Northern Idaho Fertilizer Guide

Winter Wheat

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THESE FERTILIZER GUIDELINES have been developed for soft white winter wheat through research conducted by the University of Idaho and Washington State University. They are based on relationships between soil tests and yield responses. The fertilizer rates are designed to produce above-average yields if other factors 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) crop history information is complete and accurate.

Optimal production and economical returns from wheat are achieved when the crop is managed properly. Inadequate fertilization, poor stands, and poor pest control are major contributors to low yields.

Nitrogen and sulfur are the major plant nutrients needed for wheat production. Phosphorus and potassium may also be needed. The need for these nutrients can best be determined by a soil test.

Nitrogen

The amount of nitrogen (N) fertilizer required on any field depends on the following:

1. The wheat variety and its potential yield in your location. The suggested rates in this publication were developed over many years based on several varieties. Modern varieties require high levels of available soil nutrients and superior management to achieve their high yield potentials.
2. The potential yield or the average yield obtained from the field in past years. Research has shown the amounts of N in pounds per acre required to produce 1 bushel of wheat in the less than 18-inch, 18- to 21-inch, 22- to 24-inch, 24- to 28-inch, and more than 28-inch annual precipitation zones are 2.4, 2.5, 2.7, 2.9, and 3.1, respecitvely.
3. The amount of usable N in the soil profile. This includes mineralizable nitrogen (nitrogen released by decomposing organic matter during the growing season) and inorganic nitrogen in the forms of nitrate (NO_3) and ammonium (NH_4).
4. Actual total annual precipitation and other climatic factors.
5. The density of the plant stand.

In areas of low precipitation (18 inches or less annually), determine soil moisture in the profile. In these low-moisture areas and in areas with shallow soils (2 to 3 feet maximum depth), adjust the recommended N fertilizer rate based on available soil moisture.

Total N need based on potential yield—Estimates of N needed to produce a crop of winter wheat in a particular field should be based on yield potential—the field's long-term average yield. Multiply the potential yield in bushels per acre by 2.4, 2.5, 2.7, 2.9, or 3.1 pounds N per bushel, depending on annual precipitation, to arrive at total N needed (Table 1). If, for example, annual precipitation is 19 inches and the potential yield is 100 bushels per acre, then 2.5 × 100 or 250 pounds per acre of N are needed to produce the wheat crop.

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

Annual precipitation	N needed
(inches)	(lb/acre)
less than 18	2.4 × potential yield (bu/acre)
18 to 21	2.5 × potential yield (bu/acre)
21 to 24	2.7 × potential yield (bu/acre)
24 to 28	2.9 × potential yield (bu/acre)
more than 28	3.1 × potential yield (bu/acre)

Once the total amount of N needed to produce a winter wheat crop is known, a simple equation determines the amount of fertilizer N to apply to meet this need:

$$\text{Fertilizer } N \text{ needed} = \underset{\text{(Table 1)}}{\text{Total } N \text{ need based on potential yield}} - \left(\underset{\text{(Table 2)}}{\text{Mineralizable } N} + \underset{\text{(Table 3)}}{\text{Soil test } N} \right)$$

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 2. Soils farmed using reduced tillage systems are often colder in spring than conventionally tilled soils. Consequently, N mineralization rates are slightly higher in conventionally tilled fields.

Table 2. Mineralizable nitrogen release rates for northern Idaho soils.

	Tillage	
Organic matter content	Conventional	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—Available N in the soil can be quantified most effectively with a soil test. The soil samples should represent the rooting depth of the crop because nitrate-nitrogen (NO_3-N) is mobile in soil. Winter wheat is capable of removing N to a depth of 5 feet or more.

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 3).

Table 3. Example of calculation to convert N soil test results in ppm to pounds per acre.

	Soil test results					
Depth	NO_3-N	NH_4-N[1]	Total	Factor		Total N[2]
(inches)	(ppm)	(ppm)	(ppm)			(lb/acre)
0 to 12	5	1	6	x 3.5	=	21
12 to 24	6	–	6	x 3.5	=	21
24 to 36	8	–	8	x 3.5	=	28
36 to 48	(include NO_3-N if available)					
48 to 60	(include NO_3-N if available)					
Total	19	1	20	x 3.5	=	70

[1] Soil test NH_4-N results are from the first foot only.
[2] ppm x 3.5 = lb/acre.

Nitrogen fertilizer—The calculation for N fertilizer needed is:

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

Example: With a potential yield of 100 bushels per acre, annual precipitation of 23 inches, 2.3 percent organic matter (conventional tillage), and soil test values from the example in Table 3, 154 pounds N per acre are needed:

Total N needed (Table 1)		270
Minus mineralizable N (Table 2)	–	46
Minus soil test N (Table 3)	–	70
Equals N fertilizer required	=	154

You now need to take into account the residue from the previous crop in the field. If the previous crop was a cereal (wheat or barley) and the residue was left in the field (not burned or removed) an additional 15 pounds available N for each ton of straw (or nonlegume residue) incorporated into the soil up to 50 pounds N per acre should be added to the N fertilizer recommendation. See Table 4 for the specific amount of N to be applied.

