On-Farm Test Results

Lincoln-Adams Area 1999

Aaron D. Esser

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Introduction

On-farm testing, as defined in this publication, is not researched managed small plots on farms, nor is it a single strip or split-field comparison. It is a replicated, statistically valid research with field trials established and managed by the growers with field scale equipment. On-farm testing enables farmers to evaluate different production options using an accurate low risk tool. Using these on-farm-testing methods, growers can achieve experimental precision comparable to those of intensive university research trials. Reliable results will enable farming practices to progress to greater productivity efficiencies and resource protection. This publication summarizes the on-farm test conducted in 1998 by growers in Adams and Lincoln County, Washington.

The need for scientific experimental designs in grower field trials is not readily apparent to most growers. They are usually very adept at observing how a new practice or management option performs and making decisions based on their farming experience. If this were not true most of the time, they probably wouldn't be in business today.

The need for "scientific" field trials often depends on the questions that the grower needs answered. For example, a growers does not need a scientific comparisons to answer questions like: " Will this new crop grow and reach maturity under my production condition?" But they do need a scientific approach if there question is: "What variety of this new crop works best under my production conditions?"

Utilizing basic experimental methods is critical to achieve accurate results with on-farm testing. Because of the natural variation that exists within every field, an important step is to replicate treatment comparisons. Statistical analysis of the results of replicated test can then be used to separate the effects of natural field variability from the treatment effects. Associated with most of the data tables presented in these on-farm test reports there is an "$LSD_{(0.05)}$" which stands for "least significant difference at the 5% probability level." The LSD is used to determine if the treatments averages is greater than the LSD shown, there is a 95% probability that the difference is due to the treatments and not the natural field variability. To help illustrate this variability, yield data collected from each replication of the test are included in most of the reports. Final decisions regarding management options evaluated in an on-farm test should also be based on the grower's experience, economics, interactions with other management practices and more than one year of test.

On-Farm Testing

The on-farm tests presented in this publication are designed to "scientifically" compare the performance (stand establishment, tillers, weed populations, diseases, soil moisture, yield, and cropping systems) of 2 to 4 different crop management practices, or "treatments." An on-farm test can be as simple as a comparison of fertilizer rates or more complex, with comparisons of different crop rotations and production systems.

On-farm testing methods involve:

1. Proper design and layout of the experiment.
2. Accurate measurement of yield and other factors of interest from the individual treatment plots.
3. Analysis and interpretation of results using accepted statistical procedures.

Proper Design and Layout of the Experiment

After deciding what the treatments are going to be, pick locations in the field (or area of interest) where you can place the treatments in long, side-by-side strips. Avoid field borders and corner areas where overlaps of fertilizer, seeding, herbicides or extra tillage passed might occur. Flip a coin to decide which treatment goes in which strip. Repeat this for each replication.

Designing a test that will produce accurate, conclusive information often has growers asking many questions such as:

Why is replication needed?

Replication is used to overcome the fact that any two plots under the same management will not have exactly the same yield, stand count, weed population, etc. In other words, replication allows us to determine if differences between plots are due to treatments or due to "normal" field variation. In statistical jargon this normal variation is called "experimental error." Replication is based on the theory that if one practice is superior to another, it will become evident if you give it several chances.

How many replications are needed?

Research in the PNW has shown that four replications usually give the best chance of success for the amount of effort. Five or six replications can give a slight gain in statistical power in separating treatment differences, but may not be worth the extra effort. Three replications are less precise in determining treatment differences than four replications, but may be adequate for some management practice comparisons. The danger of starting with three replications is that if data from a plot is lost, you no longer have an effective trial. With the availability of portable weighting equipment, 8 to 12 strips (4 replications of 2-3 treatments) can usually be harvested in less than three hours.

Why should treatments be randomized?

Selection of treatment locations in a field comparison must be “unbiased” or fair. This may appear obvious, but there are many ways to consciously or unconsciously give an advantage to one of the practices being compared. The scientific way to choose which practice or treatment goes in which plot is to flip a coin, or to “randomize.” Once you have chosen plot areas, which as far as you can tell should perform the same, the logical way to convince yourself and others that you did not consciously or unconsciously favor one of the treatments is to assign them at random. Remember all treatments in a replication should have an equal chance to perform well in your best judgement!

