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*Idaho Fertilizer Guide*

# Dryland Wheat Production In Southeastern Idaho and Northern Utah

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These fertilizer guidelines are based on relationships between soil test nutrient levels and crop yields. The relationships were established in experiments conducted by the University of Idaho and the U.S. Department of Agriculture Agricultural Research Service.

The suggested fertilizer rates will be accurate for your field provided (1) your soil samples represent the area to be fertilized, (2) your crop history information is complete and accurate and (3) other factors are not limiting production. Thus, the fertilizer guidelines assume the use of sound management practices.

## Nitrogen

Nitrogen (N) is the plant nutrient that most often limits dryland wheat yields in southeastern Idaho and northern Utah. Fertilizer N is needed to optimize yield of wheat given the available stored soil moisture and expected growing season precipitation.

Three methods are available for determining N fertilizer rates. The preferred method is based on levels of soil N and available soil moisture. When soil moisture measurements are unavailable, N fertilizer rates can be determined from soil N levels and potential yield. If no soil tests are available, N fertilizer rates can be estimated from a field's long-term average yield, but this method is the least exact.

### *Nitrogen recommendation based on a soil test and potential yield*

The total amount of N required to produce a given potential yield of spring or winter wheats is given in Table 1. Total N includes residual inorganic N, mineralizable N and fertilizer N.

The amount of fertilizer N to apply can be determined by subtracting mineralizable N (Table 2) and soil test or inorganic N (Table 3) from the total N requirement

**Table 1. Total N needs of winter and spring wheat crops based on potential yield.**

| Potential yield | Total N needed | |
|---|---|---|
| | Winter wheat[1] | Spring wheat[2] |
| (bushel/acre) | (lb N) | |
| 10 | 27 | 34 |
| 15 | 41 | 50 |
| 20 | 54 | 68 |
| 25 | 68 | 84 |
| 30 | 81 | 101 |
| 35 | 95 | 118 |
| 40 | 108 | 135 |
| 45 | 122 | 148 |
| 50 | 135 | 165 |
| 55 | 149 | 182 |
| 60 | 162 | |
| 65 | 176 | |
| 70 | 189 | |

[1]Based on a requirement of 2.7 lb N per bushel of wheat.
[2]Based on a requirement of 3.3 lb N per bushel of wheat.

**Table 2. Mineralizable N based on soil organic matter.**

| Soil organic matter (0 to 12 inches) | Mineralizable N |
|---|---|
| (%) | (lb/acre) |
| less than 0.5 | 5 |
| 0.5 to 1.0 | 10 |
| 1.0 to 1.5 | 15 |
| 1.5 to 2.0 | 20 |
| more than 2.0 | 25 |

**Table 3. Sample calculation of inorganic N in pounds per acre from soil test results.**

| Depth | Soil test N | | Total | Multiplier | Total inorganic N |
|---|---|---|---|---|---|
| | $NO_3$-N | $NH_4$-N | | | |
| (inches) | (ppm) | (ppm) | (ppm) | | (lb/acre) |
| 0 to 12 | 4 | 1 | 5 | x 4 | 20 |
| 12 to 24 | 2 | 1 | 3 | x 4 | 12 |
| 24 to 36 | 1 | 1 | 2 | x 4 | 8 |
| Total | 7 | 3 | 10 | x 4 | 40 |

based on potential yield (Table 1). Producers need to be aware that the nitrogen use efficiency of spring wheat is less than that of winter wheat. Yields of dryland spring wheat are often 50 to 70 percent less than yields of winter wheat.

**Mineralizable N** — Microorganisms convert organic N (N unavailable to plants) to inorganic N (available N) under favorable environmental conditions. Mineralizable N is the amount of N that microorganisms release over a growing season during the breakdown of soil organic matter. Mineralizable N can be estimated based on the percentage of organic matter in the surface 0 to 12 inches of soil (Table 2).

