University of Idaho
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CIS 920

Northern Idaho Fertilizer Guide

Spring 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 spring 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 your field if (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 University of Idaho Bulletin 704, *Soil Sampling*.

Nitrogen

Nitrogen (N) rates for spring barley depend upon previous fertilizer applications, soil type, level of soil organic matter, soil depth, length of growing season, pest control, and other management practices.

The amount of N fertilizer needed for optimal production also depends on the barley's intended use—malting or feed grain. The fertilizer rates recommended in this publication are for feed barley. To achieve desirable protein levels when growing malting barley, decrease the rates recommended here by 20 to 25 percent.

The amount of N fertilizer also depends on:

- The potential yield of the variety based on its historical yield in your location.
- 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.
- Density and vigor of the plant stand.
- The use of yield-sustaining inputs such as fungicides to control diseases and plant growth regulators to reduce lodging.
- 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 soils (2 to 3 feet maximum depth), adjust the recommended N fertilizer rate to fit yield potential limited by available soil moisture.

Nitrogen fertilizer based on soil testing—Use the following equation to determine the amount of fertilizer N to apply to meet your crop's need:

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

Nitrogen needed based on potential yield—Estimates of N needed to produce a crop of spring barley should be based on potential yield. This potential yield should be the long-term average yield for the selected field adjusted to reflect management changes that influence yield potential. Assume 4 pounds N per acre are required to produce 100 pounds spring barley with the optimal protein content for feed barley in the annual precipitation zone of 21 inches or less (Table 1).

Table 1. Total N need of spring barley based on potential yield.

Annual precipitation	N needed
(inches)	(lb/acre)
21 or fewer	0.040 x potential yield (lb/acre)
22 to 24	0.043 x potential yield (lb/acre)
More than 24	0.046 x potential yield (lb/acre)

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 to add
(tons)	(lb/acre)
0	0
0.5	7.5
1	15
2	30
3	45
4	50
More than 4	50

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

Nitrogen credit from previous legume crop—If the previous crop was a legume (peas, chickpeas, alfalfa, clover, birdsfoot trefoil, or lentils), the residue constitutes a small nitrogen credit. This credit is much smaller for a spring-seeded crop such as spring barley because at least 60 percent of the legume residue has already broken down and the resulting plant-available N will be accounted for in a soil test. The N credit value for the previous legume can be obtained in Table 3. This value should be subtracted from the total N needed to produce the spring barley crop.

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

Residue	N credit
(tons)	(lb/acre)
0	0
0.5	3
1	6
1.5	9
2	12
3	18
4	24

Note: One ton of legume residue is produced from 1,000 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, past soil erosion, available soil moisture, and soil temperature during the growing season.

Four different mineralizable N release rates are used for northern Idaho soils (Table 4). Low N release rates are found on severely eroded clay knobs and hilltops, in cutover timberland soils, in soils in areas of low precipitation, in soils with low water-holding capacities, and in soils with low organic matter contents.

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

Organic matter content	Release rate	N released during growing season
(%)		(lb/acre)
Less than 2	Low	25
2 to 3	Medium	45
3 to 4	Moderately high	60
More than 4	High	75

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. Spring 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.

	Soil test results					
Depth	NO_3-N	NH_4-N[1]	Total N	Factor		Total N[2]
(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] Ammonium (NH_4-N) content is usually low and is often not included in soil test analyses.
[2] ppm x 3.5 = lb/acre.

Nitrogen fertilizer required—The calculation for N fertilizer needed is:

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

For example, with a potential yield of 3,500 pounds per acre in a 23-inch precipitation zone, 2.5 percent organic matter, no straw residue, no legume residue, and soil test values from the example in Table 5, you would need 53 pounds N per acre:

Total N needed (lb/acre) (Table 1 + Table 2)	(150 + 0)		150
Minus mineralizable N (lb/acre) (Table 3 + Table 4)	(0 + 45)	–	45
Minus soil test N (lb/acre) (Table 5)		–	52
Equals N fertilizer needed (lb/acre)		=	53

Phosphorus

Spring barley has a relatively low 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.

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

Soil test P (0 to 12 inches)			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 different 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.

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.

Potassium

Spring 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).

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

Soil test K (0 to 12 inches)[1]	Application rate[2] 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.

K 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.

Sulfur

Sulfur (S) requirements for spring barley are influenced by soil texture, soil organic matter content, the previous crop, and fertilizer history. A soil testing less than 10 ppm SO_4-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. Have the soil tested if you suspect a deficiency. Sulfur needs of spring barley based on a soil test are shown in Table 8.

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

Soil test S (1 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

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

Soil pH values in northern Idaho have declined dramatically over the past 40 years. This steep decline has led to a reduction in yields of several crops. Research conducted in the 1980s showed that barley yields are unaffected as long as soil pH values (in the surface foot of the soil profile) remain at or above pH values of 5.3. Research shows that barley yield reductions of 7, 17, 26, 36, and 46 percent can be expected at soil pH values of 5.2, 5.1, 5.0, 4.9, and 4.8, respectively.

Try experimental lime applications on highly acid soils (less than pH 5.3) to determine whether the crop gives an economical response. Apply needed lime at a rate of 1 to 2 tons per acre and mix it thoroughly into the soil. For additional information see University of Idaho 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 the nitrate form at temperatures above 50ºF. Thus, N applied in the spring, regardless of its form, is subject to leaching in areas of heavy precipitation.
- Nitrogen applied to winter barley after the boot stage or at excessive rates can increase lodging hazard and produce higher protein levels.
- Fall N fertilization for spring cereal crop production is acceptable as long as the risk of groundwater contamination is not high based on the USDA-NRCS Idaho Nutrient Transport Risk Assessment (INTRA) model.
- 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 spring barley usually produces higher yields; however, it can increase the potential for disease.
- Starter, or pop-up, fertilizers have had 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 temperatures, which in turn reduces organic matter mineralization rates. Consequently, N fertilization rates are often slightly higher in reduced tillage systems.

Further reading

BUL 704, *Soil Sampling*, $2.00
CIS 811, *The Relationship of Soil pH and Crop Yields in Northern Idaho*

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CIS 453, *Winter Wheat*
CIS 785, *Winter Rapeseed*
CIS 788, *Bluegrass Seed*
CIS 815, *Blueberries, Raspberries, and Strawberries*
CIS 820, *Grass Seedings for Conservation Programs*
CIS 826, *Chickpeas*
CIS 851, *Legume and Legume-Grass Pastures*
CIS 853, *Grass Pastures*
CIS 911, *Northern Idaho Lawns*, also available in print for $1.00
CIS 920, *Spring Barley*
CIS 954, *Winter Barley*
CIS 1012, *Spring Canola*
CIS 1083, *Lentils*
CIS 1084, *Spring Peas*
CIS 1101, *Soft White Spring Wheat*

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