University of Idaho
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CIS 954

Northern Idaho Fertilizer Guide

Winter Barley

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The following fertilizer guidelines were developed through research conducted by the University of Idaho and Washington State University. The guidelines are based on relationships between soil test data and yields of winter barley. The suggested fertilizer rates are designed to produce above-average yields if other factors such as pests, soil moisture, planting date, and stand are not limiting production. Thus, the fertilizer guidelines assume the use of sound management practices.

The suggested fertilizer rates will be accurate for a given field provided (1) soil samples are properly taken and represent the area to be fertilized and (2) the crop history you supply is complete and accurate. For assistance in obtaining a good soil sample, refer to BUL 704, *Soil Sampling*.

Nitrogen

Nitrogen (N) rates for optimal winter barley production depend on previous fertilizer applications, soil type, level of soil organic matter, soil depth, length of growing season, pest control, and other management practices. In addition, the amount of N fertilizer needed depends on

- The potential yield of the variety based on its historical yield in your location and at your management level.
- The amount of usable N in the soil profile. This includes mineralizable N released from organic matter during the growing season and inorganic N in the forms of nitrate (NO_3^-) and ammonium (NH_4^+).
- Total annual precipitation and other climatic factors.
- The density and vigor of the plant stand.
- The lodging potential of the variety.
- The use of yield-sustaining inputs such as fungicides to control diseases.
- The type and yield of the previous crop.

In areas of low annual precipitation (18 inches or less), determine soil moisture in the profile and adjust N fertilizer rates accordingly. In these low-moisture areas and in areas with shallow soil (2 to 3 feet maximum depth), adjust the recommended N fertilizer rate to fit the yield potential as it is limited by factors such as available soil moisture. For information on adjusting N fertilizer rates in areas of low precipitation contact the extension educator in your county.

Fertilizer nitrogen based on soil testing

Use the following equation to determine the amount of fertilizer N to apply to meet your crop's need:

$$\text{Fertilizer } N \text{ needed} = \left(\underset{\text{(Table 1)}}{\text{N needed based on potential yield}} + \underset{\text{(Table 2)}}{\text{N needed for residue breakdown}} \right) - \left(\underset{\text{(Table 3)}}{N \text{ Credit}} + \underset{\text{(Table 4)}}{\text{Mineralizable } N} + \underset{\text{(Table 5)}}{\text{Soil test } N} \right)$$

Nitrogen needed based on potential yield—Estimates of N needed to produce a crop of winter barley in a particular field should be based on potential yield—the field's long-term average yield. Multiply the potential yield in pounds per acre by 0.039, 0.042, or 0.046 pounds N, depending on annual precipitation, to arrive at total N needed (Table 1). Increasing N rates are needed as precipitation increases because leaching results in reduced N use efficiency. If, for example, annual precipitation is 20 inches and the potential yield is 3,200 pounds per acre, then 0.039 x 3,200 or 125 pounds N per acre are needed.

Table 1. Estimated total N needed for winter barley based on potential yield.

Annual precipitation	N needed
(inches)	(lb/acre)
21 or fewer	0.039 x potential yield (bu/acre)
22 to 24	0.042 x potential yield (bu/acre)
More than 24[1]	0.046 x potential yield (bu/acre)

[1] If you are in an annual precipitation area above 24 inches **and** you apply more than 60 percent of your fertilizer N after March 1, use the 0.042 factor.

Nitrogen needed for residue breakdown—Nitrogen is needed to break down straw from the previous cereal crop. Apply 15 pounds available N for each ton of straw incorporated into the soil up to 50 pounds N per acre (Table 2). Remember, 1 ton of residue is produced for each 20 bushels of wheat or 1,400 pounds of barley grain produced.

Table 2. Nitrogen needed for cereal straw (residue) breakdown.

Residue	N need
(tons)	(lb/acre)
0	0
0.5	7.5
1	15
2	30
3	45
4 or more	50

Note: One ton of residue is produced for each 20 bushels of wheat or 1,400 pounds of barley grain produced.

Nitrogen credit from previous legume crop—If the previous crop was a legume (peas, chickpeas, alfalfa, clover, or lentils) the residue constitutes a nitrogen credit. This value, which can be obtained in Table 3, should be subtracted from the total N needed to produce the winter barley crop.

Table 3. Nitrogen credit for legume straw (residue) breakdown.

Residue	N need
(tons)	(lb/acre)
0	0
0.5	8
1	15
1.5	23
2	30
3	45
4	60

Note: One ton of legume residue is produced from each 1,400 pounds of lentil or pea grain produced.

Mineralizable nitrogen—Soils vary in their capacities to release N from organic matter during the growing season. The rate or amount of N released depends on factors such as the amount of soil organic matter, soil erosion, available soil moisture, tillage practice, and soil temperature during the growing season.

