Proposal for 2006 - 2007
Northwest Columbia Plateau PM$_{10}$ Project

Objective 5: Wind Erosion and PM$_{10}$ Emission Control Methods

Title: Optimizing seeding rate and phosphorus fertility to enhance the yield of recrop, late-seeded winter wheat


Accomplishments
Increasing cropping intensity would reduce fallow periods, associated bare soil conditions, and wind erosion potential in the low and intermediate rainfall zones in Washington where dryland crop-fallow is practiced. The overall goal of this study is to reduce barriers to more intensified cropping (e.g., annual cropping) in these zones. A major barrier to intensifying crop production is the requirement to plant winter wheat later in the fall under recrop situations while waiting for precipitation to facilitate seed germination. Late seeding significantly reduces grain yields of winter wheat. Preliminary results suggest that increased phosphorus nutrition can marginally improve yields of late seeded winter wheat. Higher rates of phosphorus can also significantly increase crop residue production, which in turn may reduce soil erosion by wind. Additional studies planned for 2006-07 will refine phosphorus and seeding rate treatments to improve yield and reduce erosion of soil by wind in Columbia Plateau.

Objectives
1. Assess the impact of seeding rate and phosphorus fertility on grain yield of direct-seeded, recrop winter wheat in low- and intermediate-rainfall zones of eastern Washington;
2. Evaluate the effects of seeding rate and phosphorus fertility on winter wheat grain yield components and straw production;
3. Evaluate economic returns from late seeded recrop winter wheat in comparison to recrop spring wheat or winter wheat-chemical fallow;
4. Evaluate select seeding rate and phosphorus fertility treatments in on-farm tests conducted throughout the low rainfall area.

Recent Accomplishments
2004-05: Field studies were established in fall 2004 at five locations in the low to intermediate rainfall zones of eastern Washington. Initial soil test phosphorus levels ranged from borderline-adequate to deficient at each location. One location was abandoned due to poor stand establishment. Three of the remaining locations were recrop winter wheat while the fourth was winter wheat after a year of chemical fallow. Each study involved a factorial combination of two seeding rates (40 and 70 lb/acre) and five phosphorus rates (0, 20, 40, 60 and 80 lb P$_2$O$_5$/acre) applied as fluid ammonium polyphosphate in a deep band placed 2 to 3 inches below the seed row.
Plant emergence, early season dry matter accumulation, final grain yield, grain yield components and straw and grain phosphorus uptake were determined. Under conditions of low seed zone moisture (e.g., September planting in chemical fallow), higher rates of phosphorus placed in a deep band reduced winter wheat stand density. Negative effects of phosphorus on stand density were not observed with late seeded wheat, presumably due to more favorable seed zone moisture conditions and a lower potential for fertilizer salt injury. There were linear relationships between phosphorus rate and vegetative-stage dry matter accumulation with late seeded wheat at two recrop locations, and a quadratic response at the early-seeded chemical fallow site. There was also a linear relationship between phosphorus rate and grain yield at two of the recrop locations, and a quadratic response to phosphorus rate at the chemical fallow location. Higher seeding rate resulted in higher grain yield at the chemical fallow location only. Increasing phosphorus increased total dry matter production more than grain yield at these locations. Samples for yield component and phosphorus analysis are still being processed. Preliminary results indicate that improved phosphorus nutrition can increase early season dry matter production and final grain yield of late-seeded winter wheat in recrop and chemical fallow situations. However, based on one year of data the response to phosphorus may be relatively small and not economical in recrop situations due to the low overall yield potential.

2005-06: Studies were repeated at three of the five 2004 locations. Two of the locations were recrop winter wheat while the third location was a chemical fallow situation. Factorial combinations of two seeding rates (40 and 70 lb/acre) and five phosphorus rates (0, 10, 40, 60 and 80 lb P2O5/acre) were established as described below. Conditions were typical of a recrop situation and involved late (October) seeding at the Lind and Ralston sites. Late seeding was done once fall precipitation events produced adequate seed zone moisture for germination. At the Ritzville location, treatments were established with both normal (September) and late (October) seeding dates. In addition to the recrop studies established at Lind and Ralston, phosphorus rate trials were also established in a conventional wheat-fallow rotation at these locations. Data are pending from these recrop and conventional studies.

Planned Research
Research on seeding date, seeding rate, and fertility (mainly phosphorus) management suggests a potential to manage seeding rate and fertility to overcome late-planted winter wheat yield reductions (Blue et al., 1990). Phosphorus fertility was relatively more effective than increasing seeding rate in producing more spikes per area, the major yield component limited by late planting (Blue et al., 1990). Importantly, moderate rates of phosphorus (35 to 70 lb P2O5 acre⁻¹) produced large yield responses in late-seeded winter wheat at sites with marginal soil test P levels. Another documented role of phosphorus is to improve the water use efficiency of grains under drought conditions (Payne et al., 1991; 1992; Jones et al., 2003). Although this latter finding has not been exploited in current management systems, this suggests an additional opportunity to improve yield in the low rainfall area of the Columbia Plateau.

Previous research suggests that phosphorus fertility could overcome late-seeded, recrop winter wheat yield reductions and perhaps even improve water use efficiency in the dryland areas of eastern Washington. Collectively, this could create opportunities for more intensive winter wheat production in these low rainfall areas. More intensive production under reduced tillage would meet dual needs of improved economic viability and wind erosion control. The goal of this research is to
improve recrop, late planted winter wheat yields through seeding rate and phosphorus management. This proposal describes activities for year two of a three-year project.

Objectives 1 and 2. Field studies will be repeated at three locations representing a range of environmental conditions similar to those selected for the 2004-06 studies. Locations will be in the low- to intermediate-rainfall, traditionally crop-fallow management zones in eastern Washington. At present it is anticipated that studies would be conducted at the Washington State University Dryland Experiment Station near Lind, and near the towns of Ritzville and Ralston, Washington. Each location will be sampled prior to study initiation to assess residual nutrient (mainly phosphorus) levels and characterize baseline soil properties. All studies would be conducted with reduced tillage/direct seed management practices.

Each study site will include a factorial combination of two seeding rates and five phosphorus rates. Seeding rates will be 40 and 70 lb acre, representative of seeding rate used for early and late-planted winter wheat, respectively, in the study areas. The winter wheat variety will be ‘Eltan.’ A fluid form of phosphorus will be applied at rates of 0, 10, 40, 60 and 80 lb P₂O₅ acre⁻¹. Phosphorus will be applied in a deep band 2 to 3 inches below the seed row in combination with nitrogen and sulfur at uniform rates of 50 lb N acre⁻¹. A no-till drill will be used to apply the treatments and seed in a one pass operation. Each treatment will be replicated four times in a randomized complete block experiment design. Individual plot dimensions will be seven feet wide by 50 to 100 feet long depending on the yield potential of the site. Grain yield will be measured by harvesting the center of each plot with a small plot combine. Yield components (plants per area, spikes per area, kernels per spike and weight per kernel) will be determined by sub-sampling each treatment prior to harvest. Total straw production and harvest index will also be determined. This will be the third and final year of these experiments.

Objective 3. Gross revenue and production costs will be determined each year and used to calculate net returns. Marginal returns will be compared to marginal costs for phosphorus fertilizer and existing data for winter wheat-fallow rotations and other experimental rotations currently being studied as part of ongoing or recently completed PM₁₀ and STEEP projects. This objective will commence once yield data are collected in fall 2006.

Objective 4. On-farm tests will be used to evaluate select treatments in the context of larger plot sizes and rotations characteristic of the low rainfall areas. This phase of the research will commence in fall 2006.

References