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Fluids Compared With Dry In Dryland Winter Wheat Trials

Results indicate a good potential for dryland wheat to respond to fluid P in the low-rainfall crop-fallow areas of eastern Washington.

Summary: *Quadratic responses to fluid phosphorus (P) were observed in four of six site years. High rates of fluid P reduced dry matter and grain yield, possibly due to P stimulation of vegetative growth and subsequent depletion of stored soil moisture. Grain yields with dry P fertilizer were similar to or lower than with fluid P. Results indicate a good potential for dryland wheat to respond to fluid P in the low-rainfall, crop-fallow areas of eastern Washington. Intermediate rates of fluid P should be applied to optimize plant growth and prevent yield reductions.*

Wheat growers in eastern Washington are in a below-maintenance P fertility program. In low (<12-inch annual) precipitation, winter wheat-fallow environments, many growers do not use P fertilizer due to low yield potential and need to minimize input costs. Growers who do use P place it in a band beneath the soil surface with nitrogen (N) or directly with the seed at rates below crop removal. Band placement method is leading to high P use efficiency (PUE). However, the sustainability of this P management program is questionable given the negative input/output balance. We are interested in explaining the apparent contradiction between below-maintenance P applications and the apparent increase in soil test P concentrations reported by many growers.

One explanation may be related to changing soil pH. In alkaline soil, inorganic P is associated mainly with Ca-based minerals. In acidic soil, inorganic P is associated mainly with Fe/Al-based minerals. In the past 25 years soil pH has declined throughout eastern Washington and northern Idaho due to the use of ammonium-based fertilizers. It is likely that this recent pH decline has or will result in a shift in inorganic P forms from calcium to Fe/Al-based minerals. During the transition from neutral/alkaline to acidic soil pH, soluble and plant-available forms of P may temporarily increase as calcium-based minerals dissolve and Fe/

Table 1. Study of location and average initial soil test P (0 to 1-foot depth).

	Soil test P by method (mg/kg soil)*		
Location	Year	Acetate P	Bicarbonate P
Lind	2005-2006	7.3	12.1
	2006-2007	3.9	11.0
Ralston	2005-2006	5.8	17.8
	2006-2007	5.5	22.5

*Adequate soil test values are 8 mg/kg (ppm) for the acetate (Morgan) method and 16 mg/kg for the bicarbonate (Olsen) method.

Al-based minerals form.

Beginning in fall 2004 we conducted a series of P fertility studies in a chemical fallow-winter wheat production system in the low rainfall zone of eastern Washington. Various rates of fluid P fertilizer were applied in a deep band directly beneath the seed row at planting. Responses to P were obtained in each of three years and with soil test P levels at or above critical values (Figure 1). These responses to P suggest more routine P use may be warranted in the low rainfall zones. High rates of fertilizer P appeared to reduce yield compared to intermediate rates in one year (Figure 1). Residual effects of P applications were not measured but are expected.

Based on the results of this earlier research, we conducted experiments to evaluate dryland winter wheat response to fluid and dry P fertilizer in the low and high rainfall zones of eastern Washington. The intent was to compare wheat responses to dry and fluid P in more common crop-tillage fallow and annual cropping systems.

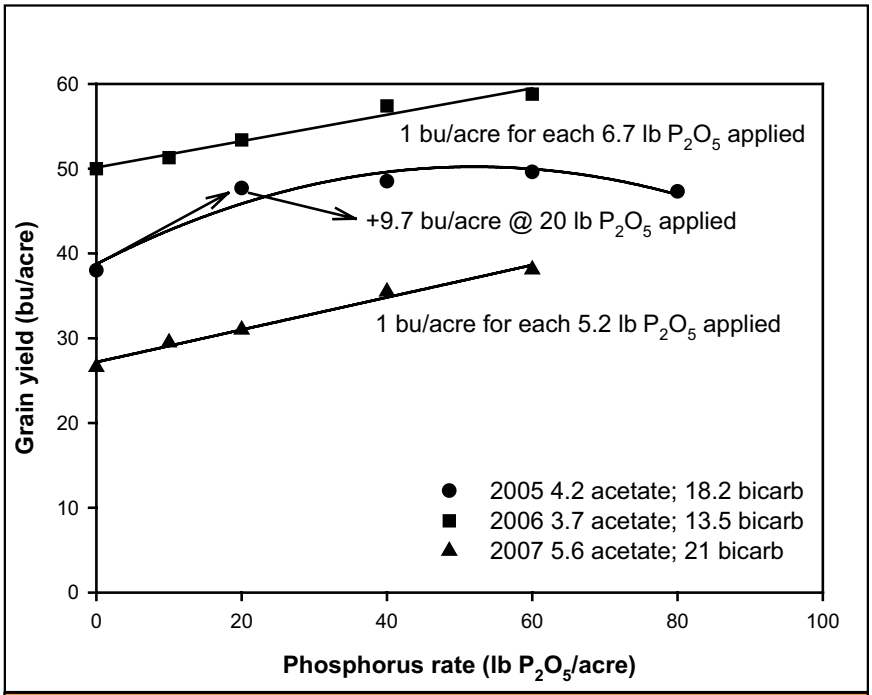

Figure 1. Effect of P rate on soft white winter wheat yield in low rainfall zone of eastern Washington. Soil test values in parts per million (ppm) are listed for the sodium acetate (acetate: Morgan) and sodium bicarbonate (bicarb.: Olsen) extract methods.

