Southern Idaho Fertilizer Guide

Irrigated Winter Barley

Brad Brown, Soil Scientist
Parma Research and Extension Center

The following fertilizer guidelines are based on University of Idaho research that relates the yield response of irrigated winter barley to soil test N and applied nitrogen fertilizer. Guidelines for other nutrients are extrapolated from research on other winter small grains. The suggested fertilizer rates are designed to produce above average yields if other factors of production are not limiting. Thus, these fertilizer recommendations assume good management practices and no other limitations to production.

The suggested fertilizer rates also assume that soil samples are properly taken and processed, and that they represent the area to be fertilized. Many fields have appreciable variation in residual nutrient soil test levels or productivity. Areas within fields that differ significantly in residual fertility or productivity should be sampled and treated separately if the areas are large enough that application rates can be conveniently adjusted and the fertilizers cost effectively applied. Accurate crop history information is also essential for making appropriate fertilizer recommendations.

Nitrogen (N)

Adequate N is necessary for maximum economic production of irrigated winter barley. Nitrogen is usually the greatest fertilizer expense for winter barley in Idaho. The amount of N required depends on many factors that influence irrigated winter barley production and quality. Yield potential and available N from all sources (soil test, previous crop, and mineralizable N) should be considered when determining N fertilizer rates to use.

Total N Requirements Based on Potential Yield

Fertilizer N rates should correspond to the yield growers can reasonably expect for their soil and management conditions. Historical yields for a specific field or area will generally provide a fair approximation of yield potential, given the grower's traditional crop management. Projected changes in crop management (water management, variety, lodging control, disease and weed control) designed to appreciably increase production may require adjustment of yield potential.

Research in western Idaho has shown that the available N from all sources required to produce a bushel (48 pounds) of irrigated winter barley depends on several crop management practices. Factors such as weed, insect, and disease control as well as irrigation, planting date and soil type can influence the N required for maximum yield. Results of field trials suggest that two pounds of available N per bushel are required for irrigated winter barley ranging in yield from 120 to 160 bushels per acre. Nitrogen requirements are greater than two pounds per bushel when expected yields are below 100 bushels per acre. The total N required for a range of expected yields is given in Table 1.

Table 1. Total available N requirement of winter barley based on expected yield.

Yield potential	N requirement
(bu/acre)	(lb N/acre)
80	200
100	220
120	240
140	270
160	300
180	330

Available Nitrogen

Available N in the soil includes mineralizable N (released from organic matter during the growing season), inorganic N as nitrate (NO_3-N) and ammonium (NH_4-N), and N credits from previous cropping or manures. Each component of available N must be estimated for accurate determination of optimum fertilizer N rates.

Mineralizable Nitrogen–Soils vary in their capacity to release N from organic matter during the growing season. The amount of N released depends on such factors as soil type, soil moisture, soil temperature, previous crop, and the history of fertilizer N applied.

Measurements of mineralizable N for winter cereals typically range from 30 to 60 pounds per acre. Unless the capacity of a specific soil to release N is known, use a midpoint mineralizable N value of 45 pounds N per acre for irrigated winter barley. While soil organic matter content is frequently used to estimate annual mineralizable N contributions, in southern Idaho irrigated soils organic matter does not accurately predict the amount of N that is mineralized.

Inorganic Nitrogen–Residual soil inorganic N (NO_3, NH_4) can be evaluated most effectively with a soil test. Soil samples should be collected in foot increments to a depth of two feet, unless roots are restricted by dense soil layers or high water tables.

Ammonium N (NH_4-N) is generally low in preplant soil samples and thus contributes little to available N. However, it can be as high or higher than NO_3-N. NH_4-N should be determined along with NO_3-N, especially when there is reason to expect the presence of appreciable NH_4-N, such as recent ammonium N fertilizer applications.

To convert soil test NO_3-N and NH_4-N values to lb N per acre, sum the N expressed in ppm for each foot increment of sampling depth and multiply times four. An example is shown in Table 2.

Table 2. Soil test N conversion example.

Depth	NO_3-N	NH_4-N	Sum	Inorganic N[1]
(inches)	(ppm)	(ppm)	(ppm)	(lb/acre)
0 to 12	13	2	15	60
12 to 24	6	2	8	32
Total	19	4	23	92

[1]ppm x 4 = lb per acre

A preplant soil sample is often only collected from the first foot of soil. Although this information is not as complete and reliable as would be provided by deeper sampling, residual N measurements from the first foot of soil can be combined with **estimates** of residual N in the second foot to predict N requirements for irrigated winter barley. For fall-planted winter cereals in western Idaho, preplant soil test NO_3-N in the second foot of the soil is commonly only one-half to two-thirds as high as in the first foot of soil. If the residual N value is only available from the first foot of soil, estimate the NO_3-N in the second foot at 50 to 67 percent of the first value and sum over the two values. However, this estimate may not be accurate after potatoes or other sprinkler irrigated crops, especially in coarser textured soils. Basing N rate recommendations on estimates of residual N in the second foot increases the risk of recommending either too little or too much N.

