

Wheat and Barley Response to Pre-plant Phosphorus at Safford Agricultural Center, 2000

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Abstract

Bread wheat and barley were seeded in low phosphorus soils which had had varying rates of ammonium phosphate-sulfate (16-20-0) applied. Statistical increases in yield were seen in the wheat study. The increased bottom line with the lowest rate of phosphorus declined as rates of phosphorus increased. Low crop values and high fertilizer costs made high application rates uneconomical. Barley yields were not statistically increased with the addition of phosphorus and the economics of applying phosphorus for this crop were negative. A two year summary is included in this report.

Introduction

Pre-plant (or at planting) phosphorus is normally applied to winter crops in the high desert soils in southeastern Arizona. The University of Arizona has phosphorus fertilizer recommendations for small grains grown in Arizona based on the bicarbonate soluble P extractions from soils. These guidelines were tested recently in a study by Ottman, et.al. (1) in an effort to encourage growers to test their soils to see if the cost of the phosphorus was justified. This study was established to find the efficacy of pre-plant phosphorus applications in the Safford Valley, particularly at our location.

Materials and Methods

This phosphorus study on hard red wheat and barley was planted on the Safford Agricultural Center in December of 1999. Seed was planted with an International 12 foot grain drill with a fertilizer attachment over four 3-foot beds. The crop history follows:

Crop History:

Elevation: 2954 feet above sea level

Soil type: Pima clay loam variant

Planting date: 20 December 1999

Seeding rate: 180 pounds per acre

Herbicide: 2,4-D on 4-3-00 to control broad-leafed weeds

Fertilizer: 16-20-0 at planting per treatment outlined, 200 lbs/ac urea was side-dressed on 2-9-00 and 3-29-00

Insecticides: None

Irrigation: Furrow, watered up plus 9 irrigations for a total of ca. 35 acre inches

Rainfall during the growing season: 0.36 inches

Plot size: 12 feet by 45 feet

Replicates: Four

Harvest dates: Barley - 6-8, Wheat - 6-13-00 Heat units (40 to 81°F) from planting to maturity (6-6) = 3260

Plots were harvested with a Gleaner Combine with a 13 foot header. Individual plots were weighed using electronic weigh scales and samples were taken to determine moisture, bushel weight and percent protein.

A soil samples was taken at planting time and submitted for chemical analysis. The results of the soil tests are found in Table 1.

Phosphorous treatments applied at planting:

Trt #	Treatment	P ₂ O ₅ Applied	Cost of Phosphorous Fertilizer
1	Untreated check	0 lbs/ac P ₂ O ₅	\$0.00/acre
2	100 lbs/ac 16-20-0 applied	20 lbs/ac P ₂ O ₅	\$14/acre
3	200 lbs/ac 16-20-0 applied	40 lbs/ac P ₂ O ₅	\$28/acre
4	400 lbs/ac 16-20-0 applied	80 lbs/ac P ₂ O ₅	\$56/acre

Results and Discussion

To have a positive response to phosphorus applications, the soil must be low in available phosphorus. A knowledge of the phosphorus status of the soil must be known or acquired through soil testing to ensure that it is economical to apply the fertilizer. University research has produced guidelines for phosphorus utilization, this information comes from reference 1 and is included in Table 1. The soil tests from the plots in this study are listed in Table 2. The top line of data, D1Wht, is from Field D-1 where the wheat trial was performed. The bottom line of data, D2Bar, came from Field D-2, where the barley trial was done. Both locations had available phosphorus levels around 2 parts per million (ppm) which is categorized as low in Table 1 and very likely to respond to 50 to 100 pounds of P₂O₅.

