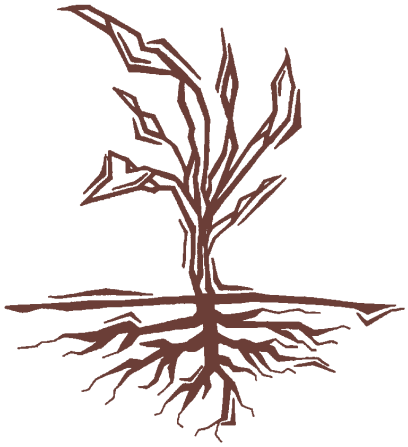

SOIL

Fertilizing Winter Wheat no. 0.544

by J.G. Davis, D.G. Westfall, J.J. Mortvedt, and J.F. Shanahan [1]

Adequate soil fertility is one of the requirements for profitable winter wheat production. Nitrogen (N) is the most yield-limiting nutrient, unless there are high residual NO_3-N levels in the soil. Phosphorus (P) is the next most limiting nutrient, and sulfur (S) may be limiting in rare situations on some soils. Levels of potassium (K) and micronutrients generally are sufficient for wheat production in Colorado soils.

Quick Facts...

Nitrogen is the most limiting nutrient for winter wheat production.

Apply nitrogen fertilizers at rates based on expected crop yields minus credits for residual soil nitrates and nitrogen mineralized from organic matter, manure, and previous legume crops.

Apply phosphate fertilizers at rates based on soil test results. Band applications are more effective than broadcast applications.

Most Colorado soils contain sufficient available potassium for dryland winter wheat production.

Colorado State University Cooperative Extension

Putting Knowledge to Work

Soil Sampling

The value of a soil test in predicting nutrient availability during the growing season directly relates to how well the sample collected represents the area sampled. Take surface samples from the tillage layer (4 to 8 inches) or the 1-foot soil depth. Take subsoil samples to a depth of 2 feet for determination of available NO_3-N. If the field has been in no-till, reduce the sampling depth of the tillage layer. A good sample is a composite of 15 to 20 soil cores taken from an area uniform in soil type. This number of soil cores is especially important in sampling fields where P fertilizers were band applied in previous years. Sample separately areas with major differences in soil properties or management practices.

Thoroughly air dry all soil samples within 12 hours after sampling by spreading the soil on any clean surface where the soil will not be contaminated. **Do not oven dry the soil** because this can change the soil test results. Place the air-dried soil in a clean sample container for shipment to the soil test laboratory.

Submit a carefully completed information form with the soil sample. This form provides information so fertilizer suggestions can be tailored to your specific situation. Take soil samples for NO_3-N analysis every year for optimum N fertilization of crops. Soil analyses for availability of the other nutrients, pH, and organic matter content may be sufficient every three to four years.

More detailed explanations of the importance of taking proper soil samples are found in fact sheets 0.500, *Soil Sampling*, 0.501, *Soil Testing*, and 0.502, *Soil Test Explanation*. Each is available at your Colorado State University Cooperative Extension county office or from the Cooperative Extension Resource Center, 115 General Services Building, Colorado State University, Fort Collins, CO 80523; (970) 491-6198.

The Colorado State University Soil, Water, and Plant Testing Laboratory is located at Room A319, Natural and Environmental Sciences Building, Colorado State University, Fort Collins, CO 80523; (970) 491-5061.

Nitrogen Suggestions

Base nitrogen rates for winter wheat on the expected yields for each field. Nearly all wheat requires some N fertilizer, unless there is a substantial release of available N in the soil prior to planting.

Other credits for N include the amounts expected to become available during the season from mineralization of soil organic matter, manure and previous legume crops. Subtract these credits from the total crop needs to determine the suggested N fertilizer rate for the expected yield.

