Southern Idaho Fertilizer Guide

Irrigated Spring Wheat

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These fertilizer guidelines are based on relationships established between University of Idaho soil tests and crop yield response. The suggested fertilizer rates are based on research results and are designed to support the yields shown if other factors are not limiting production. Thus, the guidelines assume good crop management.

The suggested fertilizer rates will be appropriate for your field if (1) the soil sample represents the area to be fertilized, and (2) your yield estimate and previous residue assumptions are accurate.

Soil Sampling

Spring soil sampling is critical for producing economical yields of high quality irrigated spring wheat. Soil fertility varies among and within fields. Therefore, each soil sample submitted to a soil test laboratory should consist of subsamples collected from at least 20 individual sites within a uniform area. Collect separate samples from the 0- to 12-inch and 12- to 24-inch depths. Skip areas that do not represent the majority of the field such as gravelly areas, saline or sodic areas, wet spots, and turn rows.

Thoroughly mix the 20 subsamples in a clean plastic bucket, keeping the first-foot samples separate from the second-foot samples. Place about one pound of the mixed soil in a plastic-lined soil sample bag. Fill out all required information (name, field number, date, depths, and crop history). Do not store samples under warm conditions because microbial activity can change the extractable N in the soil sample. Send soil samples to the laboratory for analysis as quickly as possible. For more detailed information about soil sampling, refer to EXT 704, *Soil Sampling*.

If sizable areas within fields differ visually or in productivity, these areas may need to be sampled separately and managed differently. Precision ag technology and variable rate applicators now provide options for differentially fertilizing these areas. For information on mapping soil variability and treating mapping units differently, contact an extension soil fertility specialist, your local county ag extension educator, or a fertilizer dealer/consultant.

Nitrogen (N)

Adequate N is necessary for maximum production of irrigated spring wheat. The amount of fertilizer N required to produce the maximum economic return depends on many factors. These factors include the yield estimate, amount of inorganic N remaining from the previous crop, mineralizable N, other N sources, and the previous crop residues.

Total N Requirements Based on Estimated Yield

Fertilizer N rates should correspond to the yield growers can reasonably expect for their soil conditions and management. 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 or reduce production may require adjustment of yield estimates. Areas of fields known to differ considerably in yield, based on previous long-term observations or yield mapping, may also require adjustment of the total N required.

The available N from all sources required to produce a bushel (60 pounds) of irrigated spring wheat depends on several crop management practices. Factors such

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Table 1. Total available N requirement of irrigated spring wheat based on expected yield

Expected yield (bu/acre)[1]	80	100	120	140	160
Total N (lb/acre)	160	200	240	270	300

[1]Based on historical average yield.

Table 2. Example conversion of inorganic N in ppm to lb per acre

Soil depth	Soil Test Results NO_3-N	NH_4-N	Total	Multi-plier		Total inorganic N
(inches)	(ppm)	(ppm)	(ppm)			(lb/acre)
0 to 12	13	2	15	x4	=	60
12 to 24	6	2	8	x4	=	32
Total	19	4	23	x4	=	92

as weed, insect, and disease control as well as irrigation, planting date, water management, 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 spring wheat ranging in yield from 80 to 120 bushels (bu) per acre. Nitrogen requirements per bushel may be greater for yields below 80 bu per acre, but less than two pounds N per bu for yields above 120 bu per acre. The total N required for a range of expected yields is given in Table 1.

Available Nitrogen

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

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. Research indicates that soil test inorganic N is used as effectively as fertilizer N.

Ammonium N (NH_4-N) is generally low in spring preplant soil samples and thus contributes little to available N. However, NH_4-N should be determined along with NO_3-N when there is reason to expect appreciable NH_4-N from previous ammonium N fertilizer applications.

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

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 spring wheat.

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, unless previous crop irrigation or over winter precipitation has leached N from the surface foot. Basing N rates on estimates rather than actual measurements 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 residue 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 spring wheat. Sweet corn residues typically are higher in N content than mature field corn residues. In addition, they are returned to the soil earlier and decompose more rapidly, therefore releasing more N to subsequent spring wheat than mature corn stalks.

