University of Idaho
College of Agriculture
Cooperative Extension Service
Agricultural Experiment Station

Current Information Series No. 828

Idaho Fertilizer Guide

Irrigated Spring Wheat, Southern Idaho

R. G. Gavlak, J. C. Stark and B. D. Brown

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

The suggested fertilizer rates will be accurate for your field provided (1) the soil samples represent the area to be fertilized, and (2) the crop history information supplied is complete and accurate.

Determining Fertilizer Requirements

Soil sampling is the critical initial step required to produce irrigated spring wheat at economical yield and quality levels. Soil conditions often differ considerably within a field. Each soil sample submitted to the laboratory should consist of at least 20 individual samples collected from the 0- to 12-inch and 12- to 24-inch depths within the area to be represented. Samples should not be taken from gravelly areas, turn rows, wet spots or field borders. The 20 soil samples should be thoroughly mixed in a clean plastic bucket. Place approximately 1 pound of mixed soil in a plastic lined soil bag and label with grower name, depth, date and field number. Samples should not be stored or kept under warm conditions as microbiological changes in the soil sample will adversely affect fertilizer recommendations.

Soil analysis is conducted on samples submitted to the laboratory. Samples are dried, ground, sieved and then combined with various chemical solutions designed to extract the nutrient to be measured. The extract is then analyzed to obtain the concentration of nutrient within that solution. This concentration represents an index of nutrient availability to the crop which has been developed through field research relating crop yield and quality to the soil test concentration and fertilizer application.

Interpretation of soil test results is the process of incorporating all pertinent information necessary to assess the soil's potential to meet crop nutrient needs. Historical records of crop yield and quality, along with information on residue management, crop nutrient requirement and differences in local climate and soil are used together with the soil test results to determine the need for nutrient additions.

Nitrogen (N)

Adequate N is necessary for maximum production of irrigated wheat. The amount of N required to generate maximum economic return depends on many factors that influence total wheat production and quality. Levels of residual inorganic N and previous crop are two of the major factors used to determine crop N needs.

Nearly all soil N is found in the organic form, which is unavailable to the plant. Organic N must be converted to ammonium nitrogen (NH_4-N) and nitrate nitrogen (NO_3-N), the inorganic forms, before it can be used by plants. This N conversion, called "mineralization," is controlled by soil microorganisms, and the rate of conversion therefore depends primarily on soil temperature, soil water content and the level and nature of organic residues in the soil.

Nitrogen Soil Test

Residual inorganic soil N (NO_3^- plus NH_4^+) can be assessed most effectively by soil sampling to a depth of 24 inches in the spring. 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 to pounds N/acre, add the soil test N values (ppm) for each foot and multiply by 4 as shown in Table 1.

Table 1. Example calculation of residual N from a soil test.

	Soil test				Total
Depth	NO_3-N	NH_4-N	Total NO_3-N and NH_4-N		Inorganic N
(inches)	(ppm)	(ppm)	(ppm)	(Multiplier)	(lb/acre)
0 to 12	13	2	15	×4	60
12 to 24	6	2	8	×4	32
Total	19	4	23	×4	92

Previous Crop Residue

Nitrogen associated with decomposition of previous crop residues should also be considered in determining N fertilizer needs. Soil microbes decomposing cereal straw and corn stalks (stover) remove plant-available N from the surrounding soil. About 15 pounds N/acre are needed per ton of straw or stover returned to the soil, up to a maximum of 50 pounds N/acre. Row crop residues (potatoes, sugarbeets, onions) generally do not require additional N for decomposition, so these residues have little effect on N needs for a wheat crop.

Residues of legumes — beans, peas and alfalfa — can release a significant amount of N the following crop season. This N is derived from the decomposition of both plant tops and roots. A spring soil sample will assess the N released from bean and pea residues since these residues readily decompose. Fall-plowed alfalfa stubble will provide an additional 40 to 60 pounds available N/acre for the spring wheat crop.

Rates of fertilizer N required to produce high-quality spring wheat are determined using spring soil test N levels and knowledge of the previous crop (Table 2).

Table 2. Nitrogen fertilizer rates based on spring soil test and previous crop.

Spring soil test (0 to 24 inch depth)	Apply these N rates when following: Alfalfa	Row crop	Grain crop (residue returned)
(N lb/acre)*	(lb N/acre)		
0	100	160	210
20	80	140	190
40	60	120	170
60	40	100	150
80	20	80	130
100	0	60	110
120	0	40	90
140	0	20	70
160	0	0	50

*Based on calculation of inorganic N in soil (see Table 1).

For example, a field previously cropped to alfalfa with a soil test indicating 40 pounds N/acre would require the addition of 60 pounds N/acre (Table 2). The recommendations for spring wheat following alfalfa have been adjusted for the additional N released from fall-plowed alfalfa stubble. Recommended N rates were derived from field correlation data, using several varieties of both soft white and hard red spring wheat. The recommended rates include allowances for mineralized N that becomes available through the growing season (Table 2).

Managing Nitrogen For High Grain Protein

Maximum yields of both hard red and soft white spring wheats can usually be obtained by applying all of the fertilizer N at or near planting. However, with hard red spring wheat, the production of high protein grain is an additional consideration because of the premium for grain protein.

Research has shown that the best management approach for achieving the dual objectives of high yield and high grain protein percentage is to use split applications of N. The period from heading to flowering is generally the most effective time to apply split applications of N. Studies in southern Idaho show that the highest protein percentages were obtained by applying 25 to 30 pounds of N/acre during that period.

