2004 STEEP PROGRESS REPORT

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

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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 BC_5F_5 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: Initially, this research will be conducted in the high rainfall zone near Pullman, WA to maximize the opportunity to detect changes in grain protein content based on fertility management strategy. Once promising isolines have been identified, field trials also will be conducted in the semi-arid and intermediate rainfall zone to customize fertility management plans for each production region.

ABSTRACT OF RESEARCH FINDINGS: In addition to the grain yield and protein data reported in the 2003 progress report, grain and straw samples from 2003 field experiments were further analyzed to characterize N, S and dry matter partitioning. The original 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. Preliminary 2003 results suggested GluPro x Tara improved N uptake and grain protein accumulation. Our primary objectives for 2004 were to determine genetic differences in Scarlet and Tara x GluPro isolines for a second year in replicated direct seeded fertility trials, evaluating for N requirements, N use efficiencies, yield and protein responses to N fertility levels. 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. Further improvements in N uptake and grain protein accumulation with GluPro crosses were not demonstrated in 2004.

RESULTS AND INTERPRETATION: Management details of 2004 genotype x N experiment at Dusty, 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 achieved with the addition of 120 lb N/acre. Grain protein goals of >14% were achieved when grain yields plateaued. This demonstrates the principle that yield potential must be satisfied before grain protein can be elevated to desirable levels. Split fall-spring N applications seemed to provide good N availability in direct seeded systems, as previously demonstrated in the Ralston experiment. Tara 2002 yielded better than Scarlet 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; Mr. Brady Carter, 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: Management information, including fall soil test results, for direct seeded fertility trials conducted at the Steve Camp farm (5 mi SW of Dusty, WA) in 2004.Two trials were conducted: 1) variety trial and 2) genotype x N fertility experiement. These trials were used to assess the impact of incorporating a chromosomal region conferring high grain protein concentration into the adapted hard red spring wheat varieties, "Scarlet" and "Tara 2002".

Steve Camp Farm (Fertility Trial)		Fall Soil	Fertility	Yield Goal	Nitrogen (lb/A)			Fertilizer Applied (lb/A)		
Cultural Management Practices		Test Results	Treatment	bu/A	Goal	Present	Needed	N	P	S
Previous crop	Winter Wheat	45 lb N/ac/4'	0 lb N/ac	40	144	45	99	0	15	15
Tillage	None		40*	40	144	45	99	40	15	15
Planting date	March 25th		80*	40	144	45	99	80	15	15
Planter used	Fabro no-till Drill		120*	40	144	45	99	120	15	15
Seeding rate	80 lb/A		160*	40	144	45	99	160	15	15
Soil Moisture	25% in 0-1 ft									
In crop precipitation	2.8 inches		*40 fall, remainder at planting							
Harvest date	August 9th									
Herbicide applications	Discover; Bronate, Harmony, Starane									

Steve Camp Farm (Variety Trial)		Fall Soil	Fertility	Yield Goal	Nitrogen (lb/A)			Fertilizer Applied (lb/A)		
Cultural Management Practices		Test Results	Treatment	bu/A	Goal	Present	Needed	N	P	S
Previous crop	Winter Wheat	45 lb N/ ac/4'	75 lb N/ac	40	144	45	99	75	20	20
Tillage	None									
Planting date	March 23rd									
Planter used	5 row cross slot drill									
Seeding rate	80 lb/A									
Soil Moisture	25%									
In crop precipitation	2.8 inches									
Harvest date	August 9th									
Herbicide applications	Discover , Bructril, Harmony									

Figure 1. genotype x N rate experiment at Dusty, WA, 2004
with Scarlet and derivatives from GluPro crossings