Legume residues are typically rich in N and can release appreciable N for spring wheat. Bean and pea residues are fairly rapidly decomposed and the N release from them should be reflected in the preplant spring soil test for N. Alfalfa residues decompose less rapidly and the N release is not typically indicated by the preplant soil test. 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 late summer or early fall)	-25
Grain or corn (residue returned late fall)	-50
Grain or corn (residue removed)	0
Sweet corn (residue returned late summer or early fall)	30
Row crops (potatoes, onions, sugarbeets, beans, and peas)	0
Alfalfa	35

Mineralizable Nitrogen

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

Nitrogen from Manures and Water

Fields used for spring wheat occasionally receive animal manures or lagoon wastes. Nutrient contributions from these sources can be appreciable and should be taken into consideration when estimating available N.

Manures can vary in nutrient content depending on the animal source, how the manure is processed, and the quality and quantity of bedding material included. 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 239, *How to Calculate Manure Application Rates in the Pacific Northwest.*

Irrigation waters other than lagoon effluents can also contain appreciable N. While most well and surface waters used for irrigation have low N concentrations, irrigation waters that receive appreciable return flows from other districts are likely to be higher in N. To convert the N content of each acre foot of irrigation water applied to the lb N per acre fertilizer equivalent, multiply the ppm or milligrams per liter (mg/l) N concentration by 2.7.

Preplant applied N is easily leached beyond developing seedling root systems with early season irrigation. If early season irrigation is necessary to ensure proper vegetative development, consider reducing the time for each set. Set time can be lengthened as the root system develops more fully. Nitrogen located below the developing root system is not taken up as readily by the plant or used as effectively for yield.

Calculation of N Application Rates

To calculate the fertilizer N application rate, several available N components must be estimated: (1) total N needed for 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 or irrigation water N concentration. A sample calculation is provided in Table 4. This example assumes an expected yield of 120 bu per acre, 45 lb N per acre mineralized from soil organic matter, soil test inorganic N measuring 92 lb per acre, a previous silage corn crop, and no manure applied.

Table 4. Sample N requirement calculation

Available N component	lb N per acre
Total N required (Table 1)	240
Minus inorganic N (Table 2)	-92
Minus mineralizable N	-45
Previous crop factor (Table 3)	0
Manures or other sources	0
Fertilizer N required (sum above)	**103**

Nitrogen and Lodging

Irrigated spring wheat is more susceptible to lodging at high available N levels than winter wheat. Lodging can reduce both grain yield and quality, as well as increase harvest costs.

Varieties differ in straw strength, plant height, and their susceptibility to lodging. For descriptions of varieties and their susceptibility to lodging, refer to PR327, *2000 Idaho Certified Seed Selection Guide for Some Varieties of Spring Wheat.*

Ethephon (Cerone®) is a growth regulator commonly used to shorten small grains, stiffen straw, and reduce lodging. Growers should consider using this growth regulator for wheat in soils with high available N if lodging is historically a problem.

Managing Nitrogen for High Protein Hard Wheat

The hard wheat market, both red and white, often pays a premium for high protein. Hard spring wheat varieties can differ in grain protein. However, the most critical factor for producing high protein irrigated wheat is the amount and timing of N fertilization.

To produce high protein wheat, first determine the total fertilizer N required to maximize yield (Tables 1-4). High protein generally is not realized unless available N matches or exceeds that required for maximum yield. The nitrogen applied for maximizing yield should be applied preplant.

Split applications of N can increase wheat protein, but even split applied N may not raise protein to acceptable levels if the total N available is not sufficient for maximum yield. Between boot and flowering is the best time to influence grain protein with delayed applications. The optimum N rate for increasing protein to 14 percent may vary depending on the final yield. Higher yields increase and lower yields reduce the optimal delayed N rate.

Flag leaf N testing can be useful for determining the need for later applied N. Research indicates that there is little protein increase with subsequent applied N when flag leaf total N concentration at heading is 4.2 to 4.3 percent or greater. The required N rate increases as flag leaf N values decrease below the critical value.

