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Northern Idaho fertilizer guide

Spring wheat

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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 wheat. 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 EXT 704, *Soil Sampling.*

Nitrogen

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

- The spring wheat variety, its market class, and its potential yield in the field. The suggested rates in this publication were developed over many years based on several varieties of soft white spring wheat. Modern varieties require high levels of available soil nutrients and superior management to achieve their high yield potentials.
- The potential yield of the selected variety based on its historical yield in the particular location and good management. Research in northern Idaho and eastern Washington has shown that 2.3 pounds available N per acre are needed to produce 1 bushel of soft white spring wheat in the 16- to 21-inch annual precipitation zone. In areas receiving more than 21 inches of annual precipitation, 2.4 pounds N per acre are needed to produce 1 bushel of soft white spring wheat.
- The amount of usable N in the soil profile. This includes mineralizable N (N released by decomposing organic matter during the growing season) and inorganic N in the forms of nitrate (NO_3) and ammonium (NH_4).
- Actual total annual precipitation and other climatic factors.
- The density and vigor of the plant stand.
- The type and yield of the previous crop.

In areas of low annual precipitation (18 inches or less), 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 the yield potential as limited by available soil moisture. Contact the Extension agricultural agent in your county for more information on determining crop yield based on soil-profile 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:

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

Note: The amounts of N needed to attain the desirable high-protein hard red spring wheats are about 40 percent greater than those needed for soft white spring wheats. The values in this guide are for soft white spring wheats. Increase N fertilizer rates by 40 percent for hard red spring wheat production.

Nitrogen needed based on potential yield — Estimates of N needed to produce a crop of soft

white spring wheat in a particular field should be based on potential yield — the field's long-term average yield. Multiply the potential yield in bushels per acre by 2.3 or 2.4 pounds N per bushel, depending on annual precipitation, to arrive at total N needed (Table 1). If, for example, annual precipitation in your area is 19 inches and potential yield is 60 bushels per acre, then you would need 138 pounds per acre (2.3 × 60).

Table 1. Total N needed by soft white spring wheat based on precipitation and potential yield.

Precipitation	N need
(inches)	(lb/acre)
Less than 21	2.3 × potential yield (bu/acre)
More than 21	2.4 × potential yield (bu/acre)

Note: Initial research has shown that hard red spring wheats (14% protein) require between 3.1 and 3.5 lb N per bushel of wheat.

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.

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 to describe northern Idaho soils (Table 3). 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.

Soil test nitrogen — The amount of available N in the soil can be evaluated 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. Spring wheat is capable of removing N to a depth of 3 feet.

Table 3. 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 values include both NO_3-N and ammonium-nitrogen (NH_4-N). 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 4 (Table 4).

Table 4. 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	1	1	2	× 4	= 8
12 to 24	2	2	4	× 4	= 16
24 to 36	2	1	3	× 4	= 12
Total	5	4	9	× 4	= 36

[1]Ammonium (NH_4-N) content is usually low and is often not included in soil test analyses.

[2]ppm × 4 = lb/acre.

Nitrogen fertilizer — Again, the calculation for N fertilizer needed is:

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

For example, with a potential yield of 60 bushels per acre, annual precipitation of 23 inches, 2.5 percent organic matter, no straw residue, and soil test values from the example in Table 4, you would need 63 pounds N per acre:

Total N needed (Table 1 + Table 2)	(144 + 0)	144
Minus mineralizable N (Table 3)	–	45
Minus soil test N (Table 4)	–	36
Equals N fertilizer needed	=	63

Nitrogen fertilizer based on the previous crop

You also can estimate the N fertilizer requirement on the basis of the previous crop. The values in Table 5 are generalized recommendations based on field experiments and observations of soft white spring wheat production following the production of various crops. *Note:* Fertility recommendations

Table 5. Nitrogen fertilizer rates for soft white spring wheat based on potential yield and previous crop.

Potential yield	Application rate: Grain (residue returned)	Grain (residue removed) peas, lentils, fallow	Alfalfa or green manure crop
(bu/acre)	(lb/acre)	(lb/acre)	(lb/acre)
40	40 to 60	15 to 20	0 to 15
60	60 to 80	25 to 40	15 to 25
80	80 to 100	40 to 55	25 to 40

Note: The range in values allows for varying levels of mineralizable N. Nitrogen application rates should be increased about 40 percent for hard red spring wheat.

based only on the previous crop are not as accurate as recommendations based on good soil tests.

Phosphorus

Spring wheat 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.

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 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 of N per acre.

Table 6. Phosphorus fertilizer rates for soft white and hard red spring wheats based on a soil test.

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

[1]Soil test P can be determined by two procedures — sodium acetate (NaOAc) and sodium bicarbonate ($NaHCO_3$). Use the column indicated by your soil test report.

[2]$P_2O_5 \times 0.44 = P$, or $P \times 2.29 = P_2O_5$.

Potassium

Spring wheat 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).

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.

Table 7. Potassium fertilizer rates for soft white and hard red spring wheats based on a soil test.

Soil test K (0 to 12 inches)	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]$K_2O \times 0.83 = K$, or $K \times 1.20 = K_2O$.

Sulfur

Sulfur (S) requirements for spring wheat 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.

Micronutrients and lime

Spring wheat responses to micronutrients have been uncommon in northern Idaho. If you are in doubt about your soil's micronutrient needs, have the soil tested and consult the Extension agricultural agent in your county.

Try experimental lime applications on highly acid soils (pH less than 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 well into the soil. For additional information see CIS 811, *The Relationship of Soil pH and Crop Yields in Northern Idaho.*

General comments

- Weeds, insects, diseases, and environmental stress can influence the effectiveness of a fertilizer program and reduce yields.
- Early planting of spring wheat has been shown to result in the highest yields.
- Starter or pop-up fertilizers have been tried with limited success. Starter fertilizers as a management tool have been most effective when soils were cold and root growth could be stimulated by a readily available supply of both P and N.

- Take care when banding fertilizer to prevent placing excessive amounts close to the seed. Excessive amounts of N and K result in salt damage during germination. Wheat is especially sensitive to excess salts 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 rate by 10 to 15 percent.

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Further reading

CIS 811, *The Relationship of Soil pH and Crop Yields in Northern Idaho,* 35 cents

EXT 704, *Soil Sampling,* 50 cents

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