

# Irrigated Winter and Spring Wheat Response to P in Calcareous High Lime Soil

Bradford Brown, UI Ext. Soil and Crop Management Specialist,  
Parma  
Roger Gibson, Scientific Aide, Parma  
Kerry Huber, UI Food Scientist, Moscow

## Abstract

Recommendations for fertilizer P can differ for winter and spring wheat, but it is not clear whether the differences are due to the different planting dates or to the genotypes that are grown. Irrigated field studies were conducted on a calcareous silt loam at Parma for four years (2000-2003) to evaluate the response to available P of winter (Stephens and Madsen) and spring (Treasure and Whitebird) genotypes all fall planted. Similar studies were conducted at the same site for three years to evaluate the response to P of the spring genotypes planted in both fall and spring. A range of available P (Olsen soil test P) resulted from previous P treated areas that served as whole plots for the planted varieties. Increased available P increased yield in all years and increased dough stage whole plant biomass, P concentrations, and P uptake in some years. Fall planted winter and spring genotypes did not differ in their response to available P. Spring genotypes also did not differ in their yield response to available P regardless of whether fall or spring planted. The results suggest that fertilizer P recommendations should be similar for irrigated spring and winter wheat in western Idaho.

## Introduction

NRCS standards use the University of Idaho fertilizery guides as the basis for the NRCS nutrient management guidelines. The University of Idaho fertilizer phosphorus (P) recommendations for irrigated wheat were developed in the late 60s. The P recommendations have not been extensively evaluated since. University of Idaho fertilizer P recommendations currently reflect the influence of soil lime content on the P requirement for wheat. Increased lime reduces P solubility in soils and increases the fertilizer P requirement for some crops. Research is needed to determine the extent to which the fertilizer P recommendation needs to be adjusted for a soil's lime content.

Spring wheat is thought by some to require higher residual P due to its more rapid growth and less developed root system. But winter wheat produces more biomass, has greater yield potential and conceivably uses more total P. If P requirements do not differ for the two wheat genotypes it will expedite the development of P fertilizer recommendations. Data collected for one wheat genotype could then be used for the other, precluding the need for separate soil test calibration and research. If winter and spring wheat differ in P requirements, those differences need to be quantified. The relative P requirements of fall vs spring planted wheat are poorly documented if at all. Since winter and spring wheat genotypes are typically planted at different times, comparison of their P requirements is normally confounded by planting dates. The fall planting of spring genotypes in western Idaho, while not widespread, does occur, and research trials have demonstrated the increased yield potential from fall plantings. Therefore, the objective of this research was to compare the P requirements of fall and spring planted wheat in a high lime soil.

## Methods

Irrigated wheat field studies were conducted on a silt loam at the Parma Research and Extension Center for four years (2000 to 2003) involving two soft white winter varieties

(Stephens and Madsen) and two spring varieties (Treasure and Whitebird) grown in soils previously treated with variable P or preplant applied P to give a range in residual soil test P (Olsen) and available P. The previously treated P plots served as the main plots in a split plot experimental design with the varieties as subplots. The winter varieties were seeded only in the fall whereas the spring varieties were seeded at the same time as the winter varieties as well as in the spring. The plantings allowed the comparison of the response to residual P of winter and spring genotypes grown from the same fall seedings as well as the comparison of the same spring varieties grown from fall and spring seeding dates. Previous crops were onions before the 2000 and 2001 trials and corn before the 2002 and 2003 trials. Fall planting dates were November 2, November 3, November 5, and October 6 for the 2000, 2001, 2002, and 2003 seasons, respectively.

Soil test P (Olsen) was measured in samples collected prior to broadcasting P preplant as in 1999, or pre-plant before the seeding of wheat. Wheat was sampled from 3.5 ft<sup>2</sup> at the late dough stage, the samples dried, weighed, ground in a Wiley Mill, and submitted to the UI Analytical Lab for total P analysis. Wheat P uptake was calculated from the biomass and P concentrations. Plant height and lodging were also estimated at late dough. Grain yield was measured from 75 ft<sup>2</sup> using a small plot combine. Test weight and protein were determined from harvested wheat subsamples. Subsamples were also submitted for milling and baking at the UI Aberdeen Wheat Quality Lab and starch viscosity was measured in Moscow by Kerry Huber, UI Food Science. Yield components were also measured at late dough including number of heads (effective tillers), kernel weight, and the kernels per head was calculated from the head number and kernel weights. The test weight, heading date, protein, milling and baking, and yield component data are not shown but are discussed.

