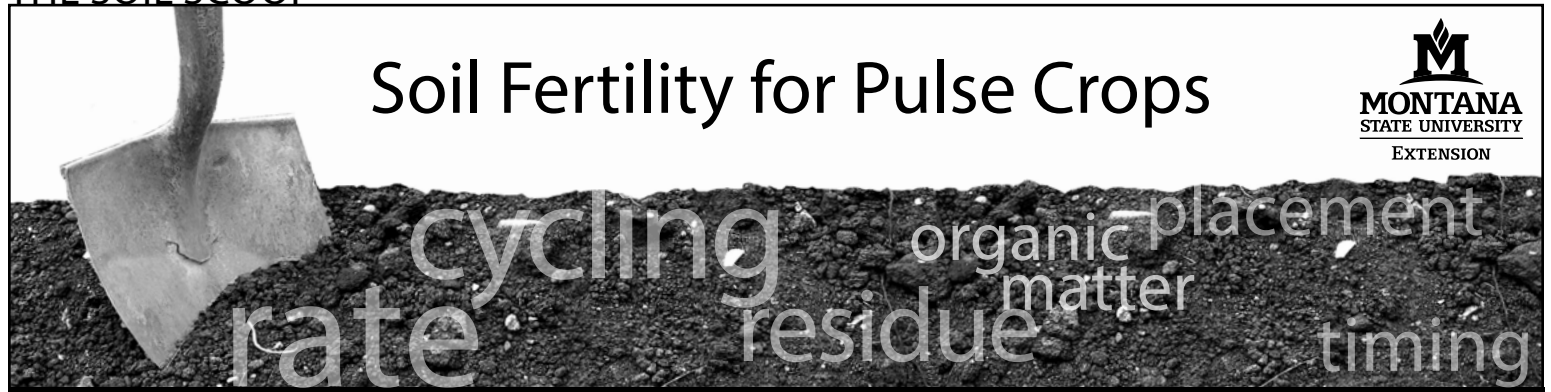




Soil Fertility for Pulse Crops



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This Soil Scoop presents the basics of soil fertility for annual legumes, also called pulses. For more details, refer to the *Montana Cool-Season Pulse Production Guide*.

GENERAL PRINCIPLES

Rate Annual legume phosphorus (P) and potassium (K) fertilizer application rates should be based on a soil test (see *Soil Testing* Soil Scoop). Table 1 presents the minimum P and K rates required to optimize net revenue in the current year. If, instead, the fertilization goal is to ‘maintain’ soil nutrient levels, then fertilizer rates can match crop nutrient removal rates (Table 2).

Tissue testing Critical tissue concentrations are available for sulfur (S), zinc (Zn) and copper (Cu; Table 3). However, variability is too high in tissue concentrations among crop varieties, growth stage, and sampling time of day, to use tissue concentrations as the only diagnostic tool. Also, there

are no fertilizer rate guidelines based on tissue testing in our region. Plant and soil samples taken from an affected area can be compared to samples from a healthy area to help identify a limiting nutrient.

Plant nutrient deficiency symptoms can also be used to identify nutrient deficiencies, but once symptoms appear, yield potential has likely already been reduced. See *Nutrient Disorders* for deficiency and toxicity symptoms. Note that disease or herbicide damage may look like a nutrient deficiency.

Source The nutrient source often does not substantially affect nutrient availability, but should be selected based on cost per pound of available nutrient, ease of application, and potential germination issues if applied with the seed. Rock phosphate and elemental-S do not provide enough phosphate and sulfate, respectively, within the season, but they can be used to bank soil P and S. Organic amendments such as manure contain variable amounts of many nutrients and should be tested for nutrient content to calculate application rates. Manure is especially high in P. See *Manure Nutrient Management* on the MSU Soil Fertility website for links to further resources.

Timing & Placement Nitrogen fertilizer and sulfate forms of S fertilizer should be applied at seeding up to early branching. They can also be applied as ‘rescue’ treatments, i.e., top-dressed, up to flowering. Potassium and P are best applied in the root zone before or at seeding.

TABLE 1. Phosphorus and potassium guidelines for pulse crops based on soil tests.

	Olsen P (ppm)				
	4	8	12	16 ¹	
Phosphorus (lb P ₂ O ₅ /acre)	30	25	20	15	
	K (ppm)				
	50	100	150	200	250 ¹
Potassium (lb K ₂ O/acre)	40	35	30	25	20

¹. At higher soil test levels consider using removal rate (Table 2)

TABLE 2. Estimated pounds of nutrient removed per bushel of pulse crop seed harvested or per ton of field pea hay.

Unit	N	P ₂ O ₅	K ₂ O	S
Seed (lb/bu)	2.18	0.67	0.87	0.15
Hay (lb/ton)	46	11	32	4 ¹

¹. Beef Magazine, March 1, 2010. <http://beefmagazine.com/nutrition/feed-composition-tables/feed-composition-value-cattle--0301>

TABLE 3. Leaf nutrient concentration at which 90% of maximum yields were obtained.

