Effects of N and P Applications on Wheat Stem Nitrate and Phosphate Levels, and Grain Production in Graham County.

Tim Knowles, Thomas Doerge, Mike Ottman and Lee Clark

ABSTRACT

Obtaining optimal yields of spring wheat in Arizona normally requires applications of fertilizer nitrogen (N), and occasionally phosphorus (P). The University of Arizona currently recommends preplant soil tests for NO_3-N and P, plus periodic stem tissue NO_3-N analyses to predict the N and P needs of wheat. Preplant application of P within the root zone of growing plants is suggested due to the immobility of P in soils. Split applications of N broadcast to dry soil preceding irrigations are generally recommended. Collecting additional data to calibrate and refine current guidelines for interpreting soil and plant test values is an ongoing need in Arizona. An experiment was conducted at the Safford Agricultural Center during the 1986-87 crop year to evaluate the response of "Aldura" durum wheat to banded and broadcast N and P, and split applications of N on a clay loam soil testing low in NO_3-N and available P. Maximum grain yields of over 4,500 lbs./A were obtained by banding of 40 lbs. P_2O_5/A and 32 lbs. N/A as 16-20-0 at planting and broadcasting 118 lbs. urea-N/A prior to seeding. Stem tissue NO_3-N analyses revealed that N deficient conditions prevailed throughout the growing season in all fertilizer treatments. Treatments in which the preassigned rate of N was split into three applications produced the lowest yields due to serious N deficiency early in the season. The stem NO_3-N tissue test proved accurate in predicting N status and a stem PO_4-P tissue test seemed reliable in monitoring P nutrition of durum wheat.

INTRODUCTION

Nitrogen (N), and to a lesser extent phosphorus (P) are the two essential nutrient elements which most often limit the production of wheat in Arizona. Current recommendations for N applications to wheat are based on a preplant NO_3-N soil test, plus stem NO_3-N tissue tests taken at the 3-4 leaf, jointing and boot growth stages. Preplant P soil analyses are used to predict if additional P may increase grain yields (Pennington et al., 1983). Stem PO_4-P tissue tests have been used to a lesser extent than NO_3-N stem tests since P deficiencies are difficult to correct during the growing season and because of a lack of data correlating stem PO_4-P levels to yield response to P fertilization (Gardner and Jackson, 1976).

Once the need for additional N or P is established, several options may be available concerning timing and methods of fertilizer application. Current recommendations involve N applications to wheat prior to planting and at the 5-6 leaf, boot and flowering stages. Any required P is normally banded with the seed at planting due to the immobility of P in soils. A common practice for wheat production in Graham County

is to apply all of the required N and P preplant as broadcast urea and banded ammonium phosphate-sulfate (16-20-0). Growers find split N applications inconvenient and question their possible benefit.

Split N applications to wheat have the potential to provide an adequate supply of N to the plant throughout the growing season without risking large N losses from heavy early season applications via leaching or dentrification. Wheat plants take up a majority of their N prior to the boot stage. Adequate N supply during this vegetative period is essential for attaining optimum plant biomass accumulation and grain yield. Applications of N following heading contribute to higher grain protein levels.

An experiment was conducted at the Safford Agricultural Center with the following objectives: 1) to determine the effect of banded or broadcast P and NH_4-N on durum wheat when grown on a soil testing below the critical level for P and NO_3-N; 2) to evaluate the effect of N and P applications on levels of stem tissue NO_3-N and PO_4-P; and 3) to determine the effect of split applications of N as opposed to applying all N at or before planting.

MATERIALS AND METHODS

A fertility trial with "Aldura" durum wheat was conducted on a Pima clay loam (fine silty, mixed, thermic, Typic, Torrifluvent) at the Safford Agricultural Center. Plots had been previously cropped with unfertilized Sudan grass to reduce the level of residual soil N. Chemical properties of the surface soil (0-12 in.) were: pH, 8.1; sodium bicarbonate extractable P, 8 ppm; electrical conductivity, 2.9 dS/m; ammonium acetate extractable sodium, 8.0 meq/100g; free $CaCO_3$, high; and computed exchangeable sodium percent (ESP), 27.3%. Preplant NO_3-N in the surface 12 inches of soil was determined by H_2O extraction and Kjeldahl steam distillation to be 1.3 ppm.

The rates, timing, sources and application methods of N and P fertilizers are listed in Table 1. Preplant broadcast N was hand spread and worked into the surface 3-4 inches of soil during the seeding operation. All midseason N applications were hand broadcast on dry soil no more than 2 hours prior to irrigation.

