Fertilizing Small Grains in Arizona

Dean Pennington, Extension Soils Specialist

Summary

Proper fertilization of all crops, forages and grains included, is essential to maintain quality and to insure continued high yields. Determining a proper fertilizer rate can be 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.

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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.

The sample can be analyzed by any of the commercial testing labs, most of which are located in the Phoenix area or through the Cooperative Extension Service by the University of Arizona Soils, Water and Plant Tissue Tesing Lab located on campus in Tucson. It must be noted 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 which can be reported as parts per million (ppm) nitrate- nitrogen or ppm nitrate. Both methods of reporting are valid but the ppm nitrate numbers will be higher by a factor of 4.4.

Making Nitrogen Fertilizer Recommendations

I. Soil test values.

After the nitrogen level in the soil is obtained from the lab, Table 1 can be used to determine the base additions of nitrogen fertilizer needed.

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.

The soil-test based recommendation is not complete by itself. Modifying factors must also be considered such as those following.

a. 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 available 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.

b. 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. Due to this mobility in water, nitrate is susceptible to losses by leaching, especially in sandier soils where water moves easily through the soil and out of the rooting zone. To compensate for potential leaching losses on sandy soils, split nitrogen applications should be made. One-third may be applied as a preplant fertilizer. The remainder of the fertilizer may be applied in at least two applications later in the season.

The method of application of nitrogen during the growing season is determined in part by the type of irrigation used. If fields are sprinkler irrigated or flat and flood irrigated, broadcast applications of urea, immediately before irrigation, are good. Irrigation water will move the urea into the soil.

If furrow irrigation is used, water run nitrogen will be the best method for applying post plant fertilizers. It must be recognized that if anhydrous ammonia is used as the nitrogen source, one-third and possibly more of the nitrogen can be lost to the atmosphere. Experience has also shown that on medium and fine textured soil, water applied ammonia is not available to the plant until the following irrigation. Urea-ammonium nitrate solutions can be run in irrigation water without loss to the atmosphere and some of the nitrogen is immediately available. Urea-ammonium nitrate solutions are much more expensive, per pound of nitrogen, than anhydrous ammonia.

c. 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 nitrogen. Irrigation water can contain 10 to 20 pounds of nitrogen per acre-foot and may be as high as 50 lbs N/acre-foot. A small grain crop receiving approximately 3-4 acre-feet of water could easily receive 30 to 100 lbs. of N in a season's irrigation water. The fertilizer recommendation should be reduced by the amount of nitrogen expected to be applied with the irrigation water, as determiend by its analysis.

II. Tissue Tests

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

The lower portion of the stem of small grains 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 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 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 but also the rate at which nitrate-nitrogen levels are declining. If test results fall in the desired range (Fig. 1), 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 excess zone indicate high levels of soil nitrogen. The plant with excessive nitrogen can 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, loss in yield will occur. The amount of yield reduction will depend upon the severity and the length of time 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.