Estimated mineralization values for N release are shown in Table 4. Soils that are farmed using reduced tillage systems are often colder in the spring than conventionally tilled soils. Consequently, N mineralization rates are slightly higher in conventionally tilled fields.

Table 4. Mineralizable nitrogen release rates for northern Idaho soils.

Organic matter content	Tillage: Conventional	Tillage: Reduced
(%)	------------(lb N/acre/year)------------	
< 1.0	20	17
1.0	20	17
1.1	22	19
1.2	24	20
1.3	26	22
1.4	28	24
1.5	30	26
1.6	32	27
1.7	34	29
1.8	36	31
1.9	38	32
2.0	40	34
2.1	42	36
2.2	44	37
2.3	46	39
2.4	48	41
2.5	50	43
2.6	52	44
2.7	54	46
2.8	56	48
2.9	58	49
3.0 +	60	51

Soil test nitrogen—The amount of available N in the soil can be evaluated most effectively with a soil test. Soil samples should represent the rooting depth of the crop because nitrate-nitrogen (NO_3-N) is mobile in soil. Winter barley is capable of removing N to a depth of 3 feet.

Soil test values include both NO_3-N and ammonium-nitrogen (NH_4-N) in the first foot of the soil profile. NO_3-N should be sampled in 1-foot increments to the crop's effective rooting depth. To convert soil test NO_3-N and NH_4-N values in parts per million (ppm) to pounds per acre, add the N values (ppm) for each foot of sampling depth and multiply by 3.5 (Table 5).

Table 5. Example of calculation to convert N soil test results in parts per million to pounds per acre.

Depth	Soil test results: NO_3-N	Soil test results: NH_4-N	Soil test results: Total N	Factor		Total N[1]
(inches)	(ppm)	(ppm)	(ppm)			(lb/acre)
0 to 12	5	1	6	x 3.5	=	21
12 to 24	2	—	2	x 3.5	=	7
24 to 36	2	—	2	x 3.5	=	7
Total	9	1	10	x 3.5	=	35

[1] ppm x 3.5 = lb/acre.

Calculation for nitrogen fertilizer needed–

Total N needed (lb/acre) (Table 1 + Table 2)		______
Minus N credit (lb/acre) (Table 3)	–	______
Minus mineralizable N (lb/acre) (Table 4)	–	______
Minus soil test N (lb/acre) (Table 5)	–	______
Equals fertilizer N needed (lb/acre)	=	______

Example: With an annual precipitation of 21 inches and a potential yield of 5,000 pounds per acre, 2.5 percent organic matter (conventional tillage), 1 ton legume straw residue, and soil test values from the example in Table 5, you would need 95 pounds N per acre:

Total N needed (Table 1 + Table 2)	(137 + 0)		195
Minus N credit (Table 3)		–	15
Minus mineralizable N (Table 4)		–	50
Minus soil test N (Table 5)		–	35
Equals fertilizer N needed		=	95*

*7 lb/acre more fertilizer N would be needed if this were a reduced tillage system.

Phosphorus

Winter barley has a relatively moderate phosphorus (P) demand, but an adequate amount must be available for use by the plant (Table 6). Thus, if the soil level of P is low, the crop will respond to applied P.

If your soil contains more than 4 ppm based on the NaOAc soil test method (or > 40 ppm using the Bray I method or > 12 ppm using the $NaHCO_3$ method) additional fertilizer P is not needed. However, if you are using reduced tillage you may apply up to 30 pounds P_2O_5 in a band. This band containing P should be placed either below or with the seed at planting.

Phosphorus should be either banded or incorporated into the seedbed before or at planting. Broadcast-plowdown, broadcast-seedbed incorporated, and drill-banding are commonly used methods of application. Drill banding P is usually the most efficient application method, allowing placement with, below, or to the side of the seed. Choose whichever application method is most convenient. *Note*: If the P material banded with the seed contains N, do *not* apply more than 20 pounds N per acre.

Table 6. Phosphorus fertilizer rates for winter barley based on a soil test.

Soil test P (0 to 12 inches)[1]			Application rate[2]	
NaOAc	Bray I	$NaHCO_3$	P_2O_5	P
(ppm)	(ppm)	(ppm)	(lb/acre)	(lb/acre)
0 to 2	0 to 20	0 to 8	60	26
2 to 3	20 to 30	8 to 10	40	18
3 to 4	30 to 40	10 to 12	20[3]	9
over 4	over 40	over 12	0[3]	0

[1]Soil test P can be determined by three procedures: sodium acetate (NaOAc), Bray I method, or sodium bicarbonate ($NaHCO_3$). Sodium bicarbonate should not be used on soils with pH values less than 6.2. Use the column indicated by your soil test report.

[2]P_2O_5 x 0.44 = P, or P x 2.29 = P_2O_5.