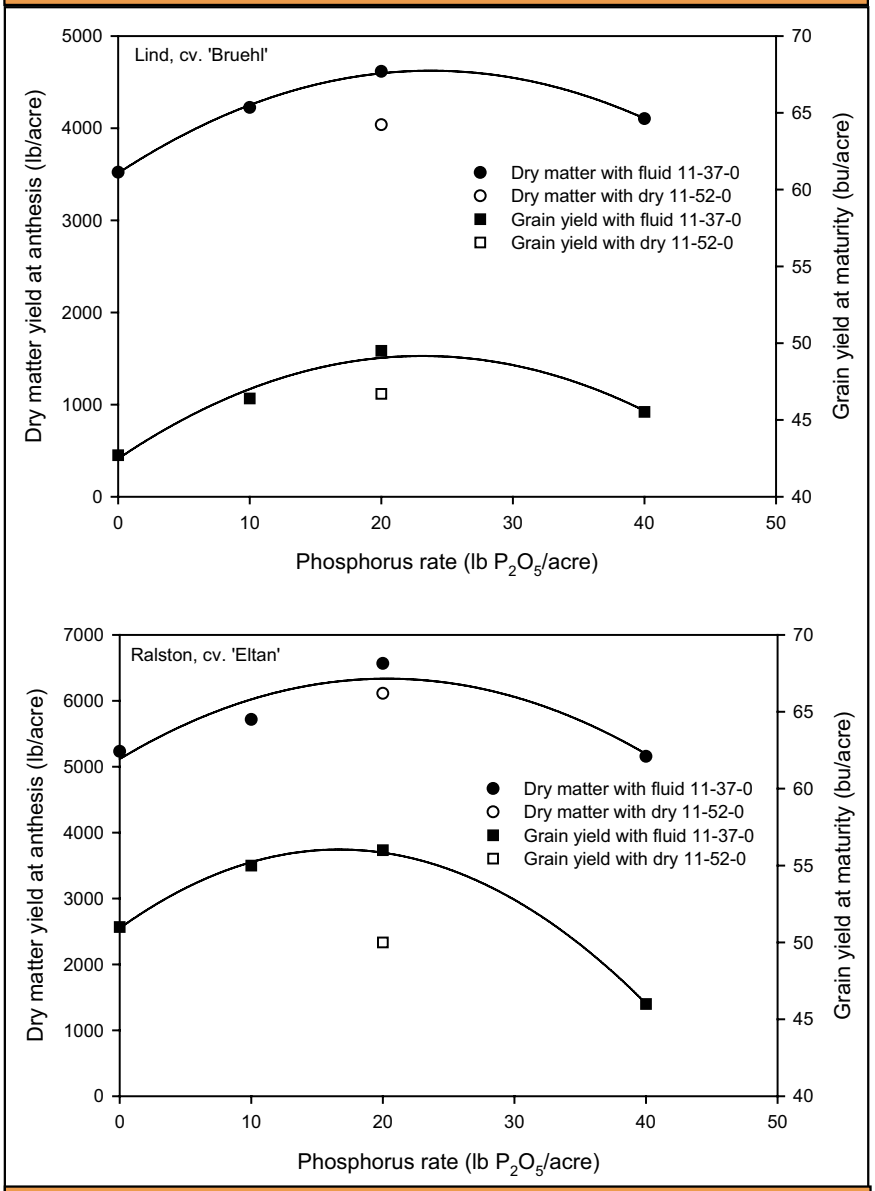

Figure 2. Effect of P rate and form on dry matter and grain yields of winter wheat at Lind (top) and Ralston (bottom) in 2005-06.

Fluids shine

Responses to fluid P at summer fallow locations were obtained when soil test levels were near or above historical critical values based on bicarbonate extraction (Table 1). This suggests that current soil-test-based fertilizer recommendations may be outdated and critical levels do not accurately predict a response to P in these situations. Alternatively, the bicarbonate extract may not be accurately estimating plant-available P in these recently acidified soils. Acetate-extractable P was below critical levels for 5 of 6 site years.

Grain yield responses to dry P were lower than responses to fluid P at three of the 6 site-years. These were similar to results from Australian research, showing better responses to fluid P than to dry P. Interestingly, responses to fluid P rate were quadratic in 3 of the 4 site-years (Figures 2 and 3). At the highest rate of P, anthesis whole-plant dry matter and final grain yields were reduced slightly at 40 lbs/A of P_2O_5 compared to the low or intermediate rate. Moisture is the main limiting factor in summer fallow cropping systems at these locations. Higher rates of P apparently

stimulated excessive vegetative growth that depleted stored soil moisture and reduced late-season grain yields. This is similar to the "haying off" response observed in wheat grown in low-moisture, crop-fallow rotations in Australia.

