

Fertilizing Barley in Minnesota

George Rehm, Michael Schmitt, and Robert Munter



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In Minnesota, barley is grown for malting as well as a feed grain. Yields of this important crop have improved steadily in recent years and proper fertilizer use has been one reason for this continuing improvement.

The use of barley in the brewing industry is well known and, when sold for malting purposes, barley is a very stable crop in Minnesota's economy. The importance of barley as a feed grain is often overlooked. Yet, this crop can easily substitute for corn in feeding rations. This substitution is especially important where soils are sandy. These soils have a low water holding capacity and drought frequently limits corn yields.

Nitrogen Suggestions:

The amount of nitrogen (N) fertilizer applied can have a major impact on yield as well as the protein percentage in the grain. For most crops, there is an advantage to having high protein content. High protein concentrations in the grain, however, are not desirable when barley is grown for malting purposes. Therefore, special attention should be given to N management.

There are two approaches to arriving at fertilizer N recommendations for barley. One approach is to base recommendations for fertilizer N on the results of the soil nitrate test. The soil nitrate test is recommended for western Minnesota (see Figure 1). When the soil nitrate test is used, the amount of fertilizer N needed to meet the yield goal is calculated from the following equations.

Barley For Malting:

$$N_{Rec} = (1.5) YG - STN_{(0-24 \text{ in.})} - N_{pc}$$

Barley For Feed Grain:

$$N_{Rec} = (1.7) YG - STN_{(0-24 \text{ in.})} - N_{pc}$$

The following abbreviations are used in these equations.

- YG = yield goal, bu./acre
- STN = nitrate-nitrogen (NO₃-N) measured to a depth of 2 feet, lb./acre
- N_{pc} = amount of N supplied by the previous crop, lb./acre

These N credits are summarized in Table 1.

Nitrogen credits should also be used when barley is grown in the second year after any of the legume crops listed above. For these situations, use of the N credit listed in Table 2.

The soil nitrate test is becoming more popular as a N management tool. The soil samples needed for measurement of carryover NO₃-N can be collected in either fall or spring. It is usually easier to collect samples in early fall. If possible, delay sampling until soil temperature drops below 50°F.

The amount of fertilizer N needed can also be based on yield goal, previous crop, and soil organic matter content. These N suggestions are summarized in Table 3.

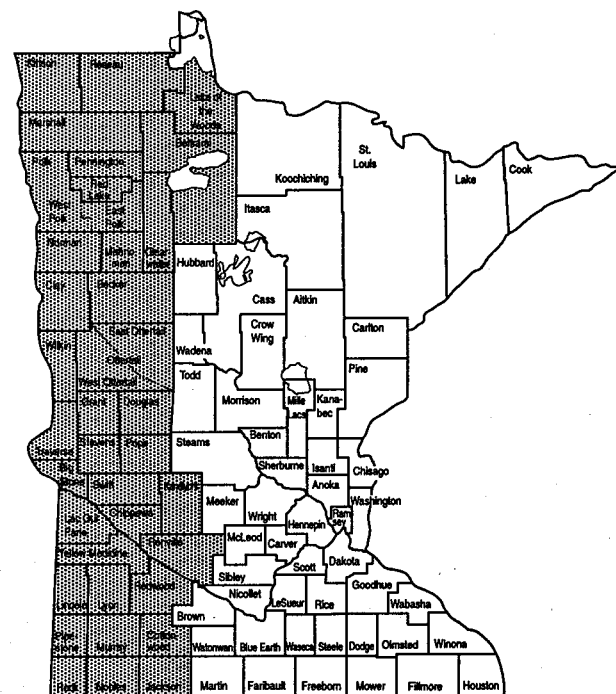


Figure 1. The soil nitrate test should be used for nitrogen recommendations in the counties that are shaded.

Table 1. Nitrogen credits for various crops that might precede barley in a crop rotation.

