

2005 STEEP PROGRESS REPORT

RESEARCH PROJECT TITLE: Optimizing Plant Genetics and Soil Fertility to Achieve High Grain Protein Content in Hard Red Spring Wheat

INVESTIGATORS: K. Kidwell, W. Pan and R. Koenig, Washington State University

CONTRIBUTORS: Gary Shelton, Melissa McClendon, Ron Bolton, Eric Harwood, Monica Allen

INTERIM REPORT: (First year's funding was allocated in October, 2003.)

PROJECT OBJECTIVES:

1. Evaluate current varieties and improved near isogenic lines (isolines) of hard red spring wheat (HRSW) for grain yield and protein response to low and high nitrogen fertilizer application rates.
2. Evaluate the most promising isolines identified in Objective 1 for agronomic potential and protein response to reduced nitrogen fertilization regimes.

KEY WORDS: hard red spring wheat, fertility, grain protein content, marker-assisted selection

STATEMENT OF PROBLEM: Developing HRSW varieties that effectively use nitrogen is important component of sustainable cropping systems geared towards maximizing profitability while minimizing environmental contamination. Our goal is to assess nitrogen use efficiency differences between the recurrent parents, Scarlet and Tara 2002, and BC₅F₅ isolines derived from these varieties, which carry a chromosomal region associated with high grain protein concentration (HGPC) from the donor parent Glupro. If protein content stability is increased in isolines with the HGPC region, or nitrogen fertilizer requirements are reduced, varieties released from this material will be of tremendous value to HRSW producers in the region.

ZONE OF INTEREST:, This research was conducted at two sites over two years in the semiarid intermediate rainfall zones of Dusty and Endicott, WA to maximize the opportunity to detect changes in grain protein content based on fertility management strategy. .

ABSTRACT OF RESEARCH FINDINGS: A 2004 and 2005 field experiment was conducted and replicated over two years a comparison of HRS cultivars Tara and Scarlet, with and without the protein gene inserted, when grown under varying N fertilizer regimes. Grain and straw samples were collected to determine N concentration and content, biomass accumulation and partitioning, grain quality and yield. Grain samples from 2004 were further analyzed for baking quality. Our primary objectives for this study were to determine genetic differences in Scarlet and Tara x GluPro isolines for two years in replicated direct seeded fertility trials, evaluating for N requirements, N use efficiencies, yield and protein responses to N fertility levels. In 2004, GluPro line was characterized as featuring low yield, high grain protein concentration, high straw biomass, high total straw N, and low harvest indices. The high straw N concentration in the GluPro line may suggest greater N uptake efficiency, but lower remobilization to low

yielding grain, with the high grain N concentration due to a concentration effect. In 2005, the Tara GluPro line was significantly higher in total plant N accumulation, when estimated from grain protein and straw N. Excellent N responses in yield and protein were observed, with yield gains immediately responsive to incremental increases in N supply. Grain protein was also responsive, particularly as grain yields plateaued. Some improvement in N uptake one of the Tara GluPro crosses was demonstrated in 2005.

RESULTS AND INTERPRETATION: Management details of 2005 genotype x N experiment at Endicott, WA are described in Table 1. Low residual soil N allowed for excellent responses in grain yield and protein to applied N (Figures 1 and 2). Predetermined yield goals of 40 bu/acre were almost achieved with the addition of 80 lb N/acre, in contrast with the 120 lb N/acre required for optimal yields in 2004. Grain protein goals of >14% were achieved with an additional 40 lb N/a input above and beyond what was needed for maximum grain yield. This demonstrates the principle that yield potential must be satisfied before grain protein can be elevated to desirable levels. Preliminary economic analysis indicates that with recent protein premiums, N fertilization for protein is still profitable in HRS, even at current high prices of N fertilizer. Split fall-spring N applications seemed to provide good N availability in direct seeded systems, as previously demonstrated in the Ralston experiment. Scarlet had higher protein concentrations than Tara 2002. Tara 2002 yielded better than Scarlet 2002 and its derivatives, particularly at low N regimes, but HiPro crosses were not distinguishable from Tara or Scarlet (Table 2). Samples continue to be analyzed for grain and straw C, N, S relationships to assess N, S uptake and partitioning.