**Soil test N** — Residual inorganic nitrate ($NO_3^-$) and ammonium ($NH_4^+$) can be measured by soil testing. Soil samples should be collected by 12-inch increments to a depth of 36 inches. Soil test $NO_3$-N and $NH_4$-N values are typically reported in parts per million (ppm). To convert soil test $NO_3$-N and $NH_4$-N values in ppm to pounds per acre, add the soil test N values for each foot and multiply by 4 as shown in Table 3.

**Fertilizer N** — The amount of fertilizer N required can be determined as follows:

| | |
|---|---|
| N needed based on yield potential (Table 1) | ____ |
| Minus mineralizable N (Table 2) | ____ |
| Minus soil test N (Table 3) | ____ |
| Equals fertilizer N required | ____ |

For example, given winter wheat with a yield potential of 40 bushels per acre, 1.4 percent soil organic matter and the soil test N values shown in Table 3, the amount of fertilizer N required can be calculated as follows:

| | |
|---|---|
| N needed based on yield potential (Table 1) | 108 lb N |
| Minus mineralizable N (Table 2) | -15 lb N |
| Minus soil test N (Table 3) | -40 lb N |
| Equals fertilizer N required | 53 lb/acre N |

## *Nitrogen recommendation based on a soil test and available soil moisture*

Moisture is the greatest limiting factor in southeastern Idaho and northern Utah dryland wheat production. A determination of both available soil moisture and residual soil N at planting provides a more precise basis for nutrient management decisions than a soil test alone.

Available soil moisture can be determined by the "feel method" or by using the Paul Brown soil moisture probe. Additional information on this method can be obtained in Montana State University Experiment Station Special Report 1SR035, *Grain Yield Related to Stored Soil Water and Growing Season Rainfall*, available from Extension Publications at Montana State University, Bozeman.[1]

Table 4 gives levels of soil moisture in fall soil samples, predicted springtime soil moisture levels and corresponding levels of inorganic soil N that are adequate for obtaining projected yields. If soil test N is lower than these soil N levels, apply the difference between them as N fertilizer.

## *Nitrogen recommendation based on average yield*

If no soil test information is available, the long-term average wheat yield of a field can be used to estimate fertilizer N (Table 5).

[1]Extension Publications, Montana State University, Bozeman 59717.

**Table 4. Adequate soil N based on available soil moisture in southeastern Idaho and northern Utah.**

| Fall moisture[1] | Spring moisture[2] | Projected yield[3] | Adequate inorganic soil nitrogen[4] (3-foot sample) |
|---|---|---|---|
| (inches/3-foot profile) | | (bushel/acre) | (lb/acre) |
| 1.5 | 4.4 | 36 | 43 |
| 2.25 | 4.8 | 38 | 46 |
| 3 | 5.3 | 40 | 48 |
| 3.75 | 5.7 | 42 | 51 |
| 4.5 | 6.2 | 44 | 53 |
| 5.25 | 6.6 | 46 | 55 |
| 6 | 7.1 | 47 | 56 |
| 6.75 | 7.6 | 48 | 58 |
| 7.5 | 8.0 | 49 | 59 |

[1]Available soil moisture for a summer fallow field before seeding. This value assumes an additional 25 percent moisture is in the 4-, 5- and 6-foot depths.
[2]Predicted available soil moisture in spring.
[3]Projected yield for dryland wheat fields of southeastern Idaho and northern Utah.
[4]Based on an average precipitation of 5.6 inches during the growing season.

**Table 5. Estimated amount of N to apply for winter wheat when soil test is unavailable.**

| Yield[1] | N fertilizer to apply |
|---|---|
| (bushel/acre) | (lb/acre) |
| 10 | 0 |
| 15 | 0 |
| 20 | 0 |
| 25 | 10 |
| 30 | 20 |
| 35 | 30 |
| 40 | 40 |
| 45 | 50 |
| 50 | 65 |
| 55 | 80 |
| 60 | 95 |

[1]For yield potentials above 60 bushels per acre add 2.7 pounds of N for every bushel increase.