## Results and Discussion

Yields were highest in 2000 and 2001 and declined each year thereafter even though wheat invariably followed onions (200 and 2001) or corn (2002 and 2003). Wheat yielded better following onions but it is not clear to what extent lower yields in 2002 and 2003 were due to the previous crop. Grain protein in all years was high indicating that N was not limiting during grain fill. Soil test P in the untreated and previously treated P whole plots ranged from 8.7 to 10.0 in fall 1999, from 7.8 to 13.3 ppm in fall 2000 for one trial and 6.8 to 11.8 ppm in fall 2000 in another trial, 6.7 to 8.5 ppm in fall 2001, and 5.4 to 7.2 ppm in fall 2002. In all years other than 2000 the response of wheat reflects the response to the pre-plant soil test P resulting from previous P applications. Supplemental P was applied for the 2000 trial just before planting so the response in that trial is to different initial soil test P as well as to the pre-plant P applied.

### Fall Planted Winter vs Spring Genotypes

Grain yield of winter and fall planted spring wheat increased each year with increased available P (Figure 1). Maximum yields were achieved in all years under these conditions with the highest available P treatment. Varieties differed in yield in all years with winter varieties typically yielding more than fall planted spring varieties. Winterkill was not an issue in any year for the fall planted spring varieties. There was no significant interaction for yield between variety and available P in any year.

In all years, as yield increased with available P, grain protein decreased. When averaged across varieties, protein declined from 11.7 to 11.4% in 2000, 12.2 to 11.4% in 2001, 12.8 to 11.9% in 2002 and 13.0 to 12.1% in 2003. There were no interactions for protein between varieties and available P. Despite the lower protein, baking quality as indicated by cookie diameter was not significantly affected by available P.

Plant P concentrations increased with available P in only two of the four years (2001 and 2003). Varieties differed significantly in plant P concentrations in 2000 and 2003. Winter wheat

varieties had the highest plant P concentrations in 2000 (1015 and 1006 ppm) compared to the fall planted spring varieties (700 and 590 ppm), and winter wheat varieties (1429 and 1211) had higher plant P in 2003 than fall planted spring varieties (1159 and 1165). There were no interactions for plant P concentrations. Plant P uptake increased with increased available P in all years but 2000. Varieties differed in P uptake only in 2003 when winter varieties took up more P than fall planted spring varieties.

The results suggest spring and winter genotypes will respond to available P very much the same from fall plantings. Therefore, P recommendations for winter wheat would be just as appropriate for similarly fall planted spring wheat.