Table 1. Rates, timing and fertilizer sources applied to "Aldura" wheat grown on a Pima clay loam at the Safford Agricultural Center.

Treatment*	Preplant		Banded at Planting		Topdressings of Urea-N		Total for Season	
	N	P_2O_5	N	P_2O_5	Joint	Boot	N	P_2O_5
	lbs/a							
1. Check	0	0	0	0	0	0	0	0
2. 16-20-0 banded	0	0	32	40	78	40	150	40
3. 21-0-0 banded	0	0	32	0	78	40	150	0
4. 16-20-0 broadcast	32	40	0	0	78	40	150	40
5. 21-0-0 broadcast	32	0	0	0	78	40	150	0
6. Local Standard (urea)	118	0	32	40	0	0	150	40

#21-0-0 and 16-20-0 refer to ammonium sulfate and ammonium phosphate-sulfate respectively.

Wheat seed was drilled on flat borders at the rate of 200 lbs./A on 23 December, 1986 and irrigated up. A total of about 29 inches of water containing approximately 14 lbs. NO_3-N was applied in five irrigations (including pre-irrigation). Rainfall during the growth period was 3.4 inches. Individual plots were 15.5 x 45 feet and all treatments were replicated four times in a randomized complete block design.

Stem tissue samples were taken on 6 March at the 3-4 leaf stage, then at the joint (3 April), boot (17 April) and heading (1 May) stages of growth. The plant parts sampled were the stem (between ground level and the seed) for samples taken prior to jointing, and the two inches of stem (just above ground level) for the remaining dates. Samples were dried, ground and analyzed for NO_3-N content using a specific ion electrode. Analysis for PO_4-P was done using a 2% acetic acid extraction and the colorimetric method of Murphy and Riley.

Grain yields were estimated by harvesting a 164 sq. ft. area in each plot using a small plot combine on 24 June.

RESULTS AND DISCUSSION

Table 2 shows the NO_3-N content of wheat stems throughout the season. Stem NO_3-N levels from all treatments fell below the deficient level (2,000 ppm NO_3-N) by the first sampling date and remained deficient through the season. Tissue levels, however, did increase in response to applications of N at the joint and boot stages in treatments 2-5.

Neither the method of applying N at planting nor the inclusion of P fertilizer at that time had any significant affect on stem NO_3-N levels as seen in treatments 2 through 5.

The local practice of applying all N at or before planting (Treatment 6) resulted in more favorable N nutrition early in the season, compared to the plants receiving split applications of N (Treatments 2-5). However, by the boot stage, the stem NO_3-N content in treatments receiving split applications surpassed the NO_3-N levels found in the plants receiving all fertilizer N at the beginning of the season.

The significantly higher grain yield for plots receiving all N by planting (Treatment 6) indicates that N deficiency was more serious when it occurred early in the season (Table 3). Yield results from an adjacent N fertility trial indicated that about 200 lbs. N/acre was required to attain the maximum yield possibility for this site (about 6000 lbs. grain/acre). Benefit from split applying fertilizer N may have been obtained if the preassigned rate of N fertilizer used in this experiment had more nearly equaled this higher rate.

Table 2. Stem NO_3-N values for "Aldura" wheat at Safford Agricultural Center receiving different rates and placement of N and P fertilizer.

Treatment	Stem NO_3-N (ppm)		
	3-4 Leaf	Joint	Boot
1	120 f	120 e	110 d
2	330 bcde	230 bcd	940 b
3	380 bcd	160 cd	990 b
4	370 bcde	280 bcd	940 b
5	460 bc	170 cd	1170 a
6	1460 a	730 a	530 c
LSD.05	160	160	160

*Numbers within the same column followed by the same letter are not significantly different at the 5% level according to the SNK method.

Table 3. Growth characteristics of "Aldura" wheat receiving various N and P treatments.

Treatment (lbs./A)	Bushel Weight (lbs/bu)	Grain Yield
1	60.2 b*	1327 a
2	59.6 ab	3397 b
3	59.9 ab	3018 b
4	58.8 a	3360 b
5	60.2 ab	3449 b
6	60.6 b	4584 c
LSD 0.05	0.98	670

*Means followed by the same letter within each column are not significantly different at the 5% level according to the SNK Method.

The N-deficient conditions observed in this trial (Treatments 2-6) were aggravated by an untimely irrigation prior to the first stem sampling date at the 3-4 leaf stage. Moisture levels at that time were probably adequate and irrigation most likely resulted in leaching of soluble NO_3-N below the root zone of the young plants.