Table 3a shows the effects of the phosphorous treatments on Yecora Rojo variety of hard red wheat in this current year's study. The first column of data shows an increase over 1000 pounds per acre with the 100 pound rate of 16-20-0. This is slightly more, but in the same order of magnitude, as the effects seen in the trial in 1999 (2). The higher rates of phosphorus tended to have higher yields (even though not significantly). The second column shows the economic differences between treatments. The numbers in this column are derived by multiplying the weight of grain yield by \$5 per hundredweight to produce a gross value of the crop, subtracting the fertilizer cost and then subtracting the value of the Untreated Check. This leaves the value labeled as "Increase over check". These values are in dollars per acre. The data indicate that the maximum economic gain is with the 100 pound per acre treatment of 16-20-0. Gains were seen with the two higher rates, but the margin decreased with the increased fertilizer applications.

Table 3b is a summary of yields and economics across the 1999 and 2000 studies. An increased wheat yield at the 400 pound per acre rate of 16-20 coupled with slightly higher grain prices and lower fertilizer prices made the maximum economic yield occur at that application rate. However, the average over the two years produced the same results as seen in 2000.

Table 4a contains information from the current study on the barley with different phosphorous levels applied at planting. No significant yield differences were seen with any of the treatments and the economics indicated a loss in profit from applying the phosphorus fertilizer to barley. Table 4b indicated the same for last year's study as well as for the average of the two years.

The recommendation apparent from this research on salty soils in the Safford valley is that soil be tested for available phosphorus prior to planting, and that phosphorus be applied to the crop according to Ottman's recommendations. Then, that a test strip be placed in individual fields with 50 pounds per acre of P₂O₅ more and less than the recommendation, to fine tune the best rate for that particular field.

References

1. Ottman, M.J., S.H. Husman and B.R. Tickes. 1997. Barley and Durum response to phosphorus at Buckeye, Maricopa and Yuma, 1997. Forage and Grain, A College of Agriculture Report, The University of Arizona, Tucson, AZ. Series P-110, pp. 125-129.
2. Clark, L.J. and E.W. Carpenter. 1999. Wheat and barley response to pre-plant phosphorous at Safford Agricultural Center, 1999. Forage and Grain, A College of Agriculture Report, The University of Arizona, Tucson, AZ. Series P-118, pp. 71-75.

Table 1. Phosphorus fertilizer recommendations for small grains grown in Arizona based on bicarbonate extractable phosphorus. (From Ottman reference 1)

Pre-plant P level (ppm)	P level description	Response to P fertilizer	Recommended P rate (lbs/ac)
<6	Low	Likely	50 to 100 lbs/ac P ₂ O ₅
6 to 12	Medium	Variable	0 to 50 lbs/ac P ₂ O ₅
>12	High	Not likely	0 lbs/ac P ₂ O ₅

Table 2. Soil analysis reports for samples submitted from test plots on the Safford Agricultural Center.

Field/ Date	pH	Calcium ppm	Magnesium ppm	Sodium ppm	Potassium ppm	Salinity EC*K ds/m	Nitrate- N ppm	Bicarb-sol Phos ppm	Exc.Na Percent	Free Lime
D1Wht 12-99	8.6	5700 VH	470 VH	1000 VH	580 VH	2.2 M	7.4 L	1.9 VL	11.4	H
D2Bar 12-99	8.5	5600 VH	450 VH	960 VH	590 VH	2.4 M	8.2 L	2.0 VL	11.1	H

Table 3a. Yield and other economic and agronomic variables in phosphorus study on wheat at the Safford Agricultural Center, 2000.

Treatment	Yield per acre @10%M	Increase over check (\$/ac ¹)	Bushel Weight	% Moisture	% Protein	1000 Kernel Weight	Plant Height	% Stand Count
Untreated check	3974.5 b ³	\$0.00	62.5 a	8.45 a	14.0	34	22.5 a	82.5 a
100 lbs/ac 16-20 @ planting	5034.4 a	\$39.00	63.3 a	8.10 ab	14.0	35	24.5 a	93.8 a
200 lbs/ac 16-20 @ planting	5075.6 a	\$27.05	63.5 a	7.70 b	14.0	35	23.9 a	96.3 a
400 lbs/ac 16-20 @ planting	5162.2 a	\$3.40	63.8 a	7.58 b	14.3	38	23.1 a	87.5 a
Average	4811.7	--	63.3	7.96	14.1	35.5	23.5	90
LSD(05)	992.1	--	1.41	0.71	--	--	3.73	14.2
CV (%)	12.9	--	1.39	5.57	--	--	9.92	9.89

Table 3b. Yield and economic summaries for phosphorous study on wheat at the Safford Agricultural Center, 1999 and 2000.