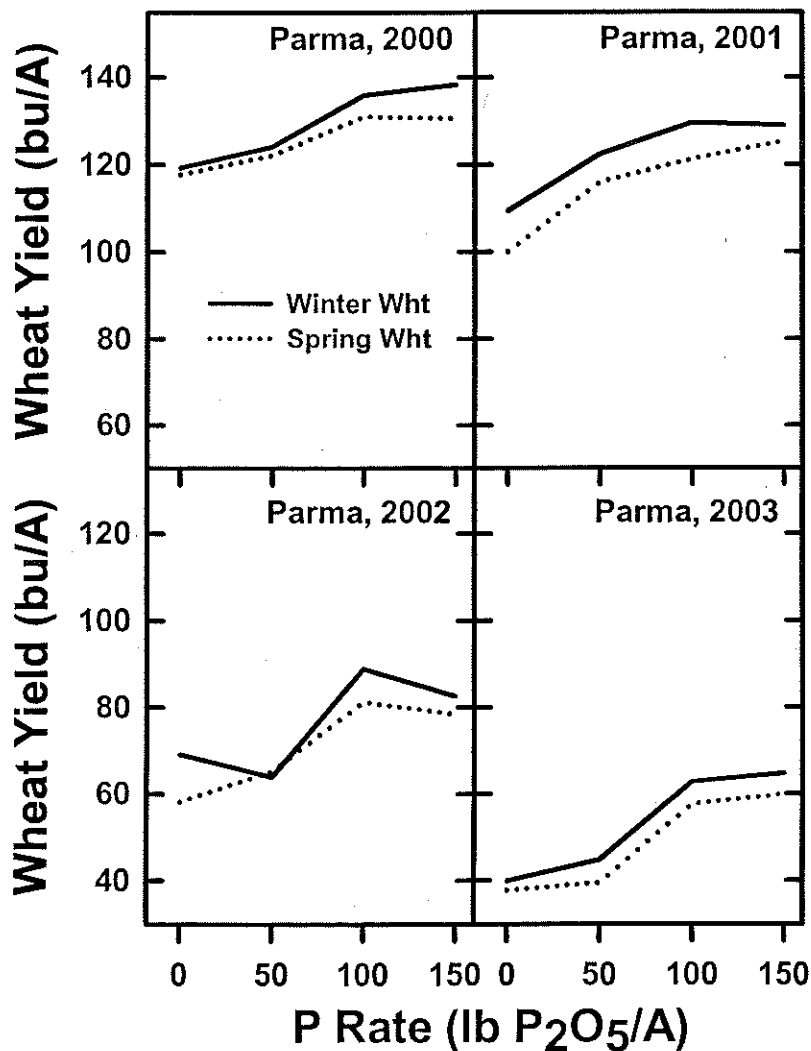


Figure 1. Mean winter and spring genotype yield response to previously applied P in 2000 through 2003.

## Fall vs Spring Planted Spring Genotypes

Fall planted spring wheat genotypes were more productive than when spring planted in 2001 and 2003, especially at higher available P (Figure 2). Higher yield from fall planting resulted to a limited extent from greater tillering as most of the increase at least in some years came from significantly heavier kernels. Yield increased in all years with increased available P. Higher yields from more available P resulted from both greater tillering, heavier kernels and in some years more kernels per head. There was no interaction for yields between planting date and available P. The Treasure and Whitebird varieties did not differ in yield and there were no interactions involving varieties.

Biomass was significantly greater for fall planted spring wheat in 2003 only. Fall and spring plantings did not differ significantly in other years possibly due to fewer days from planting to heading. The fall planting date in 2002 for the 2003 season was about three weeks earlier than the previous two years. A significant interaction occurred for biomass in 2003 indicating that fall and spring biomass differed more at higher available P. Biomass did not differ between the two varieties.

Whole plant P concentrations were affected by planting date only in 2003 when P concentrations in spring planted wheat were markedly higher than in the fall planted wheat. Again, this may be related to the earlier fall planting date for the 2003 season relative to previous years. Despite differences in whole plant P concentrations in one year, whole plant P uptake was not affected by planting date in any year. Plant P uptake significantly increased with higher available P in 2001 and 2003, but not 2002. There were no interactions in any year between planting date and available P for plant P concentrations or plant P uptake. The two spring varieties also did not differ in P content measures.

Planting dates and available P influenced three other measures worth mentioning. When increased available P increased yield, grain protein was reduced. This was especially true in 2003. Protein was lower with fall planting than with spring planting the varieties only in 2003. Fall planting spring varieties invariably caused heading to occur about 10 days earlier in the spring than did the spring planting of spring wheat at the lowest available P levels. Increased available P hastened heading dates by two days for the fall planting in 2001, and two to three days for spring planted wheat in 2002 and 2003. Test weight was higher in the fall planting in two of three years and increased available P reduced test weight in two of three years.

In summary, the results from these trials provide little justification for providing different P fertilizer recommendations for fall and spring planted wheat. Fall planted wheat has higher yield potential in most years, produces at least as much biomass as spring varieties, but apparently accumulates no more P than spring planted wheat. Spring planted wheat grows for a shorter time period than fall planted wheat, but apparently compensates by taking up P more rapidly than fall planted wheat. Furthermore, the implications of these results is that P research performed with winter wheat can very likely be applied to spring wheat and vice versa.