### *Grain protein*

Grain protein content can be increased with N fertilizer applications. Protein response lags behind yield response. If N levels have met the plant's yield requirements, excess N will be directed to protein production up to 14 percent protein. After that point, additional N is not beneficial. Growers who historically have had less than 12 percent protein in hard red winter wheat can probably benefit from additional N fertilizer. An additional 20 lb/acre N could be applied in spring at tillering, possibly in combination with a herbicide treatment.

## Phosphorus

Phosphorus (P) is critical to wheat growth. Wheat will respond to P fertilizer if soil test P is below critical levels (Table 6). Soil samples should be taken from the 0- to 12-inch depth. (See University of Idaho Extension Bulletin 704, *Soil Sampling*.)

**Table 6. Phosphorus fertilizer rates for broadcast application based on soil tests.**

| Soil test P[1] (0 to 12 inches) | Phosphorus application rate[2] |
|---|---|
| (ppm) | (lb/acre $P_2O_5$) |
| 0 to 5 | 60 |
| 5 to 10 | 30 |
| more than 10 | 0 |

[1]$NaHCO_3$ extraction.
[2]When drill banding, reduce rates by one-third.

The most effective methods of P application are drill banding with the seed or drill banding below the seed and 2 to 3 inches from the seed row. Drill banding may require less P fertilizer than broadcasting. When drill banding fertilizer directly with the seed, do not use high rates of P fertilizer materials that contain ammonium (11-52-0, for example) because of potential seedling damage. For a more detailed discussion of banding, refer to PNW 283, *No-Till and Fertilizer Band Location for Cereal Root Access*, or CIS 757, *Fertilizer Placement*. When applying N and P together, do not use more than 15 lb/acre N unless soil moisture is exceptionally high.

## Potassium

Most soils in southern Idaho and northern Utah are relatively high in potassium (K), so additional K is usually not required. To determine the K status of a soil, take samples from the 0- to 12-inch depth. Soils testing at less than 100 ppm K should receive applications of 80 lb/acre $K_2O$. If drill banding, do not apply more than 15 lb/acre N + K directly with the seed.

## Sulfur

Sulfur (S) is required in the formation of wheat protein. Sulfur deficiency appears as a general yellowing of the plant early in the season and looks much like N deficiency.

Most dryland southern Idaho and northern Utah soils should have sufficient S. Where levels of S are less than 10 ppm in the 0- to 12-inch soil depth, apply 1 lb/acre of S as sulfate with every 10 lb/acre N used. Soils likely to respond to S include those fertilized exclusively with a straight N fertilizer such as anhydrous ammonia, urea or ammonium nitrate.

## Micronutrients

Yield responses to iron (Fe), manganese (Mn), zinc (Zn), copper (Cu) and boron (B) have not been observed on dryland cereals in southeastern Idaho and northern Utah, so addition of these micronutrients is not recommended. If you suspect a micronutrient deficiency, contact the Extension agricultural agent in your county.

## General comments

1. A representative soil sample taken about August 1 from the major soil type of the field to be fertilized provides the basic information for an accurate fertilizer recommendation. Consult University of Idaho Extension Bulletin 704, *Soil Sampling*, for further information or contact the Extension agricultural agent in your county.
2. Choose the cheapest fertilizer sources available.
3. Determine subsoil moisture before planting. When winter precipitation has been above normal, check subsoil moisture again in spring then adjust your N application as needed to meet the needs of the crop based on projected yield.

**Publication orders** — To order publications, write Ag Publications, Building J40, Idaho Street, University of Idaho, Moscow 83843-4196 or call (208) 885-7982.

CIS 757 *Fertilizer Placement* (35 cents)

EXT 704 *Soil Sampling* (50 cents)

PNW 283 *No-Till and Fertilizer Band Location for Cereal Root Access* (50 cents)

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