Previous Crop	1st Year Nitrogen Credit
soybeans	20 lb. N/acre
edible beans, field peas harvested	10 lb. N/acre
sweet clover	10 lb. N/acre
harvested alfalfa* or non-harvested sweet clover	
4-5 plants/ft ²	75 lb. N/acre
2-3 plants/ft ²	50 lb. N/acre
1 or fewer plant/ft ²	none
harvested red clover	35 lb. N/acre

* If 3rd or 4th cutting was not harvested, add 20 lb. N/acre to credits listed.

The nitrogen supplied by legume crops can also be utilized by the barley crop if it is planted 2 years after the legume. The nitrogen credits for these situations are summarized below. Subtract these values from the nitrogen recommendations that are listed for crops grown in Group 2 for the appropriate yield goal (see Table 3).

Table 2. Nitrogen credits when barley is grown 2 years after a legume crop.

Previous Legume Crop	Nitrogen Credit for 2nd Year
	-- lb./acre --
alfalfa (4+ plants/ft ²), non-harvested sweet clover	35
alfalfa (2-3 plants/ft ²), alsike clover, birdsfoot trefoil	25
red clover	20

Table 3. Nitrogen recommendations for barley for situations where the soil nitrate test is not used.

Crop Grown Last Year	Organic* Matter Level	Yield Goal (bu./acre)						
		Less than 50	50-59	60-69	70-79	80-89	90-99	100+
----- N to apply (lb./acre) -----								
alfalfa, (4+ plants/ft ²) non-harvested sweet clover	low	0	0	10	25	40	55	70
"	medium and high	0	0	0	0	20	35	50
soybeans	low	30	50	65	80	95	110	125
"	medium and high	0	30	45	60	75	90	105
edible beans, field peas, harvested sweet clover	low	40	60	75	90	105	120	135
"	medium and high	0	40	55	70	85	100	115
any crop in Group 1	low	0	20	35	50	65	80	95
"	medium and high	0	0	15	30	45	60	75
any crop in Group 2	low	50	70	85	100	115	130	145
"	medium and high	30	50	65	80	95	110	125
organic soil	—	0	0	0	0	30	40	50

* Low = less than 3.0%; medium and high = 3.0% or more

CROPS IN GROUP 1

alfalfa (2-3 plants/ft²)
 alsike clover
 birdsfoot trefoil
 grass/ legume hay
 grass/ legume pasture
 fallow
 red clover

CROPS IN GROUP 2

alfalfa (0-1 plants/ft ²)	grass/pasture	sugarbeets
barley	millet	sunflowers
buckwheat	mustard	sweet corn
canola	oats	triticale
corn	potatoes	wheat
flax	rye	vegetables
grass/hay	sorghum-sudan	

Managing Nitrogen

Researchers have found that the majority of the total amount of essential nutrients used by barley is absorbed from the soil between the tillering and heading growth stages. Therefore, it's important to have an adequate supply of all nutrients in the root zone early in the growing season.

Since N is mobile in soils and can move to the roots with soil water, there can be considerable flexibility in the management of this important nutrient. Fertilizer N can be applied in the fall for barley production in most of Minnesota. There are some exceptions. Fall application of fertilizer N is discouraged when soils are sandy. Split applications are encouraged for very sandy soils. For these situations, the first application can be made before planting. The remainder should be applied at or near tillering. In southeast Minnesota, fertilizer N should be applied in the spring and incorporated before planting. Fall application of fertilizer N is discouraged in the region.

Split N applications are strongly encouraged when irrigated barley is grown on sandy soils. For this production system, some N should be applied before planting and combined with a N application at the tillering to early boot stage. The ideal percentage of total N to use at each application has not been determined. It may be practical to apply 1/2 of the total N needed before planting and the remaining 1/2 at the tiller to early boot stage.

