Part 3. Agronomics, Alternate Crops and Systems

Fifty Years of Predicting Wheat Nitrogen Requirements Based on Soil Water, Yield, Protein and Nitrogen Efficiencies

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Washington State University has been a recognized leader in the development of soil and climate based N recommendation modelling. During the early 1950’s synthetic N fertilizers were gaining widespread adoption in the wheat growing region of the inland Northwestern U.S. WSU agronomists quickly recognized water and N as the two principal determinants of grain yield and quality (Jacquot, 1953). Numerous N fertility trials across a range of climatic environments, soils and cropping systems provided the initial data for estimating wheat yield potentials based on predicted precipitation and root zone soil moisture. Nitrogen fertilizer recommendations were made from yield-based crop N requirements, estimates of soil N supplies and N use efficiencies. Leggett’s (1959) N recommendation model, based on the regional variations in yield-water relationships and crop-soil N budgets, has stood the test of time for nearly 50 years, as confirmed by recent N fertility and agronomic trials (Engle et al., 1975; Mahler, 2004; Koenig, 2005). A recent data analysis of yield-water relationships reveals a remarkably similar slope but different y-intercept defining the lowest available water levels at which grain yields are obtainable (Schillinger, 2006). Spring soil moisture remains a reasonable yield predictor in this Mediterranean climate, but variable in-season rainfall is still a major source of error. Adjustments in the N recommendation model have been made to accommodate differences in wheat class, soil characteristics, management practices and climatic factors that affect water and N use efficiencies (Fig. 1). However, our ability to extrapolate the regional model to site-specific applications has been restricted by the inability to predict landscape-scale processes that control water redistribution, water-yield and yield-nitrogen use relationships that define the unit N requirement. The generalized 50% single season N uptake efficiency used in the model is not likely to occur consistently within a given field or from year-to-year and is currently under increased scrutiny in order to realize improvements in field-scale N management and N uptake efficiencies.

Ten Years of Annual No-Till Cropping Research near Ritzville


Overview. We have completed year 10 of an ongoing large-scale (20 acre) multidisciplinary no-till and minimum-till cropping systems study on the Ron Jirava farm near Ritzville, WA. Soft white and hard white classes of winter and spring wheat, spring barley, yellow mustard, and safflower have been grown in various rotation combinations. Annual precipitation was less than the long-term average in 8 out of 10 years. Rhizoctonia bare patch disease caused by the fungus \textit{Rhizoctonia solani} AG-8 appeared in year 3 and continued through year 10 in all no-till plots. All crops were susceptible to rhizoctonia, but bare patch area in wheat was...
reduced, and grain yield increased, when wheat was grown in rotation with barley every other year. Remnant downy brome weed seeds remained dormant for 6 years and longer to heavily infest recrop winter wheat. There were few quantifiable changes in soil quality due to crop rotation, but soil organic carbon increased in the surface 0-to 5-cm depth with no-till during the 10 years to approach that found in undisturbed native soil. Annual no-till crop rotations experienced lower average profitability and greater income variability compared to WW-SF. Yellow mustard and safflower were not economically viable. Continuous annual cropping using no-till provides excellent protection against wind erosion and shows potential to increase soil quality, but the practice involves high economic risk compared to winter wheat – summer fallow. The ability of spring-planted crops to compete economically with winter wheat - summer fallow is highly dependent on the quantity of precipitation stored in the soil over the winter and the quantity of rainfall in May and June. Figure 1 shows the grain yield performance of continuous annual no-till soft white spring wheat compared to winter wheat – summer fallow (i.e., one crop every two years) at the Jirava site over the past ten years.

Fig. 1. Grain yield of soft white winter wheat after summer fallow (one crop every two years) vs. continuous annual no-till soft white spring wheat near Ritzville, WA from 1997 to 2006. The numbers above the bars are the percent grain yield of annual spring wheat compared to winter wheat-summer fallow for each year. Note that annual spring wheat is competitive with WW-SF in wet years but has low grain yields and lacks the stability of WW-SF during dry years.

Rodweeding Frequency and Timing Effects on Seed-Zone Water Retention in Summer Fallow

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A 3-year field study was initiated in 2006 at the WSU Dryland Research Station at Lind to evaluate the frequency of rodweeding operations on seed-zone moisture retention and several other agronomic and environmental factors. In mid April, primary spring tillage was conducted to a depth of 5 inches. Aqua nitrogen fertilizer was injected into the soil with the undercutter sweep implement during the one-pass primary tillage. Subsequent rodweeding operations were conducted at the 4-inch depth with a Calkins center-drive rodweeder. Treatments are:

1. No rodweeding (i.e., check). Weeds are controlled with a glyphosate herbicide with a sprayer as needed to maintain weed-free plots.
2. Rodweed only when required to control weeds (this will range from 1 to 3 rodweedings, depending on the year, but only one rodweeding was required in 2006).
3. Rodweed immediately after primary spring tillage, but thereafter only as required to control weeds (as per treatment no. 2, above).
4. Rodweed immediately after primary spring tillage and then at one-month intervals until late July-early August. This was a total of five rodweedings.

Results for 2006 show that, following a wet 2005-2006 winter season, rodweeding was not required to maintain adequate seed-zone moisture for late planting. The primary tillage alone (in this case mid April with a Haybuster undercutter sweep) was the only operation required to retain seed-zone moisture. Surface residue and surface clod mass are reduced with increased rodweedings (Fig. 1). The undercutter only treatment (i.e., no rodweedings) had relatively low surface clod mass (Fig. 1) because individual clods were difficult to identify as they had “fused” together during spring rain events. The undercutter only treatment maintained a highly crusted surface that