If flag leaf N at heading is above 3.8 percent, no more than 40 lb N per acre should be needed to increase protein to 14 percent. If flag leaf N is below 3.8 percent, higher N rates may be needed.

Phosphorus (P)

Irrigated spring wheat requires adequate soil P for maximum economic yields. Soil testing for P provides a reasonable estimate of available P. Optimum P fertilizer rates depend on both soil test P and soil lime content (Table 5).

Plant maturity may be delayed when soil test P concentrations are low and free lime content is greater than 10 percent. However, grain yields are usually unaffected when the growing season is sufficient.

When banding an ammonium P source (11-52-0) at rates above 20 lb per acre, separate the seed and the fertilizer material by two inches to avoid seedling damage from salts. For a detailed discussion of banding refer to PNW 283, *No-Till and Minimum Tillage Farming: Fertilizer Band Location for Cereal Root Access.*

Table 5. Phosphorus application rates based on soil test P and free lime content

Soil test P[1] (0 to 12 inch)	Free lime content[2] (%) 0	5	10	15
(ppm P)	--------------(lb/acre P_2O_5)-----------			
0	240	280	320	360
5	160	200	240	280
10	80	120	160	200
15	0	40	80	120
20	0	0	0	40

[1]$NaHCO_3$ extraction

[2]Free lime is determined as calcium carbonate equivalent.

Incorporate P fertilizer during seedbed preparation. Solution P, such as ammonium polyphosphate, may be applied through a sprinkler irrigation system. Check the compatibility of the irrigation water and the P material. If precipitates form, decrease the fertilizer concentration or increase the injection time.

Potassium (K) and Chloride (Cl)

Soil test K is a reasonable indication of available K in southern Idaho soils (Table 6). Incorporate K during seedbed preparation.

Table 6. Potassium rates based on soil test K

Soil test K (0 to 12 inches)	Application rate
(ppm)	(lb/acre K_20)
0	240
25	160
50	80
75	0

Potassium chloride increases yields where take-all root rot is prevalent, regardless of the soil test K level. This response is due primarily to the chloride component. Wheat yield may also increase when not infected with take-all if extractable soil Cl is below 30 lb per acre in the first two feet. Low soil Cl has been associated with physiological leaf spot. Soil Cl can be measured with a soil test. If soil test Cl is less than 8 ppm for the first two feet combined, apply 40 lb Cl per acre in the form of potassium chloride. Do not drill band Cl with the seed as germinating seed may be injured by excessive salts.

Sulfur (S)

Sulfur fertilizer requirements for spring wheat depend primarily on the S content of irrigation water and the S soil test. Coarse-textured soils are more likely to be low in S than fine-textured soils. Wheat irrigated with Snake River water or waters consisting of significant runoff from other fields should not require fertilizer S.

Soils should be tested for S to a depth of two feet as the available form of S, or sulfate, is mobile. Soils low in S (less than 35 lb per acre in the 0- to 24-inch depth) should receive 20 to 40 lb of S per acre. Use S fertilizers containing readily available sulfate rather than elemental S to rapidly correct S shortages.

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

Spring wheat yield responses to iron (Fe), manganese (Mn), zinc (Zn), copper (Cu), boron (B), and other micronutrients are rarely observed in southern Idaho. Micronutrient applications may be needed occasionally on severely scraped or eroded areas.

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For Further Reading

You may order this and other publications about fertilizers and crops in southern Idaho from the University of Idaho Cooperative Extension offices in your county or Ag Publications, P.O. Box 442240, University of Idaho, Moscow, ID 83844-2240, phone (208) 885-7982, fax (208) 885-7982, email *cking@uidaho.edu,* or *http://info.ag.uidaho.edu* on the internet.

BUL 704 *Soil Sampling*, $2.00

CIS 825 *Wheat Straw Management and Nitrogen Fertilizer Requirements*, $1.00

PNW 239, *How to Calculate Manure Application Rates in the Pacific Northwest, $0.25*

PNW 283 *No-Till and Minimum Tillage Farming: Fertilizer Band Location for Cereal Root Access*, $0.50

PR 327 *2000 Idaho Certified Seed Selection Guide for Some Varieties of Spring Wheat*, free

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