What statistical design works best?

The statistical design often the most appropriate for on-farm testing with field-scale equipment is called “Randomized Complete Block” design (figure 1). The “complete block” means that each of the two or more treatments are included in side-by-side comparisons in each of the trial “replications or blocks.” A randomized complete block means that the order of each treatment in each replication is chosen randomly to ensure no bias in assigning treatments to plots. Because field variability generally increased with distance across the field, data variability is decreased through establishing the replications of side-by-side comparisons in areas where field variability is lower. Variability in results due to natural variability between blocks can then be separated in the statistical analysis of the results.

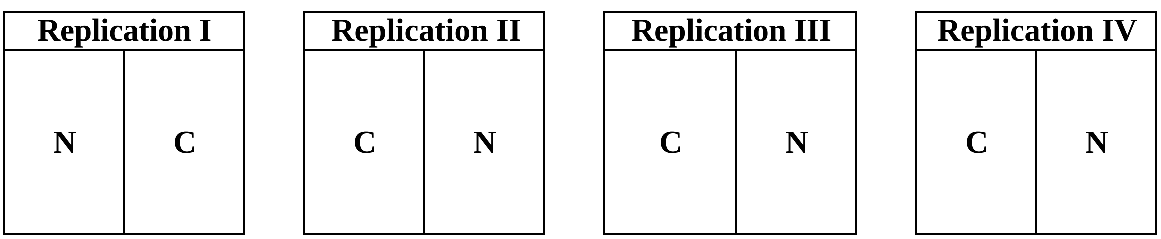

Figure 1. Potential randomized complete block design on-farm test with two treatments (C=control; N=new practice) and four replications. Each block, or replication can be placed side-by-side or at different locations.

Finally, how long should on-farm test plots be?

The longer the plots are, the better the data is likely to be, but that depends on landscapes, soil variability, and past farming practices in the field. Although, there have been many successful tests with four replications of 300 feet strips, research in the Pacific Northwest (PNW) has shown strip lengths of 750 feet or longer strips usually produce more precise results.

Accurate Measurement of Interest from the Individual Treatment Plots

Accurate data collection is very important for good results and should start with keeping notes on what you observe throughout the trial year. Observation is a valuable learning tool and will often help explain the "scientific" results. When data measurements are taken, such as plant populations or yield, record them separately for each strip. At harvest, cut a full header width out of the center of each plot, and weight the grain from each plot separately. Measure the length of each cut, especially if plot length varies, for more accurate calculations of yield. Portable truck scales or weigh wagons are available for making yield comparisons within a 5 to 10 pound accuracy.

Analysis and Interpretation of Results Using Accepted Statistical Procedures

When measurements are made, such as stand counts or yield, record them separately for each replication of each treatment. The data can then be analyzed statistically using a hand calculator and step-by-step formulas. Assistance in analyzing the test data is also available through your county extension agent. Even without statistics a lot can be learned from observation of different treatments to see if one is consistently better than the other in each of the replications.

Before you start your first replicated on-farm test, ask for assistance in design and conduction on-farm test from your county extension agent or others experienced with on-farm testing. Effectively designed and conducted, on-farm tests can provide growers with an accurate, low-risk tool for evaluating new production options and making successful management decisions.

This information was obtained from the Idaho, Oregon and Washington STEEP II on-farm-testing project. For additional information on designing an on-farm test talk to your local extension agent or Washington State Cooperative Extension publication EB1706 "On-Farm Testing, a Grower's Guide".

Hard Red Spring Wheat Introduction

by Aaron Esser

With the price of soft white wheat at such low prices, farmers are looking to produce any crop that will potentially help increase farm income. One crop growers are looking at is hard red spring wheat (HRSW). HRSW is comprised of three subclasses, of which one is Dark Northern Spring (DNS) wheat, defined as being at least 75% dark, hard, vitreous kernels.