Crop	Plant tissue concentration		
	S ¹ (%)	Zn ² (ppm)	Cu ³ (ppm)
Chick/field pea	0.18	17	2.6
Faba bean	0.038	18	2.8
Lentil	0.29	25	4.6

¹ Sampling 2nd to 4th mature leaf at 7th leaf stage, 4 weeks after seeding.

² Sampling the newest growth 46 days after seeding.

³ Sampling the newest growth 62 days after seeding.

Potassium may be top-dressed very early in the growing season, while top-dressed P is most likely ineffective in the current growing season.

Legume seedlings are very sensitive to salt, and proper fertilizer placement is critical to avoid injury. Avoid placing more than 10-15 lbs N+K₂O/acre, especially urea or urea ammonium nitrate, directly with the seed. Safe rates of seed-placed fertilizer based on crop, moisture, and texture can be found in South Dakota State University's *Fertilizer Seed Decision Aid*. Phosphorus and K can be placed with the seed in limited amounts (see specific nutrients). Potential for seedling injury from fertilizer tends to be higher in dry and/or coarse textured sandy soils.

SPECIFIC NUTRIENTS

Nitrogen It is cheap insurance to inoculate seed with the proper rhizobium at each planting. Low temperatures, drought or excess moisture, or more than 25 to 35 lb total available N/acre (nitrate plus ammonium N) can inhibit nodulation and N-fixation. If nodules are lacking or inactive (inactive nodules are white, active nodules are red inside) 3 to 5 weeks after emergence, an immediate fertilizer N top-dress might be justified.

In soils with less than 20 lb N/acre or in dry growing conditions, 10-20 lb N/acre can be placed away from the seed or top-dressed to boost early seedling growth. Starter MAP (discussed later) supplies some N at seeding. Although starter or rescue N benefits plant health, it might not translate to increased yield. Alberta field trials found starter N increased pea yield in only 33% of the trials, by an average 11%. High N may produce excessive vegetative growth resulting in reduced pod set, seed production, N fixation, and delayed maturity.

Phosphorus Low amounts of P can be seed-placed to encourage vigorous seedlings and N-fixation. Safe rates of seed-placed P depend on the P source, soil, and moisture conditions. MAP should not exceed 20 lb P₂O₅/acre. Safe-rates are lower for triple superphosphate (TSP), and DAP should not be seed-placed. Safe rates tend to be higher in finer-textured soils, soils with high soil organic matter and with seeding/fertilizer equipment with wide openers.

Higher P rates can be sub-surface side-banded or broadcast and incorporated prior to planting, or banked in the soil with the alternate crop the previous year. Phosphorus fertilization is more likely to increase seed yield when initial soil N and P levels are low (Olsen P < 9-12 ppm).

Potassium & Sulfur Seed-placed K₂O+N should not exceed 10-15 lb/acre. Sulfur fertilization must be based on prior crop performance, S removal rates (Table 2) or plant tissue concentrations (Table 3) because the soil test for sulfate-sulfur (SO₄-S) is not a reliable indicator of plant available S. If the prior crop indicates the field may be S deficient, then 15-20 lb S/acre as sulfate should be applied at planting. If legume tissue concentrations indicate low S (Table 3), then use expected yield and Table 2 removal amounts to estimate S rescue rate. For example, a 30 bu/acre expected yield would require about 4.5 lb S/acre, likely applied as an ammonium sulfate liquid (e.g., 8-0-0-9S). Granular 21-0-0-24 can also be used but many fertilizer spreaders can't spread accurately at the low rates needed (about 15-20 lb product/acre) and plants might not rebound if driven on at too late a growth stage. Soil S can be banked with elemental S, 2 to 3 rotations before the pulse crop. Sulfate based S fertilizer does not 'bank' well.

Micronutrients Iron (Fe), manganese (Mn), zinc (Zn), chloride (Cl) and boron (B) have occasionally been found deficient in Montana soils. Annual legume requirements for micronutrients are not well known. Iron, copper (Cu), Mn and Zn are unavailable to the plants if broadcast. Foliar applications may help deficient plants. Chloride and B deficiency can be corrected with top-dressing. Be cautious when using micronutrients as crops need very little.

For more information: Complete references are given in the pulse production guide.

Montana Cool-Season Pulse Production Guide EB0210 <http://landresources.montana.edu/soilfertility/publications.html>

MSU Soil Fertility website <http://landresources.montana.edu/soilfertility/>

Nutrient Disorders. By C. Toker, H. Canci, and K.H.M. Siddique. 2011. In *Compendium of Chickpea and Lentil Diseases and Pests*. W. Chen, H.C. Sharma, and F.J. Muehlbauer. (Eds.). APS Press, St. Paul, Minnesota, USA. 153 pp. http://www.ars.usda.gov/SP2UserFiles/Place/53482000/Compendium/Part4-Noninfectious_Disorders.doc

Soil Testing Soil Scoop <http://landresources.montana.edu/soilfertility/soilscoop.html>

IPNI Online Fertilizer Damage Tool - safe seed-placed fertilizer rate calculator <http://anz.ipni.net/article/ANZ-3076>