The N management program for hard red spring wheat can be summarized as follows:

1. Determine the total amount of fertilizer N required based on residual soil inorganic N and previous crop residues.
2. Apply all but 25 to 30 pounds N/acre preplant.
3. Apply the remaining 25 to 30 pounds N/acre during the period between heading and flowering.

Phosphorus (P)

A soil test can indicate whether phosphorus fertilization is needed for maximum spring wheat production. Soil samples should be taken from the 0- to 12-inch depth. Phosphorus fertilizer rates based on soil test P levels are shown in Table 3.

Table 3. Phosphorus fertilizer rates based on soil tests.

Soil test P* (0 to 12 inches)	Phosphorus application rates (P_2O_5)
(ppm)	(lb/acre)
0 to 3	160
4 to 7	120
8 to 11	60
over 12	0

*$NaHCO_3$ extraction

Effective methods of application are to broadcast P fertilizer on the surface and incorporate it into the soil, or to drill-band low rates of P fertilizer with seed. Drill-banding may reduce the fertilizer P required. Drill-banding high rates of P, 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)

Potassium is absorbed by the plant as the monovalent ion (K^+) and is very mobile in the plant. Most K in the soil is in the primary and secondary mineral forms which are unavailable to the plant. Exchangeable K, that adsorbed on soil colloids, is the form available to plants. Soil tests are useful indicators of the need for K. Table 4 gives K rates based on soil tests. Potassium moves very little in the soil and should be incorporated during seedbed preparation. Potassium chloride has been shown to increase yields where "take all" root rot is prevalent.

Table 4. Potassium rates based on soil tests.

Soil test K* (0 to 12 inches)	Potassium application rates (K_2O)
(ppm)	(lb/acre)
0 to 21	240
22 to 45	160
46 to 68	80
over 68	0

*$NaHCO_3$ extraction

Sulfur (S)

Sulfur deficiency appears as a general yellowing of the plant early in the season and looks much like N deficiency. Sulfur is absorbed by the plant as the sulfate ($SO_4^=$) ion. Sulfur is important in protein formation. Sulfur deficiency results in accumulation of increased N compared to S in the tissue. Thus, a nitrogen/sulfur (N/S) tissue test can be used to detect S-deficient plants. An N/S tissue ratio of 17 or higher in whole plant tissues generally indicates an S deficiency. Sulfur-deficient wheat has also been known to contain high NO_3-N concentrations.

Sulfur fertilizer additions for spring wheat production will vary depending on soil texture, previously incorporated crop residues, leaching losses, S content of irrigation water and S soil test. Sulfur acts much like N in the soil. Nearly all of the soil S is in the organic form, which must be "mineralized" to inorganic SO_4-S for plant uptake. Wheat irrigated with Snake River water should not have S shortages. Soils low in S (less than 8 ppm in the 0- to 12-inch depth) should receive 20 to 40 pounds of S/acre. Elemental S that is applied requires microbial conversion to the SO_4-S form. Application of elemental S may not provide sufficient levels of plant available SO_4-S to correct an S deficiency promptly and efficiently.

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

Yield responses to iron (Fe), manganese (Mn), zinc (Zn), copper (Cu), boron (B) and other micronutrients have not been observed in southern Idaho. Need for micronutrient applications are not expected with spring wheat except occasionally on severely scraped or eroded areas.

General Comments

1. A representative soil sample from the major soil type of the area to be fertilized provides the basic information for an accurate fertilizer recommendation.
2. Previous crop residue impacts the N fertilizer recommendation required to produce irrigated spring wheat at maximum economic levels.
3. Irrigated soft white and hard red spring wheats require similar amounts of N for maximum economic yields. On hard red spring wheat, however, split N application can boost protein and may increase net return.
4. Excessive N applications can increase lodging of irrigated wheat, reducing profitability.
5. Micronutrient deficiencies have not been observed in southern Idaho. Therefore, "shotgun" micronutrient applications are not recommended.

The Authors — R. G. Gavlak is Extension soil scientist, J. C. Stark is research agronomist, and B. D. Brown is research soil scientist and Extension crop management specialist, all with the Department of Plant, Soil and Entomological Sciences in the University of Idaho College of Agriculture.

SERVING THE STATE

Teaching . . . Research . . . Service . . . this is the three-fold charge of the College of Agriculture at your state Land-Grant institution, the University of Idaho. To fulfill this charge, the College extends its faculty and resources to all parts of the state.

Service . . . The Cooperative Extension Service has offices in 42 of Idaho's 44 counties under the leadership of men and women specially trained to work with agriculture, home economics and youth. The educational programs of these College of Agriculture faculty members are supported cooperatively by county, state and federal funding.

Research . . . Agricultural Research scientists are located at the campus in Moscow, at Research and Extension Centers near Aberdeen, Caldwell, Parma, Tetonia and Twin Falls and at the U. S. Sheep Experiment Station, Dubois and the USDA/ARS Soil and Water Laboratory at Kimberly. Their work includes research on every major agricultural program in Idaho and on economic activities that apply to the state as a whole.

Teaching . . . Centers of College of Agriculture teaching are the University classrooms and laboratories where agriculture students can earn bachelor of science degrees in any of 20 major fields, or work for master's and Ph.D. degrees in their specialties. And beyond these are the variety of workshops and training sessions developed throughout the state for adults and youth by College of Agriculture faculty.

Issued in furtherance of cooperative extension work in agriculture and home economics, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, H. R. Guenthner, Director of Cooperative Extension Service, University of Idaho, Moscow, Idaho 83843. We offer our programs and facilities to all people without regard to race, creed, color, sex or national origin.

1,000, August 1988

35 cents per copy