One thing a grower must understand and manage with HRSW production is the risk associated with this crop, especially compared to soft white spring wheat (SWSW). Overall, HRSW has greater risk than SWSW in four elements: weather, yield, price and production inputs.

Untimely summer rains may reduce protein content in HRSW, but growers have very little control over weather conditions. Timely harvest is one management practice to help reduce risk associated with weather in HRSW production.

Yield potentials will vary within regions, varieties and on individual farms, but overall, yield of HRSW is about 6 bu/acre less than SWSW in trials throughout eastern Washington (Figure 1). Understanding the yield potential of HRSW varieties in specific areas will help growers make better management decisions.

HRSW has increased risk in price as the final protein content determines the market price. Premiums and discounts for protein content are historically pretty variable. During the 1990's, HRSW with 13% protein was sold for an average $0.31/bu less than HRSW with 14% protein, and HRSW with 15% protein was sold for an additional $0.19/bu over 14% protein. Overall, discounts for 13% protein HRSW during the 90's ranged from -0.28 to $1.38/bu, and price premiums for 15% protein ranged from -$0.38 to $1.76/bu.

Understanding the historical price difference between HRSW and soft white wheat (SWW) will also help growers make better management decisions concerning HRSW production. Figure 2 shows the historical price advantage of HRSW over SWW. During the 1990's HRSW with 14% protein sold for an additional $0.81/bu more than SWW, and it ranged from as low as -$0.18 too as high as $2.73/bu Although not calculated in this breakdown, the Loan Deficiency Payment (LDP) impacts market price differently for both classes of wheat and should be considered under the current farm program.

One question often asked by growers is "will the price premium for 14% HRSW in the spring of the year be there in the fall of the year?" During the 1990's, the price of SWW, although variable, has been significantly negatively correlated with the price difference between HRSW and SWW (Figure 3). Meaning, when the price of SWW decreases, the difference in price between the 2 classes of wheat increases.

Production inputs are very important for HRSW to maximize yield, protein and overall profitability, yet they are poorly understood among growers and researchers. A study at Pullman, WA (20-inch precipitation zone) in 1988 examined the impact of protein and yield with nitrogen applied at 40, 80, 120 and 160 lb N/acre with the nitrogen being applied in the fall, spring and split between fall and spring application. Additional nitrogen increased yield, but timing of nitrogen application did not impact grain yield. Protein also increased with additional fertilizer (Table 1), and was significantly greater for the fall and split N as compared to the spring applications (Figure 4). This study determined that by final harvest, plant N for the spring application was significantly less than the fall and split application, and soil nitrate levels were significantly greater at the 3 ft depth for the fall applied N. A similar trend was observed for the split application, although not significant.

On-farm Testing of HRSW Management Practices

Six on-farm tests were established in Adams and Lincoln Counties to look at the agronomic and economic impacts of production inputs and different management practices with HRSW production. Nitrogen fertilizer treatments were calculated using residual soil test nitrogen:

Crop Nitrogen Required (lb N/bu x potential yield)
+ Nitrogen needed for incorporated cereal straw breakdown
- Estimated N released from organic matter
- Soil test results:
  NH_4 (1')
  NO_3 (3')
= total N to be applied

Gross economic returns were calculated using the market price at Ritzville Warehouse's FOB price on September 14, 1999. At this time the market price for HRSW was $3.67/bu at 14% protein and an additional $0.07/bu was added for every ¼% above 14% protein. Twelve cents per bushel was deducted from the market price for every ¼% below 14% protein. The LDP was not included to calculate gross economic returns. Net economic returns were calculated taking the gross return minus variable costs. Variable costs were estimated at $0.20/lb for nitrogen fertilizer, $0.25/lb for sulfur fertilizer, $16/cwt for HRSW seed, $12/cwt for SWSW seed and an interest cost of 12% where applicable.

Table 1. Total nitrogen required for a bushel of grain to reach a desired protein level in HRSW at Pullman, Washington, and total nitrogen required for SWSW in different precipitation zones.