Table 4. Nitrogen needed for cereal straw (residue) breakdown.

Residue	N need
(tons/acre)	(lb/acre)
0	0
0.5	7.5
1	15
2	30
2.5	37.5
3	45
3.5 or more	50

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

Table 5. Nitrogen credit for legume straw (residue) breakdown.

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

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

Conversely, 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 5, should be subtracted from the N fertilizer recommendation.

Phosphorus

Wheat has a relatively low demand for phosphorus (P) (Table 6). Either incorporate P fertilizer during seedbed preparation or band it below the seed at planting.

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.

Broadcast plowdown, broadcast seedbed incorporated, or drill banding are commonly used methods of application. Drill banding P is usually the most efficient. It allows fertilizer placement with, below, or to the side of the seed. Choose whichever method is most convenient.

Table 6. Phosphorus fertilizer rates for winter wheat 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 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] $P_2O_5 \times 0.44 = P$, or $P \times 2.29 = P_2O_5$.
[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

Wheat needs little potassium (K). The most likely areas of need are eroded knobs and hilltops. Incorporate K fertilizer into the soil during seedbed preparation before or at planting. Apply K fertilizer as needed according to a soil test (Table 7).

Broadcast plowdown, broadcast seedbed incorporated, and drill banding are effective methods of application. Use whichever is most convenient. Drill-banded fertilizer can be placed with, below, or to the side of the seed. When applied with the seed, the total of N plus K (as K_2O) should not exceed 25 pounds per acre.

Table 7. Potassium fertilizer rates for winter wheat 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] $K_2O \times 0.83 = K$, or $K \times 1.20 = K_2O$.

Sulfur

Wheat requires sulfur (S) to produce maximum yields and high-quality flour. Sulfur requirements for winter wheat are influenced by soil texture, soil organic matter, the previous crop, and fertilizer history. Apply 20 pounds S per acre to soils testing less than 10 ppm SO_4-S or 4 ppm S in the 0- to 12-inch layer. Avoid using elemental S. Never apply more than 25 pounds of S as sulfate-S to your field; research has shown that excessive levels of sulfate may depress wheat yields.

Sulfur deficiency appears as a yellowing of the plant early in the growing season and is impossible to distinguish visually from N deficiency. Sulfur needs of winter wheat based on a soil test are shown in Table 8.

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

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

Micronutrients and lime

Wheat in northern Idaho has not been observed to respond to micronutrients. If in doubt, test your soil.

Based on historical research data, northern Idaho soils are deficient in Cu, Fe, Mn, Mo, and B for winter wheat production less than 1 percent of the time. Severely eroded ridges are often Zn deficient; however, these low-yielding areas of fields constitute less than 10 percent of a field's area and thus Zn applications are not economical.

Lime applications on strongly acid soils (pH less than 5.1) should be tried on an experimental basis to determine if an economical response is likely. When needed, apply 1 to 2 tons per acre (based on the lime requirement test available from soil testing labs) and mix it thoroughly into the surface 6 inches of the soil.

Agonomy/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*.
- 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.
- In areas receiving less than 22 inches of precipitation use split or fall applications of N. In areas receiving more than 21 inches of annual precipitation, apply N as a split (fall-spring) application. N applied too early in fall (when soil temperatures are above 50°F) may leach after heavy winter precipitation.
- In areas of heavy winter precipitation (annual precipitation more than 24 inches) or sandy soils, spring applications of N may be more desirable than fall applications. In these areas over 70 percent of the N fertilizer required should be spring applied.
- In areas receiving more than 21 inches of annual precipitation, test the top 2 feet of soil for NO_3-N in spring and topdress additional N if soils contain less than 50 pounds of plant-available N per acre.
- Use caution in topdressing with N in spring because N applied after the boot stage or at excessive rates can result in undesirably high protein levels in soft white wheats. Excessive N rates also increase the lodging hazard.
- Banding fertilizer improves both N and P use efficiencies. Consequently, if applying N and/or P in a band, cut the recommended N fertilizer application rate by up to 10 percent and the recommended P rate by up to 20 percent.
- The ammoniacal forms of N (ammonium and ammonia) do not leach as readily as NO_3. When temperature and moisture are favorable for plant growth, however, ammoniacal N and urea are quickly converted to the NO_3 form. Thus, N applied in early fall, regardless of its form, is subject to leaching in areas of heavy winter precipitation.
- N-Serve and other N stabilizers block the conversion of NH_4-N to NO_3-N. Results obtained from N stabilizers are inconsistent although reduced N fertilizer losses have been obtained 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 wheat 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 NO_3-N into gaseous forms of N that dissipate into the atmosphere).
- If you have questions regarding this information, contact the Extension educator in your county or your fertilizer dealer.

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