Irrigated Spring Wheat Responds to Phosphorus

By John D. Walker, Jim Thorup and Greg Blaser

Idaho studies emphasize the importance of adequate phosphorus (P) for yield, profitability and competitiveness of spring wheat. Adequate P supplies were directly related to wheat's ability to compete with wild oats.

DURING periods of low wheat prices, farmers often dramatically reduce fertilizer inputs. If any fertilizer is used during times of economic stress, it is usually a limited amount of nitrogen (N).

Considerable research has been directed towards the use of P for wheat over the past five years. Researchers have studied rates of application as well as P placement to improve wheat production and maximize returns to growers. As a result of this research, some states are now recommending higher P soil test levels for profitable wheat production.

Data summarized and released by the Tennessee Valley Authority show that there is a substantial need for improved P fertilization of wheat. Kansas farmers applied an average of 13 lb/A of P_2O_5 for wheat in 1990. Farmers in Colorado and Washington applied an average of only 4 and 6 lb/A P_2O_5, respectively.

Considering the fact that wheat removes approximately 0.5 lb of P_2O_5 per bushel of production, many farmers are still "mining" their soils of P. Kansas farmers applied enough P for only 26 bushels of wheat, while those in Colorado and Washington applied enough for only 8 and 12 bu/A, respectively. Since state average production figures are considerably higher than these numbers, available P continues to decline. Research shows that yields suffer in many areas as a result of this neglect.

Plots were established in 1989 at the Ricks College Hillview Farm to study N and P rate effects on yield of irrigated hard

PHOSPHORUS is frequently a limiting nutrient for both dryland and irrigated wheat in Idaho and surrounding areas. This photo shows the effects of added P (left) versus no P (right) with the same amount of available N. Yield, water use efficiency, N use efficiency and overall profitability improve with adequate P.

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Table 1. Irrigated spring wheat response to P–1989.

Treatment, lb/A N	Treatment, lb/A P_2O_5	Yield, bu/A	Protein, %	Net return to land and capital, $/A $4.00/bu	Net return to land and capital, $/A $3.50/bu
120	0	64	13.2	39	7
120	50	77	13.3	79	53
120	100	76	13.4	63	25
180	0	71	14.0	54	18
180	50	85	13.6	98	56
180	100	82	14.5	74	33

Nitrogen, $.22/lb; P_2O_5, $.24/lb. Variable costs except fertilizer $190/A.

red spring wheat. The initial soil test level for sodium bicarbonate extractable P was 15 parts per million (ppm). Many consider this soil P level to be more than adequate for wheat production.

Four rates of N (0, 60, 120, 180 lb/A) and three rates of P (0, 50 100 lb/A P_2O_5) were utilized. Nitrogen was applied as ammonium nitrate broadcast just prior to planting. Phosphorus (monoammonium phosphate) was applied with the seed using a Concord Air Seeder.

Large plots (34 x 100 ft.) were used so field-scale equipment could be accommodated for planting and harvesting. The area has been under no-till management for the past 15 years.

Results

In the first year of the study, P increased yields at all rates of N by as much as 25 bu/A. Highest returns resulted from the application of 180 lb/A N and 50 lb/A P_2O_5 (**Table 1**).

Second year data (1990) showed similar increases from N and P, but yields were reduced substantially due to excessive heat and wind and the inability to move hand lines fast enough to prevent damage to the crop.

In the third year under center pivot irrigation, P was applied to half of each plot to assess residual effects. Continued P application increased yields up to 26 bu/A (**Table 2**). Residual P produced smaller yield increases . . . a maximum of 16 bu/A from 100 lb/A P_2O_5 and 180 lb/A N. This combination also produced highest net profits. The 100 lb/A P_2O_5 residual effects resulted in yield increases at every rate of N. This was not true with the 50 lb/A P_2O_5 residual plots.

Soil Test P

Soil samples were collected in October 1991 to determine changes in soil available P levels (**Table 3**). Soil test values were close to calculated numbers using a value of 9 lb P_2O_5 to increase soil test P by 1 lb/A. Using the 180 lb N and 100 lb/A P_2O_5 treatment as an example, 300 lb/A P_2O_5 was applied during the 3-year study.

Table 2. Spring wheat reponse to annual and residual P applications–1991.

Treatment, lb/A N	Treatment, lb/A P_2O_5	Yield, bu/A	Protein, %	Net return to land and capital, $/A $4.00/bu	Net return to land and capital, $/A $3.50/bu
120	0	63	12.4	35	3
120	50	77	12.9	79	41
120	Residual	61	12.5	27	-4
120	100	78	12.8	71	32
120	Residual	67	12.7	51	17
180	0	75	12.8	69	31
180	50	92	13.4	125	79
180	Residual	87	13.1	117	73
180	100	101	13.3	149	99
180	Residual	91	13.2	133	87

Residual received indicated rate of P_2O_5 for 2 years. Nitrogen $.22/lb; P_2O_5 $.24/lb. Variable costs except fertilizer $190/A.

ADEQUATE P helps wheat compete with weeds. Wild oats have dominated (right) where P was not provided, even though both plot areas received herbicide. The plot on the left received 100 lb P_2O_5/A.

Table 3. Effects of P fertilization of sodium bicarbonate extractable soil P.

Treatment	Sodium Bicarbonate Extractable P, ppm
Initial sample (September, 1989)	15
180 N, 50 P_2O_5	20
180 N, 100 P_2O_5	25

Sampled October 1991.

Approximately 250 bu/A of wheat was harvested during that period, containing approximately 0.5 lb P_2O_5 per bushel (125 lb P_2O_5/A) and leaving a net of 175 lb/A P_2O_5 in the soil. Dividing 175 lb P_2O_5 by 9 gives a possible soil test increase of about 19 lb/A or 9.5 ppm. The measured value of soil test change during the period was 10 ppm (**Table 3**), an increase from 15 to 25 ppm.

Based on recent studies in the northern Great Plains and Prairie Provinces, some researchers are now recommending a critical level of 22 to 25 ppm sodium bicarbonate extractable P for optimum wheat production. Growers whose soils test below that range are encouraged to use or evaluate P use in their production systems for higher yields, higher profits, better water use efficiency and soil protection. Large-scale (1,300 acres) implementation of the results of this study on hard red spring irrigated wheat produced an average yield of 105 bu/A, an increase of 14 bu/A over a 40-acre control area which had an initial sodium bicarbonate extractable P test of 15 ppm.

Weed Pressure

In addition to yield increases, observations of weed pressure in the study indicated an advantage in plots receiving adequate N and P. Herbicides were applied for the control of wild oats and other weeds. However, in the residual P study area in 1991, wild oat pressure developed as the crop neared harvest. Pressure was much greater in plots without adequate P. Apparently, wild oats could not compete with vigorously growing wheat which received adequate P.

Summary

Data from this 3-year study show the importance of an adequate fertilization program on yields and profits from hard red spring wheat in eastern Idaho. Use of adequate P for wheat on soils testing medium or below in available P will result in increased rate of growth, lowered competition from weeds, higher N use efficiency, improved water use efficiency, higher yields, and higher profitability. ■