IMPACT: Nitrogen fertilizer use is an important economic and environmental concern for regional wheat producers. Reducing the risk of producing high quality HRSW varieties while minimizing nitrogen fertilizer requirements would be a tremendous asset to the region. Results from this research will generate fertility management guidelines for recent HRSW varieties released by WSU, and a new generation of HRSW varieties with enhanced nitrogen use efficiency and reduced nitrogen fertilizer requirement may be identified through this work.

INTERACTION (COOPERATION) WITH OTHER SCIENTISTS CONDUCTING RELATED ACTIVITIES: Dr. Jorge Dubcovsky, Dep. of Agronomy & Range Science, UC-Davis; Dr. B-Y Baik, Wheat Quality Specialist, WSU

PUBLICATIONS AND PRESENTATIONS:

McClendon, Melissa, Monica Allen, Ron Bolton, Gary Shelton, William Pan and Kimberlee Kidwell. 2005. Impact of introgressing a high grain protein concentration region from *Triticum turgidum* into bread wheat (*Triticum aestivum* L.) via marker-assisted backcross breeding. Plant and Animal Genome Meetings, San Diego, CA.

Table 1: Soil and Crop Management for direct seeded fertility x genotype trial conducted at the at Endicott, WA in 2005

Cultural Management Practices		N	Fertilizer Applied (lb/A)	
			P	S
Previous crop	Winter Wheat	0	15	15
Tillage	None	40	15	15
Planting date	March 22	80	15	15
Planter used	Fabro no-till Drill	120	15	15
Seeding rate	80 lb/A	160	15	15
Soil Moisture	TBD			
In crop precipitation	5.48 inches		*40 fall, remainder at planting	
Harvest date	August 16th			
Herbicide applications	Discover; DSV Adjuvant, Harmony extra, Starane			

Table 2. 2005 Plant N Accumulation (Genotype Means Across all N rates)

Lines	Above-ground N (kg/ha) (est from protein)	Significance p<0.0001
3586-6G	52.54	A
3512-1G	48.739	B
TARA	48.467	B
3512-26T	48.31	B
1584-12G	46.662	BC
SCARLET	46.45	BC
1519-16S	45.004	C
1553-25G	44.632	C

Fig. 1. HiPro Fertilizer Response 2005 - Tara Series

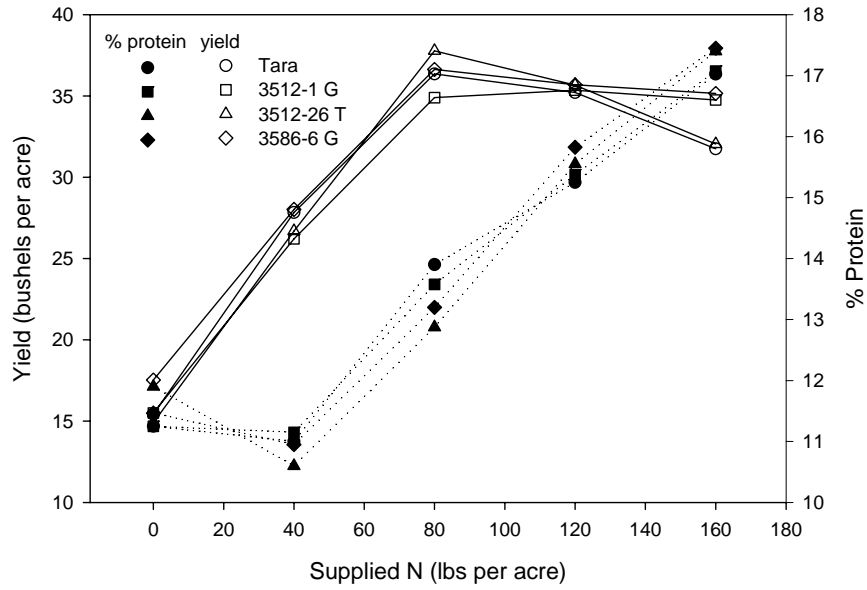


Fig. 2. HiPro Fertilizer Response 2005 - Scarlet Series

