedt, Colorado State University Cooperative Extension soils specialist; P.N. Soltanpour, professor; soil and crop sciences; R.T. Zink, Cooperative Extension potato specialist; and R.D. Davidson, Cooperative Extension seed potato specialist; San Luis Valley Research Center.*

Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, Milan A. Rewerts, Director of Cooperative Extension, Colorado State University, Fort Collins, Colorado. Cooperative Extension programs are available to all without discrimination. No endorsement of products mentioned is intended nor is criticism implied of products not mentioned.