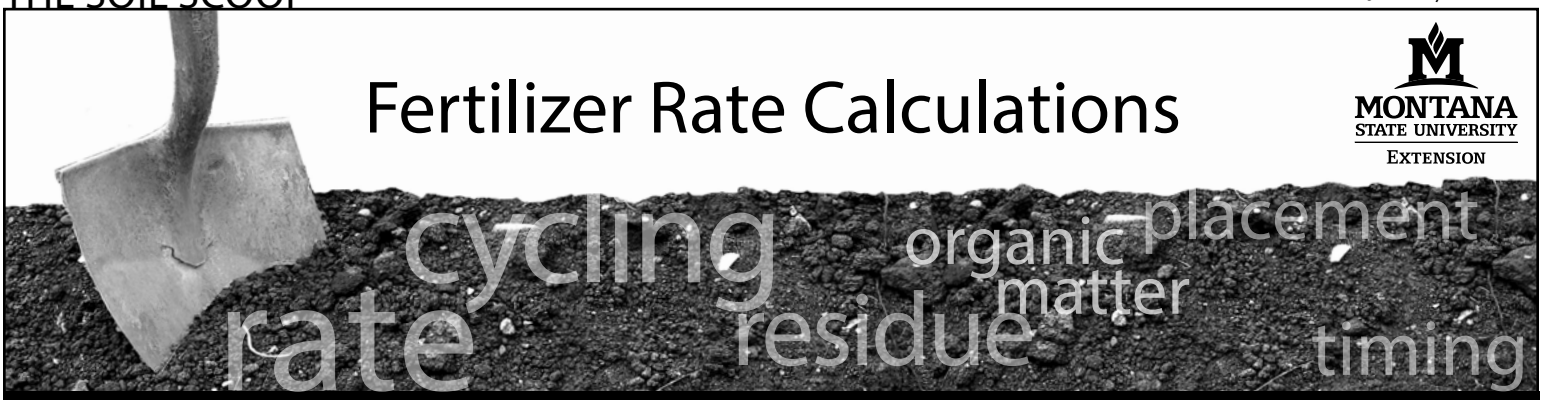
Fertilizer Rate Calculations



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This guide sumarizes strategies to calculate optimal fertilizer rates for crop yield and to reduce loss of nutrients to the environment.

The guidelines presented are considered the best averages for the entire state. Given the variability of climate across the state of Montana, recommended fertilizer rates should be adjusted based on climate and soil properties at your specific location. Please see *Interpretation of Soil Test Reports for Agriculture* for more information on fertilizer calculations.

SOIL ANALYSIS CONVERSION

Soil test laboratories report nutrients in parts per million (ppm) or pounds per acre (lb/acre). Determining N application rates requires ppm results to be converted to lb/acre , if the lab does not report nitrate-N in lb/acre (see Calculation Box 1).

CALCULATION BOX 1. Soil analysis conversion (ppm to lb/acre)

CALCULATION:

N (lb/acre) = Nitrate-N (NO_3-N; ppm) x 2 x soil sample thickness (in)/6 in

(Assumes 2 million pounds of dry soil in upper 6 in/acre)

EXAMPLE:

Depth	Nitrate-N (ppm)
0-6 in	8 ppm
6-24 in	4 ppm

N (0-6 in) = 8 x 2 x 6 in/6 in = 16 lb N/acre

N (6-24 in) = 4 x 2 x 18 in/6 in = 24 lb N/acre

Total N (0-24 in) = 40 lb N/acre

FERTILIZER RECOMMENDATIONS

Nitrogen N fertilizer rate calculations require 1) the soil nitrate-N level, 2) crop to be seeded, and 3) yield goal.

After the total available N need (soil nitrate-N + fertlizer N) is calculated (or found in Tables 1 to 7 of *Fertilizer Guidelines for Montana Crops*) the amount of soil nitrate-N is subtracted from the total available N needed, to determine fertilizer N need. Some location specific factors affect adjustments to your standard rate.

1. Level of soil organic matter (SOM): This should relate directly to how much N is released during the growing season. Decrease N rate by 15-20 lb N/acre if SOM > 3% and increase N rate by same if SOM < 1%.

2. N 'credit': Residues from previous crops that are high in N, like legumes, contribute to total available soil N. Crops require less N fertilizer following legumes as follows:

- Alfalfa: 40 lb N/acre
- Annual legume for 1 rotation: 10 lb N/acre
- Annual legume for 3 or more rotations: 20 lb N/acre

3. Immobilization: Stubble left from the previous crop will tie up, or immobilize, some N, especially if N is broadcast. To account for this see Calculation Box 2.

CALCULATION BOX 2. Determine N adjustment for remaining stubble

CALCULATE STUBBLE REMAINING

Stubble remaining = total stubble (lb/acre) - stubble removed (lb/acre). Total stubble can be assumed to be 1.67, 1.33, and 1.12 times greater than grain weight (lb/acre) for winter wheat, spring wheat, and barley, respectively.