% protein	Total N Required (lb N/bu)
12	3.0
14	3.6
16	4.2
SWSW (<21" precipitation)	2.3
SWSW (>21" precipitation)	2.4

Source: Washington State University and the University of Idaho.

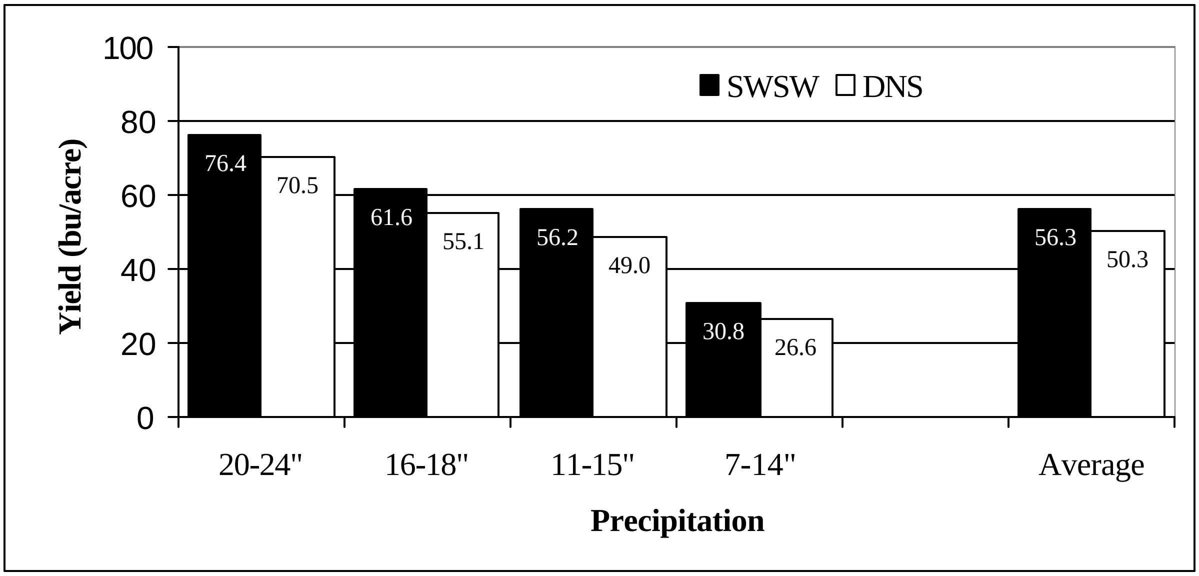

Figure 1. Average yield based on 97, 98 and 99 WSU variety trial results of 4 commercially available SWSW and HRSW varieties in different precipitation zones located throughout eastern Washington. Source: http://variety.wsu.edu/