[3]Under reduced tillage you can apply up to 30 lb P_2O_5 per acre in a band either with or below the seed at planting, regardless of P soil test level.

Potassium

Winter barley has a relatively low demand for potassium (K). Few soil samples have soil test values low enough to warrant the use of K fertilizer. Those that do are usually from eroded areas of hilltops, clay knobs, or both. Apply K fertilizer as needed according to a soil test (Table 7).

Potassium should be incorporated into the seedbed before or at planting. Broadcast-plowdown, broadcast-seedbed incorporated, and drill-banding are effective methods of application. Drill-banded fertilizer can be placed with, below, or to the side of the seed. Choose whichever application method is most convenient. The total of N plus K (as K_2O) applied with the seed should not exceed 20 pounds per acre due to potential harm to the seed.

Table 7. Potassium fertilizer rates for winter barley based on a soil test.

	Application rate[2]	
Soil test K (0 to 12 inches)[1]	K_2O	K
(ppm)	(lb/acre)	(lb/acre)
0 to 35	80	66
35 to 75	60	50
More than 75	0	0

[1]Sodium acetate extractable K.

[2]K_2O x 0.83 = K, or K x 1.20 = K_2O.

Sulfur

Sulfur (S) requirements for winter barley are influenced by soil texture, soil organic matter, the previous crop, and fertilizer history. A soil testing less than 10 ppm SO_4-S or less than 4 ppm S should receive 15 to 20 pounds S per acre. Avoid using elemental S. Use a material containing sulfate. Sulfur deficiency appears as a yellowing of the plant early in the growing season and is visually indistinguishable from N deficiency. Sulfur needs of winter barley based on soil test results are in Table 8. Sulfur application rates should never exceed 25 pounds S (as sulfate) per acre.

Table 8. Sulfur fertilizer needs of winter barley based on a soil test.

Soil test S (0 to 12 inches)		S application rate
(ppm SO_4-S)	(ppm S)	(lb/acre)
0 to 10	0 to 4	20
over 10	over 4	0

Micronutrients and lime

Winter barley responses to micronutrients have been uncommon in northern Idaho. If you are in doubt about your soil's needs, have the soil tested and consult the extension educator in your county.

Try experimental lime applications on highly acid soils (less than pH 5.3) to determine whether the crop gives an economical response. Apply lime at a rate of 1 to 2 tons per acre and mix it well into the soil. For additional information see CIS 811, *The Relationship of Soil pH and Crop Yields in Northern Idaho*.

Agronomy/Water quality considerations

- Soil sampling is an essential component of nutrient management. To learn more about soil sampling procedures, the correct soil sampling tools, and the handling of your soil sample refer to University of Idaho Bulletin 704, *Soil Sampling*.
- Weeds, insects, diseases, and environmental stress can influence the effectiveness of a fertilizer program and reduce yields.
- Poor N management can result in excessive nitrate leaching and groundwater pollution under certain conditions. Poor management practices can cause excessive erosion and contamination of surface waters with P.
- The ammoniacal forms of N (ammonium and ammonia) do not leach as readily as nitrate. When temperature and moisture are favorable for plant growth, however, ammoniacal N and urea are quickly converted to nitrate. Thus, N applied in the early fall, regardless of its form, is subject to leaching in areas of heavy precipitation.
- N-Serve and other N stabilizers block conversion of ammonium to nitrate. Results obtained from N stabilizers are inconsistent although N fertilizer losses have been reduced in some areas. N stabilizers have not been effective in deep, dark-colored soils that have high organic matter contents.
- Cutover timberlands (which usually have clayey subsoils) used for barley production are not as susceptible to leaching losses because of the low permeability of the subsoil. Low permeability, however, makes these soils subject to wetness or waterlogging that can result in N loss by denitrification (conversion of nitrate into gaseous forms of N that dissipate into the atmosphere).
- Nitrogen applied to winter barley after jointing or at excessive rates can increase lodging hazard and produce higher protein levels.
- Lodging of winter barley is a common production hazard with recommended production practices. Reduced N rates may help to minimize lodging losses in highly productive fields.
- Early planting of winter barley usually produces higher yields; however, it can increase the potential for disease.
- Starter, or pop-up, fertilizers have limited success. Starter fertilizers have been most effective when soils were cold and root growth could be stimulated by a readily available supply of both P and N.
- Avoid banding high amounts of fertilizer close to the seed. High amounts of N and K can result in salt damage during germination.
- Banding fertilizer improves N and P use efficiency. Consequently, if applying N, P, or both in a band, cut the recommended fertilizer application rates by 10 to 15 percent.
- Lower soil disturbance in reduced tillage systems results in lower soil temperature, which in turn reduces organic matter mineralization rates. Consequently, N fertilization rates are often slightly higher in reduced-tillage systems.

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