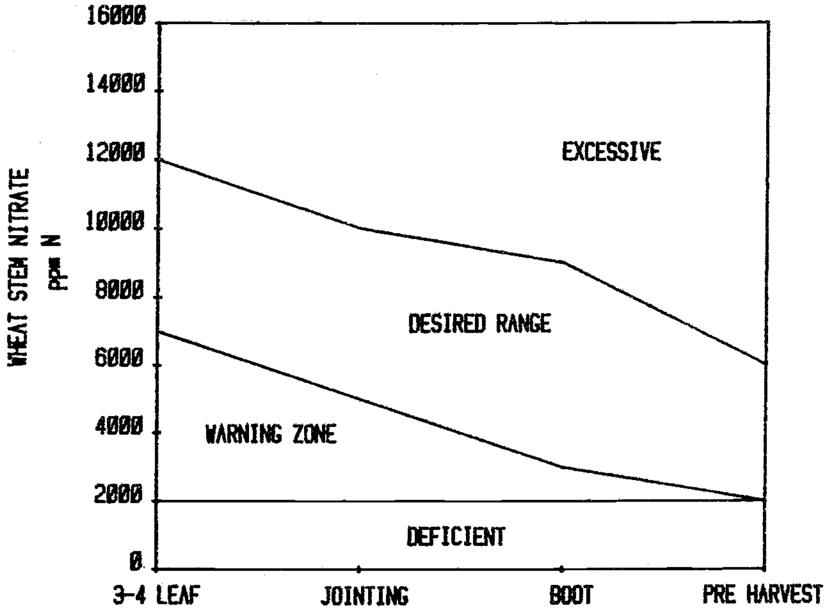

TABLE 2.

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 with 2% acetic acid and reported as ppm elemental nitrogen.

Making Phosphorus Fertilizer Recommendations.

Phosphorus recommendations are generally less complicated than those of nitrogen.

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 ppm P to ppm PO_4 multiply by 3.1.

Management of phosphorus and nitrogen fertilizers differ primarily in the mobility of phosphate compared to nitrate. Unlike nitrates, phosphate fertilizers stay near where they are applied; they do not move significantly with water. Because of this low mobility, phosphorus fertilizers must be mechanically placed in the root zone by methods such as injection or plowing or deep disking after a broadcast application, before planting or drilled with the seed.

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.

Yellowberry in Durums

When growing durum wheats, control of "Yellowberry" can be nearly as important as the quantity of wheat grown. Timing and amounts of nitrogen fertilizer and water can substantially influence the occurance of Yellowberry.

Nitrogen Deficiencies between heading and flowering cause a higher incidence of Yellowberry. Monitoring with tissue testing and split nitrogen fertilizers applications can help prevent nitrogen deficiencies at this crucial time.

Heavy Irrigations between heading and flowering can also increase Yellowberry content. Wet, nearly saturated soils reduce the ability of the wheat to use available nitrogen. Heavy watering at this time is more likely to be a problem on fine textured soils that stay wet for several days after irrigation. To prevent the problem, avoid heavy single irrigations during the heading to flowering stage.

Yield Responses of Wheat to Nitrogen and Phosphorus in the Upper Gila Valley

B.R. Gardner, J.H. Park and D.A. Pennington

Summary

Grain yield was increased with 50 lbs of N per acre with no further increases with higher rates of N applied. Applied P had no significant effect on grain yields. N applications decreased the percentage of yellowberry in the grain. Nitrate levels in wheat stems were inversely related to the percent of yellowberry.

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Super X wheat was planted on the Safford Experiment Station and irrigated up on December 18, 1980. Six nitrogen treatments and two phosphorus treatments were replicated 6 times in a split-plot design. Phosphorus was the whole plot treatment and nitrogen the subplot treatment. Treble super phosphate was used as the P source and urea was used for N. The dates and rates of application are shown in Table 1.

TABLE 1. Grain yield, bushel weight and yellowberry response to nitrogen and phosphorus treatments.

Treatment Preplant 12-17-80	Treatment Topdress 2-25-81	Grain Yield	Bushel Weight	Percent Yellowberry
lb N/acre		lb/acre	lb	%
0	0	3670a	59.9	53.3 b
50	0	4390 b	60.0	16.6a
100	0	4270 b	59.3	8.8a
200	0	4080a	58.7	1.9a
50	50	4610 b	59.4	10.3a
100	100	4140ab	58.3	2.5a
	LSD	517	N.S.	13.5
lb P_2O_5/acre				
0	0	4110	58.8a	13.8a
100	0	4280	59.7 b	17.3 b
	LSD	N.S.	0.8	3.4

Stem tissue samples were taken 3 times during the season and analyzed for NO_3-N and PO_4-P. The plots were harvested on June 19, 1981. Subsamples of the grain were taken to measure bushel weight and to determine yellowberry percentage.