## Acknowledgements

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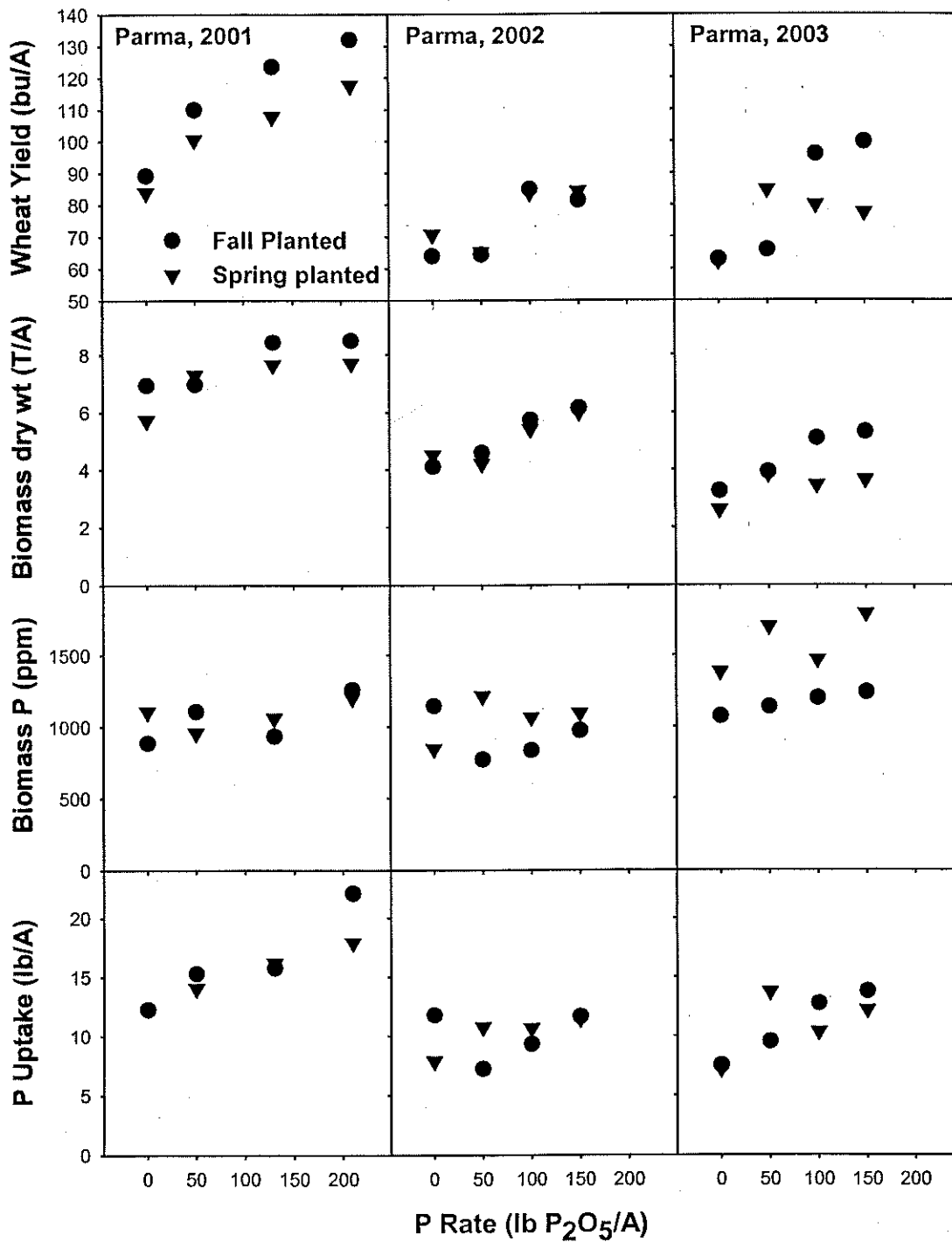


Figure 2. Wheat grain yield, dry biomass, whole plant P concentration and P uptake as affected by available P and fall or spring planting for the years 2001, 2002, and 2003. Parma, Idaho.