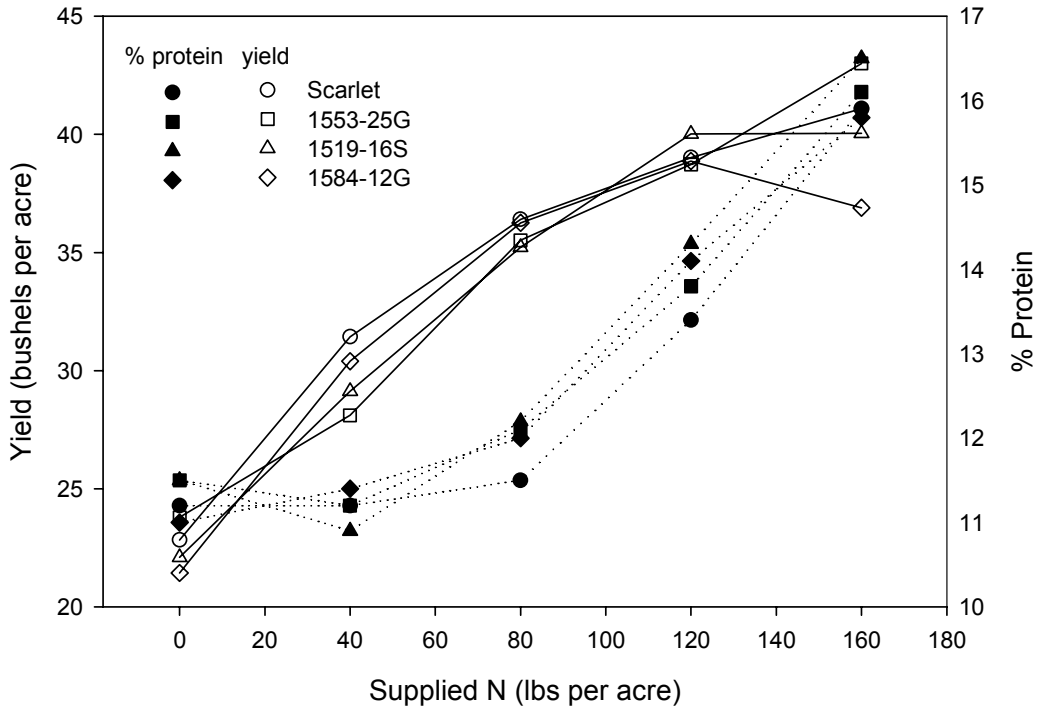

Figure 2. genotype x N rate experiment at Dusty, WA, 2004
with Tara 2002 and derivatives from GluPro crossings

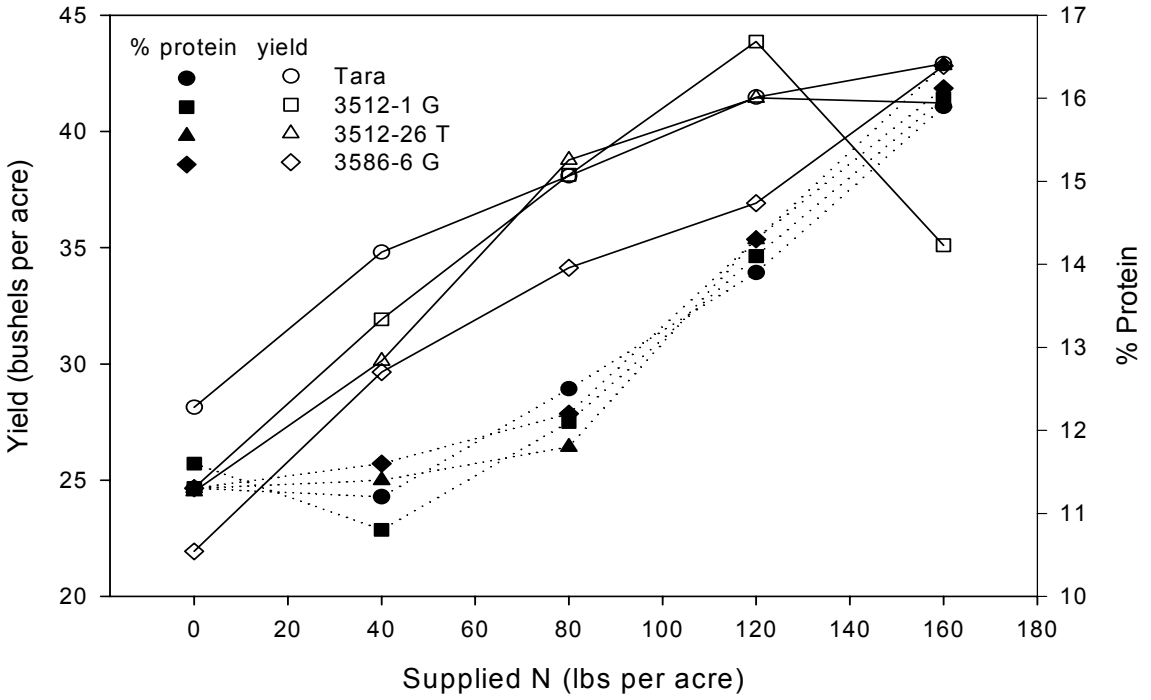

Table 2 Grain yield, protein concentration and protein yield for 2004 at Dusty, WA.

	bu/acre	% protein	lbs protein/A
Tara	37.1 A	12.89NS	286.8NS
3512-26 T	35.2 AB	13.1	276.1
3512-1 G	34.7 AB	12.9	269.1
3586-6 G	33.1 B	13.1	259.5
Scarlet	34.2 B	12.6	258.3
1553-25 G	33.8 B	13.0	263.8
1519-16 S	33.3 B	13.1	261.5
1584-12 G	32.8 B	12.9	252.9

*data averaged acrossed N rates