CALCULATE N ADJUSTMENT FOR STUBBLE REMAINING

N adjustment = 10 lb N/1000 lb x stubble remaining (lb/acre)

= _____lb N/acre (add this to N rate, up to 40 lb N/acre)

4. Soil sampling timing: MSU guidelines assume soil sampling is done in the spring. Fall samples may not give an accurate representation of what will be available at spring seeding. Decomposition of SOM in the winter releases plant-available N in a process called mineralization, increasing soil N from fall to spring. Nitrate has been found to increase from August to April on average by about 25 lb N/acre following broadleaf crops to about 15 lb N/ac following small grains. Conversely, soil N can be lost over winter to leaching or denitrification (N-gas loss).

5. Sampling depth: Most nitrate-N uptake occurs in the top 2 feet of soil. A general guideline to account for any available nitrate-N below 2 feet is to assume 50% of nitrate-N at depths 2-4 feet will be taken up.

See Calculation Box 3 (on next page) for an example N calculation.

CALCULATION BOX 3. Example fertilizer N rate calculation for winter wheat		
Step	N need (lb N/acre)	N credit (lb N/acre)
1. Select realistic yield goal (e.g., 50 bu/acre winter wheat)		
2. Look up recommended lb N/bu (e.g., 2.6 lb N/bu x 50 = 130 lb N/acre) or use economic N rate calculator	+130	
3. Adjust for:		
a. Residual soil nitrate in top 2 ft (e.g., 40 lb N/acre)		-40
b. Soil organic matter (e.g., < 1%)	+20	
c. Cropping system (e.g., grain pulse crop grown once)		-10
d. Stubble (e.g., legume prior crop)	0	0
e. Soil sampling time (e.g., fall)		-25
f. Soil sampling depth (e.g., soil test at 2-4 ft = 44 lb N/acre)		-22
4. Total fertilizer N need	53 lb/acre	

Phosphorous & Potassium Because phosphorous (P) and potassium (K) are less plant available than nitrate, application rates are determined by soil tests designed to estimate plant availability. See *Developing Fertilizer Recommendation for Agriculture* to get more information about rate recommendations based on soil tests.

There are 3 approaches used to determine P and K fertilizer rates:

1. Sufficiency: apply the minimum amount of fertilizer necessary to maximize yield.

2. Maintenance: replace only the nutrients removed at harvest, generally used when soil test levels are above 'critical' levels, meaning levels where additional fertilizer is generally not worthwhile.

3. Build: apply fertilizer to increase nutrient availability over time and save on fertilizer in future seasons.

Sulfur MSU fertilizer guidelines do not contain S guidelines due to a number of inconsistencies with testing for, and responses to, application. The best way to determine if S applications will result in positive responses is to test a field for increases in yield (or grain protein) after applying soluble S fertilizer in strips.

Micronutrients Mineral micronutrients, naturally present in soil, are required by plants in lower quantities than macronutrients and therefore deficiencies are uncommon. Montana's micronutrient fertilizer guidelines (for B, Cu, Fe, Mn, and Zn) are independent of crop. General guidelines for micronutrient fertilizer rates based on soil test results are given in *Developing Fertilizer Recommendation for Agriculture*. One exception is Cl, the only micronutrient with a confirmed deficiency in Montana, documented only in wheat. For wheat, apply about 20 lb Cl/acre if plants appear Cl deficient or soil levels are below 12 lb Cl/acre. If K needs are met with 50 lb KCl (0-0-60)/acre, this should more than meet the crop's Cl needs.

DETERMINATION OF FERTILIZER COSTS

Caution must be used in calculating costs per ton or per acre because fertilizers do not contain 100 percent of any one nutrient (see Calculation Box 4).

CALCULATION BOX 4. Cost per pound of N and cost per acre of urea
EXAMPLE: urea (46-0-0) Urea nutrient fraction = 0.46 lb N/lb urea (46% N) Cost of urea = $400/ton (example cost) Urea application rate = 50 lb N/acre (example rate) *CALCULATION:* Cost/lb N = cost of fertilizer per ton / (2000 lb x nutrient fraction) = $0.43/lb N (note: NOT per lb fertilizer) Cost of urea/acre = (cost/lb N) x application rate = $0.43/lb N x 50 lb N/acre = $22 of urea/acre

For more information:

Developing Fertilizer Recommendations for Agriculture MT200703AG

Fertilizer Guidelines for Montana Crops EB0161

Interpretation of Soil Test Reports for Agriculture MT200702AG

Soil Sampling Strategies MT200803AG

Available under "Extension publications" at http://landresources.montana.edu/soilfertility/ or at MSU Extension Publications, (406) 994-3273, http://msuextension.org/store.

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