If applied properly, all of the common N fertilizers will have an equal effect on barley yields. Some precautions in the application of some N sources are necessary. With anhydrous ammonia (82-0-0), there can be loss during application. If white fumes appear during application, some change in application technique is needed. Nitrogen loss may also occur if urea (46-0-0) is not incorporated where soil pH is higher than 7.3, air temperatures are high, and the weather is windy and dry. Shallow incorporation of urea as well as fertilizers containing urea is highly recommended when these N sources are used for barley production.

Urea-ammonium nitrate solution (28-0-0) can be applied either before planting or as a foliar treatment. The foliar application may cause some leaf burning, but there will be no reduction in yields if reasonable rates are used. Leaf burn may be excessive if foliar N rates exceed 60 lb. per acre. The fall application of 28-0-0 is not considered to be a best management practice and should be discouraged.

Phosphate Suggestions

Suggestions for phosphate fertilizer use are summarized in Table 4. The phosphorus status of Minnesota soils is determined by using either the Bray or the Olsen analytical procedure in the laboratory. In general, the Olsen test provides more accurate recommendations if the soil pH is 7.4 or higher.

The phosphate suggestions change with soil test level and placement. At very low, low, and medium soil test levels, the needed phosphate can be broadcast and incorporated before planting or applied with the drill at planting. Rates can be reduced substantially if the phosphate fertilizer is applied with the drill.

No broadcast phosphate is suggested when the soil test for P is high (Bray = 16-20 ppm P; Olsen = 12-15 ppm P). A small amount of phosphate applied with the drill is suggested for these situations. No phosphate fertilizer will be needed when the soil test for P is in the very high range (Bray = 21+ ppm P; Olsen = 16+ ppm P) unless soils are cold and wet at planting. In north-central Minnesota, soils may be cold and wet at planting time. Even though the soil test for P may be high, some phosphate fertilizer (10 lb. P₂O₅/acre) placed in a band near the seed may improve barley yields on these soils.

Potash Suggestions

Suggestions for the use of potash fertilizer are summarized in Table 5. As with phosphate, suggestions vary with placement and soil test level for K. No broadcast potash will be needed when the soil test K is 121 ppm or higher. No potash (either banded or broadcast) is suggested when the soil test for K is 161 ppm or higher.

It may not be practical to broadcast some of the low rates of phosphate and potash that are suggested. For these situations, it may be more practical to double the suggested broadcast rate and apply in alternate years if the grain drill is not equipped to apply fertilizer with the seed.

Any phosphate and/or potash that is broadcast should be incorporated before seeding. These nutrients do not move in most soils and will have very little effect on production if they are topdressed to an established stand. Application before a primary tillage operation is preferred.

Table 4. Phosphate fertilizer suggestions for barley production in Minnesota.*

Yield Goal	Phosphorus (P) Soil Test (ppm)											
	v. low		low		med.		high		v. high			
	Bray:	0-5	6-10	11-15	16-20	21+	Olsen:	0-3	4-7	8-11	12-15	16+
	Bdcst or Drill		Bdcst or Drill		Bdcst or Drill		Bdcst or Drill		Bdcst or Drill		Bdcst or Drill	
bu./acre	----- lb. P ₂ O ₅ /acre to apply -----											
less than 50	35	20	25	15	15	10	0	10-15	0	0		
50 - 59	40	20	25	15	15	10	0	10-15	0	0		
60 - 69	45	25	30	15	20	15	0	10-15	0	0		
70 - 79	50	25	35	20	20	15	0	10-15	0	0		
80 - 89	60	30	40	20	25	15	0	10-15	0	0		
90 - 99	65	35	45	25	25	15	0	10-15	0	0		
100+	70	35	50	25	30	20	0	10-15	0	0		

* Use one of the following equations if a phosphate recommendation for a specific soil test and a specific yield goal is desired.

$$P_{2O_{5Rec}} = [0.785 - (.039) (\text{Bray P soil test, ppm}) (\text{yield goal}) \\ [0.785 - (.050) (\text{Olsen P soil test, ppm}) (\text{yield goal})]$$