Table 1: Suggested N rates for dryland winter wheat, as related to NO_3-N in the soil and soil organic matter content (expected yield, 50 bu/A).

ppm NO_3-N in soil*		Soil organic matter, %		
0 - 1 ft	0 - 2 ft	0 - 1.0	1.1 - 2.0	>2.0
		---Fertilizer rate, lb N/A----		
0 - 3	0 - 5	75	75	75
4 - 6	6 - 9	75	70	50
7 - 9	10 - 12	75	45	25
10 - 12	13 - 15	50	20	0
13 - 15	15 - 18	25	0	0
> 15	> 18	0	0	0

* Concentration of NO_3-N in the top foot of soil or the sum of NO_3-N concentrations in 1-foot sample depths to 2 feet.
- To adjust N rate for expected yields different from 50 bu/A, add or subtract 25 lb N/A for each 10 bu/A difference (maximum N rate is 75 lb/A for dryland winter wheat).

Table 2: Suggested nitrogen rates for irrigated winter wheat, as related to NO_3-N in the soil and soil organic matter content (expected yield, 100 bu/A).

ppm NO_3-N in soil*	Soil organic matter, %		
	0 - 1.0	1.1 - 2.0	>2.0
0 - 6	125	95	75
7 - 12	105	75	55
13 - 18	85	55	35
19 - 24	65	35	15
25 - 30	45	15	0
31 - 36	25	0	0
> 36	0	0	0

* Sum of ppm NO_3-N in 1-foot sample depths to 2 feet (for sample depths of 1 foot only, multiply the ppm value by 1.67 before using the table).
-To adjust N rate for expected yields different from 100 bu/A, add or subtract 20 lb N/A for each 10 bu/A difference.
NOTE: Increase the above rates by 40 lb N/A for irrigated wheat in Alamosa, Conejos, Costilla, Rio Grande and Saguache counties.

Soil Nitrate-N Credit

Residual NO_3-N in soil is immediately available to plants, so decrease the fertilizer rate to give credit for the amount of NO_3 in the root zone. Sample soil to a depth of 2 feet in 1-foot or less increments and test for NO_3-N. The sum of the ppm values for the two samples is used to estimate the NO_3-N content in the soil. For example, if the NO_3-N contents of the 0-1 and 1-2 foot soil samples are 10 and 4 ppm, use the N rates in the 13 to 15 ppm row in the second column of Table 1. When soil is sampled to a 1-foot depth, use the first column in Table 1.

Soil Organic Matter Credit

Nitrogen in soil organic matter becomes available to plants through a mineralization process. About 30 pounds of nitrogen per acre will be available to the crop during each growing season for each 1.0 percent organic matter in the surface soil layer. When a soil test result for organic matter is not available, assume a level of 1.5 percent organic matter for eastern Colorado soils.

Dryland Wheat

Suggested N rates for dryland wheat are given in Table 1 at an expected yield of 50 bushels per acre. Fertilizer N rates decrease with increasing levels of NO_3-N in the top foot or 2 feet of soil and increasing soil organic matter content. Suggested N rates in this table do not account for manure and legume N credits. Subtract these credits from the N rates in Table 1 to determine the N rate for the field.

To increase grain protein content to above average levels (i.e., >12 percent protein), increase the N rate. It takes 20 to 30 pounds of nitrogen per acre to increase grain protein by one percentage point above 12 percent protein.

Irrigated Wheat

Table 2 gives suggested N rates for irrigated wheat at an expected yield of 100 bushels per acre. Fertilizer N rates decrease with increasing levels of NO_3-N in the top 2 feet of soil and increasing soil organic matter content. Suggested N rates in this table do not account for manure and legume N credits. Subtract these credits from the N rates in Table 2 to determine the N rate for the field. Late season N applications are not suggested for soft wheat because a lower protein content is desired.

Methods and Timing of N Applications

Nitrogen may be applied to soil by various methods. Most efficient use of fertilizer N can be obtained by applying some of the N prior to or at planting and the remainder in the early spring. Some growers prefer to apply anhydrous ammonia in combination with P fertilizers in a tillage operation during the fallow period for dryland wheat. Some N may be applied with or near the seed in combination with P in starter fertilizers, but the rate should be less than 20 pounds of nitrogen per acre because seedling emergence may be decreased in dry soil. All sources of N fertilizers are equally effective for wheat per unit of N if properly applied. Base your choice of N on availability, equipment available and cost per unit of N.