Treatment	1999 Yield per acre @10%M	Increase over check (\$/ac ²)	2000 Yield per acre @10%M	Increase over check (\$/ac ¹)	Avg Yield per acre @ 10%M	Average Increase over check (\$/ac)
Untreated check	3948.7 b ³	\$0.00	3974.5 b	\$0.00	3961.6	\$0.00
100 lbs/ac 16-20 @ planting	4767.6 a	\$42.47	5034.4 a	\$39.00	4901.0	\$40.74
200 lbs/ac 16-20 @ planting	4680.0 a	\$26.03	5075.6 a	\$27.05	4877.8	\$26.54
400 lbs/ac 16-20 @ planting	5545.0 a	\$60.70	5162.2 a	\$3.40	5353.6	\$32.05
Average	4735.4	--	4811.7	--	4773.6	--
LSD(05)	970	--	992.1	--	--	--
CV (%)	12.8	--	12.9	--	--	--

1. Increase over the check is the increased value of the crop calculated at 5.0 cents/lb less the phosphorous fertilizer costs (\$280/ton).
2. Increase over the check is the increased value of the crop calculated at 6.5 cents/lb less the phosphorous fertilizer costs (\$215/ton).
3. Values followed by the same letter, within columns, are not significantly different at the 95% level of confidence using Duncan's Multiple Range test.

Table 4a. Yield and other economic and agronomic variables in phosphorus study on barley at the Safford Agricultural Center, 2000

Treatment	Yield per acre @ 10% M	Increase over check (\$/ac ¹)	Bushel Weight	% Moisture	1000 Kernel Weight	Plant Height
Untreated check	4777.8 a	\$0.00	52.3 a	9.75 a	39	23.6 a
100 lbs/ac 16-20 @planting	4996.7 a	(\$3.05)	52.0 a	9.85 a	38	23.4 a
200 lbs/ac 16-20 @planting	5098.9 a	(\$11.95)	52.8 a	9.65 a	38	22.8 a
400 lbs/ac 16-20 @planting	4867.7 a	(\$51.50)	50.5 b	9.65 a	38	23.9 a
Average	4935.3	--	51.9	9.73	--	23.4
LSD(05)	1428.3	--	1.1	1.05	--	3.64
CV (%)	18.1	--	1.32	0.08	--	9.73

Table 4b. Yield and economic summaries for phosphorous study on barley at the Safford Agricultural Center, 1999 and 2000.

Treatment	1999 Yield per acre @10%M	Increase over check (\$/ac ²)	2000 Yield per acre @ 10% M	Increase over check (\$/ac ¹)	Average Yield per acre @ 10%M	Average Increase over check (\$/ac)
Untreated check	6514.8 a	\$0.00	4777.8 a	\$0.00	5646.3	\$0.00
100 lbs/ac 16-20 @ planting	6687.4 a	(\$2.12)	4996.7 a	(\$3.05)	5842.05	(\$2.59)
200 lbs/ac 16-20 @ planting	6756.8 a	(\$9.40)	5098.9 a	(\$11.95)	5927.85	(\$10.68)
400 lbs/ac 16-20 @ planting	7150.8 a	(\$11.20)	4867.7 a	(\$51.50)	6009.25	(\$31.35)
Average	6777.5		4935.3	--	5856.4	
LSD(05)	1199.4	--	1428.3	--		
CV (%)	11.06	--	18.1	--		

1. Increase over the check is the increased value of the crop calculated at 5.0 cents/lb, less the phosphorous fertilizer costs (\$280/ton).
2. Increase over the check is the increased value of the crop calculated at 5.0 cents/lb, less the phosphorous fertilizer costs (\$215/ton).
3. Values within columns followed by the same letter are not significantly different at the 95% level of confidence using Duncan's Multiple Range Test.