Objective 5: Identify and test wind erosion and PM$_{10}$ emission control methods of alternative cropping systems (tillage, crops, rotation, weed control, etc.), and evaluate their effectiveness through descriptive measurements and portable wind tunnel tests

Title: Optimizing Seeding Rate and Phosphorus Fertility to Enhance the Yield of Recrop, Late-Seeded Winter Wheat

Personnel: Principal investigator: Rich Koenig, WSU, Pullman; Collaborators: Bill Schillinger, WSU, Lind; Eric Harwood, Ron Bolton and Mary Fauci, WSU research technicians

Objectives
1. Assess the impact of seeding rate and phosphorus fertility on grain yield of direct-seeded, recrop winter wheat in the low rainfall zone of central and 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
None – new project

Background
Dryland wheat production in the low (<12-inch annual) rainfall region of eastern Washington is characterized by conventional winter wheat-tillage fallow rotations. Recent advancements in reduced-tillage equipment, improved knowledge of cropping systems and weed management, environmental pressures related to reducing wind erosion from fields during conventional fallow periods, and economic demands have generated interest in alternatives to winter wheat-fallow. Tillage systems that create less disturbance and retain more residues on the surface can reduce soil erosion, improve soil moisture retention and soil quality, and potentially improve economic returns. Improving soil moisture retention presents opportunities to increase cropping intensity and transition from winter wheat-fallow to annual cropping or some intermediate rotation, in the low rainfall area. Some success in increasing cropping intensity has already been documented in various PM-10 and USDA-STEEP III projects.

Annual cropping of spring wheat has generally been less economical than winter wheat-fallow (Schillinger, 2004). However, annual cropping of winter wheat or perhaps annual cropping rotations with 1 out of 3 or 4 years in winter wheat could produce higher yields and economic returns than annual cropping spring wheat. Annual cropping would mean delayed winter wheat planting until fall rains created more favorable seed zone moisture conditions. Delayed
planting of winter wheat generally reduces grain yields (Shah et al., 1994). Therefore, overcoming yield reductions with late-planted winter wheat would be necessary to make recrop winter wheat a more agronomical and economically feasible option.

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, low to moderate rates of phosphorus (35 to 70 lb P$_{2}$O$_{5}$ 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.

**Planned Research**

Objectives 1 and 2. Field studies will be established at three locations representing a range of environmental conditions in the <12-inch annual rainfall, traditionally crop-fallow management zone in eastern Washington. At present it is anticipated that studies would be conducted at the Washington State University Dryland Experiment Station near Lind, in the Horse Heaven Hills area, and near Ritzville. Each location would be sampled prior to study initiation to assess residual nutrient 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 this area. The winter wheat variety sown will be ‘Eltan.’ A fluid form of phosphorus will be applied at rates of 0, 20, 40, 60 and 80 lb P$_{2}$O$_{5}$ acre$^{-1}$. Phosphorus will be applied in a deep band 2 inches below the seed row in combination with nitrogen and sulfur at uniform rates of 50 lb N and 5 lb S acre$^{-1}$. Each treatment will be replicated four times in a randomized complete block experiment design with 40 total plots per location. Individual plot dimensions will be eight feet wide by 100 feet long. Experiments would be established in the fall of 2004 and continued for a minimum of three years.

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 on subsamples.

Objective 3. Gross revenue and production costs will be calculated each year and compared to existing data for winter wheat-fallow rotations and other experimental rotations currently being studied as part of ongoing or recently completed PM10 and STEEP III projects.

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. It is expected that this phase of the research will commence in years 2 or 3 of the proposed study, and may involve evaluations of wind erosion from treatments established on larger plots.

References