Table 5. Potash fertilizer suggestions for barley production in Minnesota.*

Yield Goal	Potassium (K) Soil Test (ppm)									
	v. low 0-40		low 41-80		med. 81-120		high 121-160		v. high 161+	
	Bdcst or Drill		Bdcst or Drill		Bdcst or Drill		Bdcst or Drill		Bdcst or Drill	
<i>bu./acre</i>	----- <i>lb. K₂O/acre to apply</i> -----									
less than 50	50	25	40	20	20	15	0	10-15	0	0
50 - 59	60	30	45	25	25	15	0	10-15	0	0
60 - 69	70	35	50	25	30	20	0	10-15	0	0
70 - 79	85	40	60	30	35	25	0	10-15	0	0
80 - 89	95	50	65	35	40	25	0	10-15	0	0
90 - 99	105	55	75	40	45	30	0	10-15	0	0
100+	110	55	80	40	50	35	0	10-15	0	0

* Use the following equation if a potash recommendation for a specific soil test and a specific yield goal is desired.

$$K_2O_{Rec} = [1.286 - (.0085) (K \text{ soil test, ppm})] (\text{yield goal})$$

Fertilizer With The Drill

Since most of the small grain acreage in Minnesota is usually planted in early spring when soil conditions are cold and wet, the application of fertilizer with the drill should be a standard management practice. **CAUTION! Do not** apply more than 5 lb. N/acre as urea in contact with the seed (in the row). If the soil is dry at planting time, do not apply more than 40 lb. N plus K₂O per acre with the drill. Higher rates can be used if the soil is wet at planting time. **Do not** place ammonium thiosulfate (12-0-0-26) in direct contact with the seed. **Do not** place boron fertilizers in direct contact with the seed. Phosphate in fertilizers has no negative effect on seed germination and seedling growth. Therefore, ample amounts of phosphate can be placed in contact with the seed.

Other Nutrients Needed

For barley production, major emphasis should be directed to efficient and effective management of nitrogen, phosphate, and potash fertilizers. Sulfur and copper can be important in limited situations as described below:

Sulfur: Sulfur (S) can increase barley yields when the crop is grown on sandy soils. Research trials have shown that there is no need to add S to a fertilizer program when barley is grown on fine-textured soils in Minnesota.

The broadcast application of 25 lb. S per acre in the sulfate form will be adequate for growing barley when S is needed. For more efficient applications, use 10-15 lb. S per acre with the drill at planting. The sulfate form is also suggested for this method of application.

Copper: Copper (Cu) may be required in a fertilizer program when barley is grown on organic soils. Suggestions for Cu use are summarized in Table 6.

Table 6. Suggestions for use of copper in a fertilizer program when barley is grown on an organic soil.

Copper Soil Test	Method of Application			
	Broadcast		Foliar Spray	
	Copper	Copper Sulfate	Copper	Copper Sulfate
<i>ppm</i>	----- <i>lb./acre to apply</i> -----			
0-2.5 (low)	6-12	24-48	0.3	1.2
2.6-5.0 (marginal)		trial only	0.3	1.2
more than 5.0 (adequate)	0	0	0	0

These suggestions are for organic soils only. The use of Cu in a fertilizer program is not suggested in Minnesota when barley is grown on mineral soils.

Research from throughout Minnesota has shown that magnesium, calcium, boron, zinc, iron, and manganese are not needed in fertilizer programs for barley production. Most soils are able to supply ample amounts of these nutrients for crop production.

Related Publications

The following publications provide more details for fertilizer management. They are available in the local county extension office.

- AG-FO-0648 *Copper for Organic Soils*
- AG-FO-2774 *Using the Soil Nitrate Test for Corn in Minnesota*
- AG-FO-0792 *Phosphorus for Minnesota Soils*
- AG-FO-0636 *Fertilizer Urea*
- AG-FO-3073 *Using Anhydrous Ammonia in Minnesota*
- AG-FO-0794 *Sulfur for Minnesota Soils*



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