COLORADO STATE UNIVERSITY
EXTENSION

Fertilizing Potatoes in Colorado

Fact Sheet 0.541 | Crop Series | Soil

*By S.Y.C. Essah and J.G. Davis**

Adequate soil fertility is one of the requirements for profitable potato production. Potatoes are mainly grown on sandy to gravely sandy loam 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) may also be deficient in some Colorado soils.

Use cultivar specific management practices whenever possible because potato cultivars vary significantly in their response to N application rate and N application timing, as well as environmental conditions. Optimum yield and quality should result from using such practices.

Sampling Soil before Planting

Soils should be sampled and tested for available nutrients before planting. Accurate prediction of nutrient availability depends on good soil sampling. For potatoes, soil cores should be taken to a depth of 12 inches. Take about 15 to 20 soil cores from an area uniform in soil type. Soil cores should be taken in a zig zag manner across the sample area. Areas with major differences in soil properties or management practices should be sampled separately.

Air-dry all soil samples within 24 hours after collection by spreading the soil on 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 laboratory's information form and send it in with the soil sample. The 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 potatoes. To analyze soil pH, soil organic matter, and other nutrients, it is sufficient to sample the soil every three to four years.

For further information and the importance of taking good soil samples contact the Colorado State University Soil, Water and Plant Testing Laboratory in Room A320, Natural and Environmental Sciences Building, Colorado State University, Fort Collins, CO 80523; (970)491-5061; www.soiltestinglab.colostate.edu.

Nitrogen Fertilization

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

Other factors that affect N rates are plant population, planting and harvesting dates, crop residues incorporated into

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 ½ of the first year N credit.*

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.

**S.Y.C. Essah, Associate Professor and Potato Extension Specialist, Horticulture and Landscape Architecture, Colorado State University, San Luis Valley Research Center; J.G. Davis, Professor and Department Head, Horticulture and Landscape Architecture, Colorado State University, Fort Collins. Original authors included R.D. Davidson, Professor and Extension Seed Potato Specialist, Horticulture and Landscape Architecture, San Luis Valley Research Center; J.J. Mortvedt, former Colorado State University Extension Soil Specialist; P.N. Soltanpour, former professor, soil and crop sciences; and R.T. Zink, former Extension Potato Specialist. 06/2019*

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*	Nitrogen 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 soil*
*** Note that this is an estimation, and that the actual fertilizer rate is cultivar dependent.*
- 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 below 400 cwt/A.
- To adjust N rate for expected yields from 400 to 500 cwt/A, add 30 lb. of N/A for each 50 cwt/A above 400 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.

Cultivar	Nitrogen Fertilizer Rate, lb N/A		
	Total Rate	Pre-Plant	Sprinkler Applied
Atlantic	180	80 - 90	90 - 100
Centennial Russet	190	90 - 100	80 - 100
Chipeta	140	60 - 70	60 - 80
Ranger Russet	170	70 - 90	80 - 100
Russet Burbank	200	90 - 110	80 - 100
Russet Norkotah Sel 3	190	100 - 110	80 - 90
Russet Nugget	140	60 - 80	60 - 80
Sangre	150	90 - 100	40 - 60
Colorado Rose	180	70 - 80	100 - 110
Rio Grande Russet	170	80 - 90	70 - 80
Canela Russet	160	80 - 90	70 - 80
Mesa Russet	170	70 -80	90 - 100

1. Subtract 8 lb of N/A for each ppm of soil NO_3-N above 5 ppm prior to planting.
2. Subtract 10 lb of N/A for each percent soil organic matter above 1.0.
3. See Table 1 for N credits from previous legume crops.
4. To adjust N rate for expected yields from 300 to 400 cwt/A, subtract 30 lb of N/A for each 50 cwt/A below 400 cwt/A.
5. To adjust N rate for expected yields from 400 to 500 cwt/A, add 30 lb. of N/A for each 50 cwt/A above 400 cwt/A.

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. N fertilizer rates decrease with increasing levels of 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 some potato cultivars grown in the San Luis Valley are given in Table 3. This table gives the total suggested N rate for an expected yield of 400 cwt/A. The suggested N rates for pre-plant N and subsequent applications through sprinkler systems during the growing season are also 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 rate of N applied through sprinkler systems should not be more than 20 pounds per acre per application. Frequent N application through the sprinkler system is most efficient with about 10 lb N/A per application.

Methods and Timing of N Applications

Proper N management is among the most important practices needed to obtain high yields of high quality potatoes. Supply of N 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 yield and decrease specific gravity in some cultivars. Cultivars like Rio Grande Russet and Mesa Russet are extremely sensitive to excessive early season N application. Growers must know the specific cultivar characteristics prior to applying early season N fertilizer. In addition, excessive fertilizer N late in the growing season can delay tuber maturity and result in poor skin set, which can adversely affect tuber quality and storage characteristics. In general, for early maturity potatoes, about 2/3 (67%) of the total N need should be applied pre-plant or at planting, and the remaining required N applied in split applications after tuber formation. For medium to late maturity cultivars, about 1/3 (33%) of the total required N should be applied pre-plant or at planting. The remaining required N should be applied

through the sprinkler system in split applications after tuber formation.

Under San Luis Valley conditions, all fertilizer N should be applied before July 31 to avoid delaying tuber maturity. Use in-season 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 lb N/A.

Phosphorus Fertilization

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 cool temperatures in the spring. The main soil tests for extractable P in Colorado soils are the AB-DTPA and sodium bicarbonate ($NaHCO_3$ also known as Olsen) 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, 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.

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 uptake is greater. However, broadcast P fertilizers may be fixed rapidly in high pH, high lime soils causing some of the applied P to quickly become 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 N per acre.

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

ppm P in soil AB-DTPA $NaHCO_3$		Relative level	Fertilizer rate, 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.

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

ppm K in soil AB-DTPA or NH_4OA	Relative level	Fertilizer rate, lb. K_2O/A
0 - 60	low	160
61 - 120	medium	80
121 - 180	high	40
> 180	very high	0

Table 6: Suggested zinc rates for potatoes.

ppm ZN in soil (DTPA or AB-DTPA)	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.

Potassium Fertilization

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.

Zinc Fertilization

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 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 listed for zinc sulfate, or Zn chelates, such as zincEDTA. Band application of Zn fertilizers with starter fertilizers is more effective than broadcast application. 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

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.

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 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), or molybdenum (Mo) in potatoes in Colorado.