Fertilizing Small Grains in Arizona

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Proper fertilization of all crops, forages and grains included, is essential to insure continued high yields. Determining a proper fertilizer rate is not always simple but can be easy and reasonably precise if soil and tissue tests are used and a few fundamental principles are recognized. This material is a review of those tests and principles as they apply to Arizona small grain production.

Collecting A Soil Sample

The first step in establishing a fertilizer recommendation is to collect a representative soil sample well before any preplant fertilizers are to be applied. Early sampling will allow for analysis time and for subsequent purchasing of fertilizers. Before sampling, size up your field. If areas in the field are visibly different or are known to be different from past experience, sample each area as a separate unit. Take samples at random across each sampling unit, collecting and compositing at least 20 soil cores or samples from each area. The composite sample is mixed and a portion of the composite is used for soil analysis. Agri-File number 208.0 titled "How to Sample Arizona Soils" is available at most county co-operative extension offices and contains a more complete description of soil sampling procedures.

The sample can be analyzed by the University of Arizona Soils, Water and Plant Tissue Testing Lab located on campus in Tucson or by any of the commercial testing labs, most of which are located in the Phoenix area. It must be added that different labs often use different testing techniques. Results from one lab cannot always be directly compared to those of another. One should also be aware that reported units also vary. An example is nitrogen reported as parts per million (ppm) nitrogen or ppm nitrate. Both methods are valid but the numbers will be different by a factor or 4.4.

Making Nitrogen Fertilizer Recommendations

a. Soil test values.

After the nitrogen level in the soil is obtained from the reporting lab, Table 1 is used to determine the initial additions needed. This provides a basis to make recommendations. The soil test is not complete by itself. Modifying factors must also be considered such as those following.

TABLE 1.

Soil Test Value* ppm N	lb. N/acre Recommended
>10	0
5 to 10	0 to 50
<5	50 to 100

*CO_2 extractable nitrate reported as parts per million (ppm) elemental nitrogen.

To convert to ppm nitrate (NO_3^-) multiply by 4.4.

b. Plant residue returned and previous crop.

Microbial decomposition of crop residues from non-leguminous crops such as corn, cotton, or sorghum, decrease the amount of nitrogen availavle for immediately following crops. Additional nitrogen must be applied to compensate for this reduction. Generally 15 pounds of nitrogen must be added for each ton of non-legume residue remaining in the field, up to an additional 50 lb N/acre. If a legume crop such as alfalfa is plowed down, no adjustments need to be made for crop residue.

c. Soil texture.

When field conditions are favorable for crop growth, conversion of any ammonium forms of nitrogen to nitrate-nitrogen is rapid. Nitrate-nitrogen is highly mobile in the soil. Generally nitrate-nitrogen goes where the water goes. Consequently nitrate is susceptible to losses by leaching, especially in sandier soils where water moves easily through the soil, out of the rooting zone. To compensate for potential leaching losses on sandy soils, split nitrogen applications should be made. One-third should be applied broadcast as a preplant fertilizer. The remainder of the fertilizer should be applied in at least two applications later in the season.

The method of application of nitrogen during the growing season is determined by the type of irrigation used. If fields are flat and flood irrigated or sprinkler irrigated, aerial applications of urea, immediately before irrigation, is best. Irrigation water will move the urea into the root zone.

Conversion of urea nitrogen to nitrate-nitrogen is fairly rapid and consequently the nitrogen is readily available to the grain. If furrow irrigation is used, water run nitrogen will be the best method for applying late fertilizers. It must be recognized that if anhydrous ammonia is used as the nitrogen source, at least one-half and possibly more of the nitrogen will be lost by volatilization. Experience has also shown that on medium and fine textured soil, water applied ammonia is not available to the plant until the following irrigation.

d. Nitrogen in irrigation water.

Although it is not often considered, irrigation waters can contain significant amounts of nitrogen. Nitrogen found in irrigation water is as valuable as an equal amount of commercial fertilizer. Irrigation water will sometimes contain 10 to 20 pounds of nitrogen per acre-foot and can be as high as 50 lbs/acre-foot. A small grain crop receiving approximately 3 acre-feet of water could easily receive 30 to 50 lbs. of N in a season's irrigation water. The commercial fertilizer recommendation should be reduced by the amount of nitrogen expected to be applied with the irrigation water. In some cases, the cost of a water analysis which reports the amount of nitrogen in the water can be returned many times over in reduced fertilizer costs.

Tissue Tests

Tissue testing is the second major tool available to evaluate the N status of small grains. Analysis of plant tissue collected early in the growing season can indicate if nitrogen deficiencies can be expected later in the season, before the grain matures. If a potential deficiency is encountered, early applications of nitrogen as broadcast urea or water run nitrogen can head off a developing nitrogen deficiency.