Nitrogen From Previous Crop Residues–Nitrogen associated with decomposition of previous crop residues should also be considered when estimating available N. Residues that require additional N for decomposition include cereal straw and mature corn stalks. Research has shown that 15 pounds of additional N are needed per ton of straw returned to the soil, up to a maximum of 50 pounds. For more information on compensating for cereal residues, refer to CIS 825, *Wheat Straw Management and Nitrogen Fertilizer Requirements*.

Row crop residues (potatoes, sugarbeets, onions) generally do not require additional N for decomposition. Consequently, these residues have little effect on the N needs of winter barley.

Legume residues from beans, peas, and alfalfa can release appreciable N during the following crop season that may not be reflected by the preplant soil test. This N is derived from the decomposition of both plant tops and nodulated root systems. Table 3 estimates the net N contribution from previous cropping.

Table 3. Estimated nitrogen credit for previous crop.

Previous crop	Nitrogen credit
	(lb N per acre)
Grain or corn (mature residue returned)	-50
Grain or corn (residue removed)	0
Sweet corn (residue returned)	0
Row crops (potatoes, sugarbeets, onions)	0
Beans and Peas	40
Alfalfa	60

Nitrogen From Manures–Soils in which winter barley is grown occasionally receive animal manures or lagoon wastes. Nutrient contributions from these sources should also be taken into consideration when estimating available N for the next season. Manures can preclude the need for any fertilizer, depending on the rate applied and their nutrient composition.

Manures can vary appreciably depending on the animal, how the manure is processed, and the kind and extent of bedding material. For the most accurate estimate of fertilizer equivalent values, the manure should be analyzed for its nutrient content. For more detailed information on animal manures and their nutrient contributions to soils refer to PNW Bulletin 239, *How to Calculate Manure Application Rates in the Pacific Northwest*.

Calculation of N Application Rates

To calculate the fertilizer N application rate, four or five values must be estimated: (1) total N needed to produce a given yield, (2) mineralized N, (3) inorganic N (NO_3 + NH_4) as measured by the soil test, (4) previous crop/residue management, and (5) manuring practice. A sample calculation is provided in Table 4. This example assumes an expected yield of 140 bushels per acre, 45 pounds N per acre mineralized from soil organic matter, soil test inorganic N measuring 92 pounds per acre, a previous crop of corn taken as silage, and no manures applied.

Table 4. Sample N requirement calculation.

Available N component	lb N/acre
Total N required (from Table 1)	270
Minus mineralizable N	-45
Minus inorganic N	-92
Previous crop factor (from Table 3)	0
Manures	0
N fertilizer required (sum above)	133

In research trials, irrigated winter barley required from 180 to 220 pounds per acre of fertilizer N plus soil NO_3-N (measured to a depth of two feet). Maximum yield in the trials ranged from 95 to 158 bushels per acre. Significant lodging sometimes occurred at high available N levels associated with maximum yields.

Timing of Nitrogen Application

Excessive irrigation or heavy winter precipitation can result in leaching of nitrate N beyond root systems. This hazard exists on all soils, but particularly on coarse-textured soils such as sands, and sandy loams. Fall preplant N was once thought to be as good or preferable to spring topdressed N in calcareous silt loam or clay soils in areas of low rainfall. However, even under these conditions, southern Idaho research has shown that N applied in late winter or early spring is frequently used more effectively than early fall preplant applied N.

Nitrogen fertilizers containing ammonium (ammonium sulfate, anhydrous or aqua ammonia, or urea) are less subject to leaching losses when lower soil temperatures (less than 40 °F) inhibit the microbial conversion of ammonium to nitrate. Lower temperatures also reduce the microbial activity that is responsible for the immobilization of applied N. Late fall, split, or spring applied N is also recommended when residues from previous grain or mature corn crops are returned to the soil in early fall.

Nitrogen Impact on Lodging

Winter barley lacks the straw strength commonly found in irrigated winter wheat. The poor straw strength makes irrigated winter barley especially susceptible to lodging at near optimum to high available N levels. Lodging can reduce both grain yield and quality, as well as increase harvest costs. The yield response to available N is seriously limited in the event of lodging.

Varieties differ in straw strength, plant height, and their susceptibility to lodging. If lodging is a concern, use winter barley varieties that are the least susceptible to lodging. For descriptions of varieties and their susceptibility to lodging, refer to Progress Report 311, *1997 Certified Seed Selection Guide for Public Varieties of Winter Wheat and Winter Barley*, or the most recent guide available.