Early results of this study indicate a good potential for dryland wheat to respond to fluid P in the low rainfall, crop-fallow areas of eastern Washington. Intermediate rates of fluid P should be applied to optimize yield and prevent grain yield reductions in this moisture-limited environment.

Methodology

Fertilizers. Fertilizers used were fluid ammonium polyphosphate, 32-0-0, and MAP.

Placement. P was placed at (Figure 1) or two weeks before seeding (Figures 2 and 3). Soft winter wheat seeding rates were 40 lbs/A with 12-inch spacing.

Crop. Winter wheat grown in a traditional, 2-year crop-tillage fallow rotation.

Plots. Individual plot dimensions were 7 to 8 feet wide by 50 feet long.

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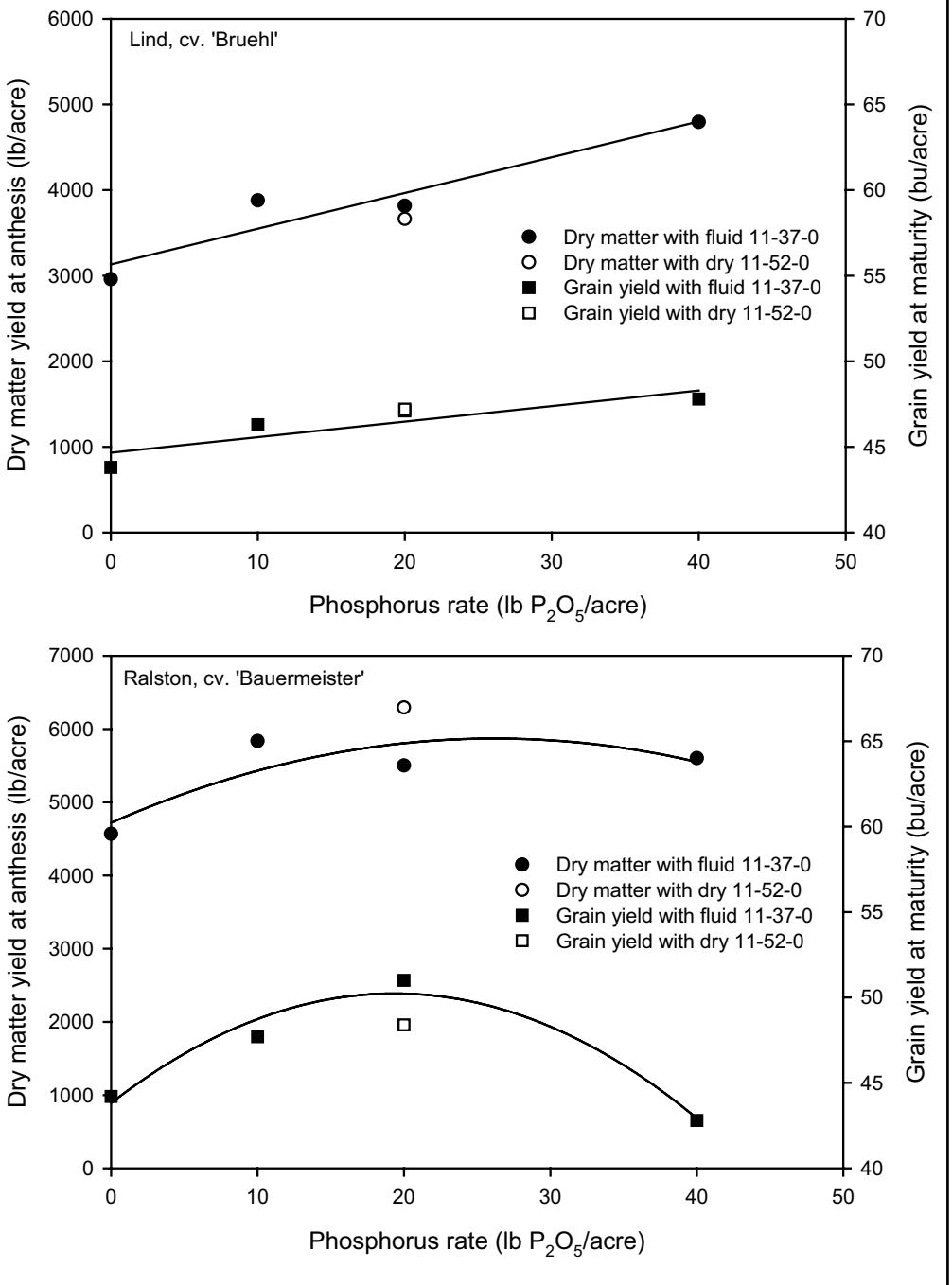

Figure 3. Effect of P rate and form on dry matter and grain yields of winter wheat at Lind (top) and Ralston (bottom) in 2006-07.