For small grains, the lower portion of the stem has been found to be indicative of the nitrogen status of the plant. Prior to jointing, the portion of the stem below the soil level and above the seed is used for chemical analysis. After jointing, the lower two inches of the stem just above the soil level is used. Thirty to 40 randomly selected stems are necessary to provide sufficient plant material for chemical analysis. Again, sample uniform areas of the field and avoid areas that are not representative of the field overall. Samples are then tested for extractable nitrate-nitrogen. Information in Figure 1 and Table 2 can then be used to interpret the results of the chemical analysis of the stems. It is advisable to collect at least 3 sets of samples during the growing season: 3 to 4 leaf stage, jointing, and boot. Results will indicate not only the present nitrate status of the wheat stems, but also the rate at which nitrate-nitrogen levels are declining. If all samples fall in the desired range, no fertilizer applications are needed. If the level of nitrate-nitrogen in the wheat stems falls into the warning zone, an application of nitrogen should be made to prevent deficiencies from occuring later in the season. Levels of nitrate-nitrogen within the excessive zone indicate high levels of soil nitrogen. The plant with excessive nitrogen will tend to grow vegetatively with possible loss of grain yield and an increased potential for lodging. When nitrate-nitrogen levels are allowed to decline into the deficient range, some loss in yield will occur. The amount of yield reduction will depend upon the severity and the length of the nitrogen deficient conditions. Applications of nitrogen fertilizer to plants that are nitrogen deficient will increase yield as compared to nitrogen deficient plants not receiving additional nitrogen. However, some loss of yield will occur as compared to plants that are not allowed to become nitrogen deficient.

FIGURE 1. RANGES FOR TISSUE NITRATE NITROGEN.

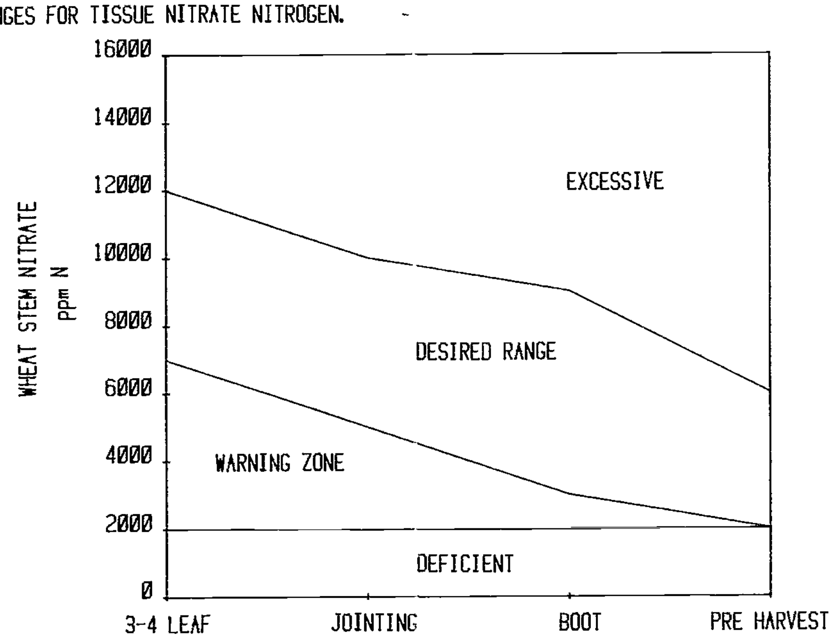

TABLE 2

Stage of Growth	Tissue Analysis ppm N*	lb. N/acre recommended
3 to 4 leaf	>7000	None
	2000 to 7000	0 to 50
	<2000	50 to 100
Jointing	>5000	None
	2000 to 5000	0 to 50
	<2000	50 to 75
Boot	>3000	None
	2000 to 3000	0 to 25
	<2000	0 to 50

*Nitrate-nitrogen extracted 2% acetic acid and reported as ppm elemental nitrogen.

Making Phosphorus Fertilizer Recommendations.

Phosphorus recommendations are generally less complicated than those of nitrogen. Previous crop, soil texture, and irrigation water usually have minimal influence upon a phosphorus fertilizer recommendation based on an initial soil test value for phosphorus. After a soil analysis, Table 3 can be used to determine rates of phosphorus needed.

TABLE 3

Soil Test Value* ppm P	lb. P_2O_5/acre recommended
>3	0
1 to 3	0 to 50
<1	50 to 100

*CO_2 extractable phosphate reported as ppm elemental phosphorus.

To convert to ppm PO_4 multiply by 3.1.

Management of phosphorus and nitrogen fertilizers differ primarily in the mobility of phosphate compared to nitrate. Nitrate is mobile in the soil and can be moved by water from the soil surface, where availability is low, into the root zone where availability is high. Phosphates are not mobile. Phosphate fertilizers stay near where they are applied, they do not move significantly with water. Because of this low miblity, phosphorus fertilizers must be mechanically placed in the root zone by methods such as injection or plowing or deep disking after a broadcase application.

The returns from a small investment in time and money are usually high. A few hours spent collecting soil and tissue samples and a few dollars for analysis can often net large returns in higher yields and protein content or can avoid unnecessary costs associated with excessive fertilizer applications.