Topdressing N fertilizers in the spring is an efficient way to supply a portion of the total N needs of wheat. Producers can evaluate spring-stored moisture and plant populations to better predict yield potential in the spring than at planting, so N needs by the crop can be better determined. Granular fertilizer can be broadcast on the wheat just after greenup. Fluid N solutions also may be dribble-applied to the wheat crop, although there is some potential for leaf burn.

Apply nitrogen fertilizers through sprinkler irrigation systems for irrigated wheat. All closed-irrigation systems must be equipped with backflow prevention valves if N fertilizers are applied through the system.

There is a strong relationship between protein content of wheat and the N fertility status of a given field. Fields that produce grain with protein content with less than 11 percent are likely to have N deficiencies. Those fields that produce grain with protein between 11 and 12 percent may respond to additional N fertilizer, while those that produce grain with more than 12 percent protein probably have adequate N for the present grain yield levels. Therefore, protein analysis of wheat will give the producer a good indication if the N fertilizer program was adequate for that season.

This information can be used to help plan N fertilization management in future years. The above relationships do not hold well under extreme drought conditions. Field conditions also should be considered. For more information, see 0.555, *Grain Protein Content and N Needs*.

Phosphorus Suggestions

Crop responses to applied P are most likely on soils with low or medium levels of extractable P. Suggested P fertilizer rates (Table 3) are for band (or row) application and are similar for dryland and irrigated wheat. The main soil tests for extractable P in Colorado soils are the AB-DTPA and sodium bicarbonate ($NaHCO_3$) tests. Values for both tests are given in Table 3.

Placement of P fertilizers in the root zone is important because P is not very mobile in soil. Band application of starter fertilizers with or near the seed is the most efficient placement method for P, and suggested rates for broadcast application are about double those for band application. Incorporate broadcast applications of P fertilizers into the soil prior to planting.

Dual application of N and P together in a band improves efficiency of P uptake by crops. Subsurface placement of P may be especially important for reduced tillage cropping systems. Monoammonium phosphate (MAP, 11-52-0), diammonium phosphate (DAP, 18-46-0), and ammonium polyphosphate (10-34-0) are equally effective per unit of P if properly applied. Base choice of fertilizer product on availability, equipment available and cost per unit of P.

An effective method of band application of P with hoe drills was developed that allows the P fertilizer to be banded on the soil surface directly above the seed row after row closure.

Table 3: Suggested phosphorus rates for band application to dryland and irrigated winter wheat.

ppm P in soil AB-DTPA	ppm P in soil $NaHCO_3$	Relative level	Fertilizer rate, lb P_2O_5/A
0 - 3	0 - 6	low	40
4 - 7	7 - 14	medium	20
> 7	> 14	high	0

Table 4: Suggested potassium rates for dryland and irrigated winter wheat.

ppm K in soil AB-DTPA or NH_4OAc	Relative level	Fertilizer rate, lb K_2O/A
0 - 60	low	30
> 60	high	0

Potassium Suggestions

Most Colorado soils are relatively high in extractable K, and few crop responses to K fertilizers have been reported. Suggested K rates related to soil test values (AB-DTPA or NH_4OAc) are similar for dryland and irrigated wheat (Table 4). The main K fertilizer is KCl (muriate of potash). Broadcast application incorporated into the soil prior to planting is the usual method.

Other Nutrients

Most Colorado soils contain adequate levels of available S, and soil tests for available S are not routinely performed. Under rare situations some sandy soils may require S applications; the chances of getting a yield response to S fertilization increase when the soil pH is 7.5 or higher and the soil organic matter is 1.5 percent or lower. Irrigation water from most surface waters and some wells often contains appreciable SO_4-S, so irrigated soils usually are adequately supplied with S.

There have been no confirmed deficiencies of boron (B), copper (Cu), iron (Fe), manganese (Mn), molybdenum (Mo), zinc (Zn), and chloride (Cl) in wheat in Colorado.

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