Ethephon (Cerone®) is a growth regulator commonly used to shorten small grains and to stiffen straw. It can significantly reduce the incidence and severity of lodging in winter barley. Field trials in western Idaho indicated that the use of Cerone® increased yield under high N conditions from 14 to 26 bushels per acre in areas susceptible to lodging. Growers should consider using this growth regulator for soils with nearly optimum to high available N, particularly if lodging has historically been a problem in their location.

Phosphorus (P)

Phosphorus deficient winter barley appears stunted but may not otherwise exhibit obvious symptoms. Winter barley grown in rotation with P fertilized crops such as potatoes, onions, or sugarbeets will often not need additional fertilizer P.

Although winter barley requires little phosphorus compared to other crops, minimum soil levels are necessary for maximum production. Winter barley is less cold tolerant than winter wheat and adequate P is necessary for winter hardiness.

Soil tests can indicate whether soils require P fertilization for maximum winter barley production. Soil samples are collected from the first foot of soil before planting. Lime content of soil interacts with fertilizer P to reduce its effectiveness. Fertilizer P rates should be increased as soil lime increases. Table 5 gives phosphorus fertilizer rates based on the soil test P level and lime content.

Table 5. Recommended phosphorus fertilizer rates (lb P_2O_5 per acre)[1] based on soil test P and lime content.

Soil test P[2]	Lime content[3] (%)			
0 to 12 inches	0	5	10	15
(ppm)	(lb P_2O_5 per acre)			
0	160	200	240	280
5	100	140	180	220
10	40	80	120	160
15	0	20	60	100
20	0	0	0	40
25	0	0	0	0

[1]To convert P from the oxide (P_2O_5) to the elemental form (P), multiply by 0.43.

[2]$NaHCO_3$ extraction (sodium bicarbonate).

[3]Lime content is measured as calcium carbonate equivalent.

Effective methods of application include broadcasting at plowdown, broadcasting and incorporating during seedbed preparation, or drill banding low rates of P with the seed. Drill banding may reduce the amount of fertilizer required. Drill banding high rates of P with the seed, especially ammonium phosphate fertilizers, can cause seedling damage. For more detailed discussion of banding, refer to PNW 283, *Fertilizer Band Location for Cereal Root Access*.

Potassium (K)

Winter barley has a lower requirement for K than sugarbeets, corn, or potatoes. Potassium deficiency in southern Idaho winter barley is relatively rare compared to N and P deficiency. Application of K should not be necessary if winter barley is rotated with other annual crops that receive fertilizer K.

Soil test K can be a useful indicator of the need for K. Table 6 gives K rates based on the K soil test. Fertilizer K should be plowed down or incorporated during seedbed preparation.

Table 6. Recommended potassium fertilizer rates (lb K_2O per acre) for winter barley based on soil test K.

K soil test[1] 0 to 12 inches	Potassium rates
(ppm)	(lb K_20 per acre)[2]
25	160
50	80
75	0

[1]$NaHCO_3$ extraction.

[2]To convert from the oxide (K_20) to the elemental form (K) multiply by 0.84.

Sulfur (S)

Sulfur requirements for winter barley will vary by soil texture, previously incorporated crop residues, leaching losses, S content of the irrigation water, and the S soil test. The S soil test in the first foot of soil is less reliable than soil tests for other macronutrients.

Sulfur in the first foot of soil is easily leached to lower depths but, unlike other mobile nutrients such as NO_3-N, it may precipitate with calcium to form gypsum. Precipitated gypsum prevents further leaching of S and serves as a reservoir of S for deeper winter barley roots. Consequently, soils should be tested for S to a depth of two feet, similar to N.

Accordingly, soil that tests low in S near the surface (less than 8 ppm SO_4-S in the first foot of soil) may be temporarily deficient in S until root growth extends deeper into the profile. Severe S shortages early in the season can reduce tillering and limit yield. Severe shortages are indicated by the yellowing of new leaves while older lower leaves retain their green color. Under the most severe conditions, upper leaves may actually become white. Normally, barley will withstand the less severe shortages with little if any yield loss. If preplant soil test S is low to a depth of two feet, 20 to 40 lb of S per acre should be applied.

In many areas, the S content of the irrigation water is high enough to satisfy the S requirements of winter barley. Winter barley irrigated with Snake River water or waters consisting of significant runoff from other fields should not experience S shortages.

Plant analysis can be useful in confirming a sulfur deficiency. The ratio of N to S in whole plants should not exceed 17:1. Ratios above 17:1 indicate a shortage of S.

Most sources of preplant applied S are effective in supplying S to winter barley. To address S shortages with spring topdressings, use fertilizers containing readily available S such as gypsum.

Micronutrients (Fe, Mn, Zn, Cu, B)

Winter barley growth response to micronutrients has generally not been observed in irrigated southern Idaho soils. Even in severely scraped or eroded soils, other nutrients tend to be more limiting to yield than micronutrients. Applications of micronutrients are generally not recommended unless need is indicated by a reliable soil or plant tissue test.

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