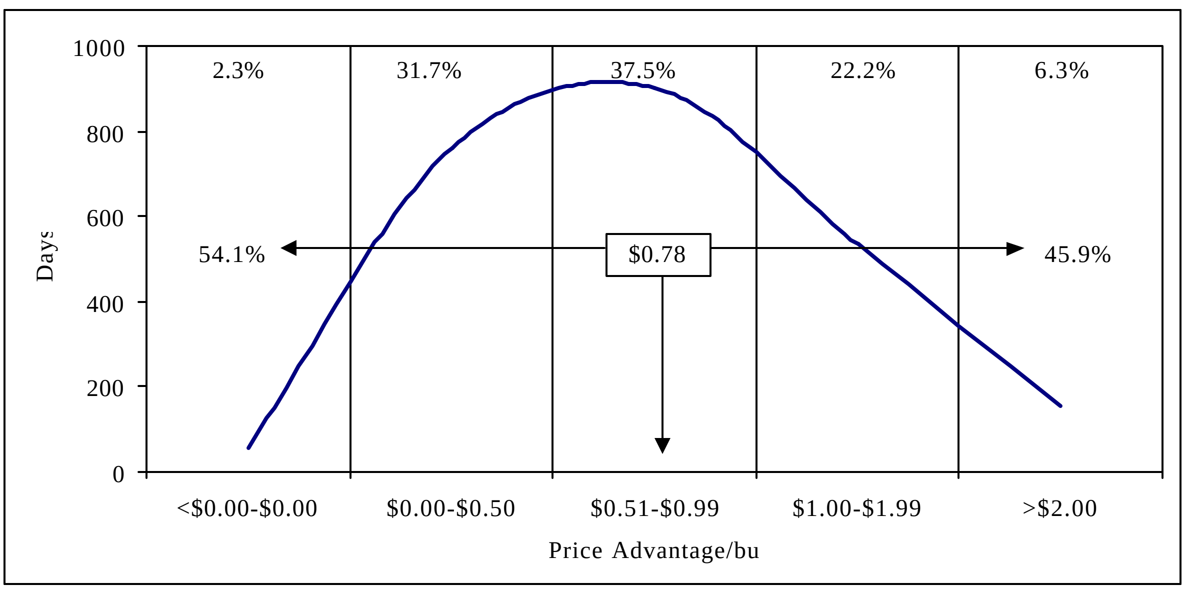

Figure 2. The historical price advantage of 14% protein HRSW over soft white wheat during the 1990's and how the price advantage ($0.78/bu) used in the economic analysis in the on-farm trials relates to the historical price advantage. For example, 37.9% of the days in the 90's, HRSW at 14% protein has had a price advantage between $0.51 to $0.99/bu.

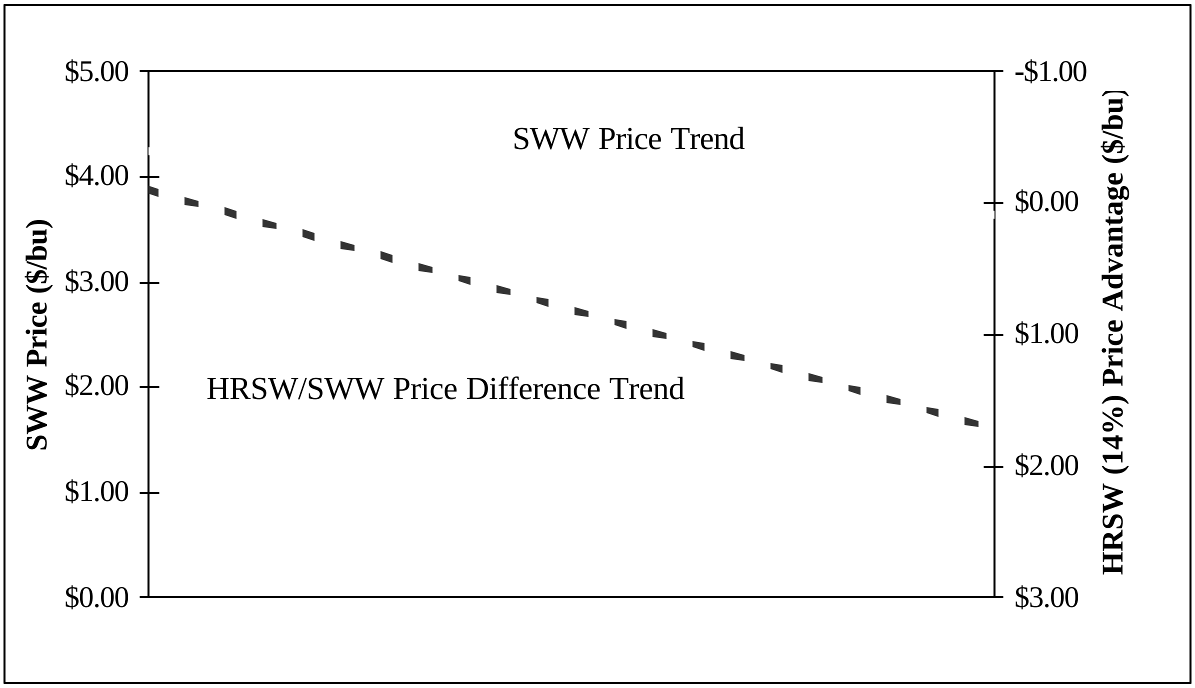

Figure 3. Relationship between decreasing SWW price and the price advantage of 14% protein HRSW over SWW during the 1990's.

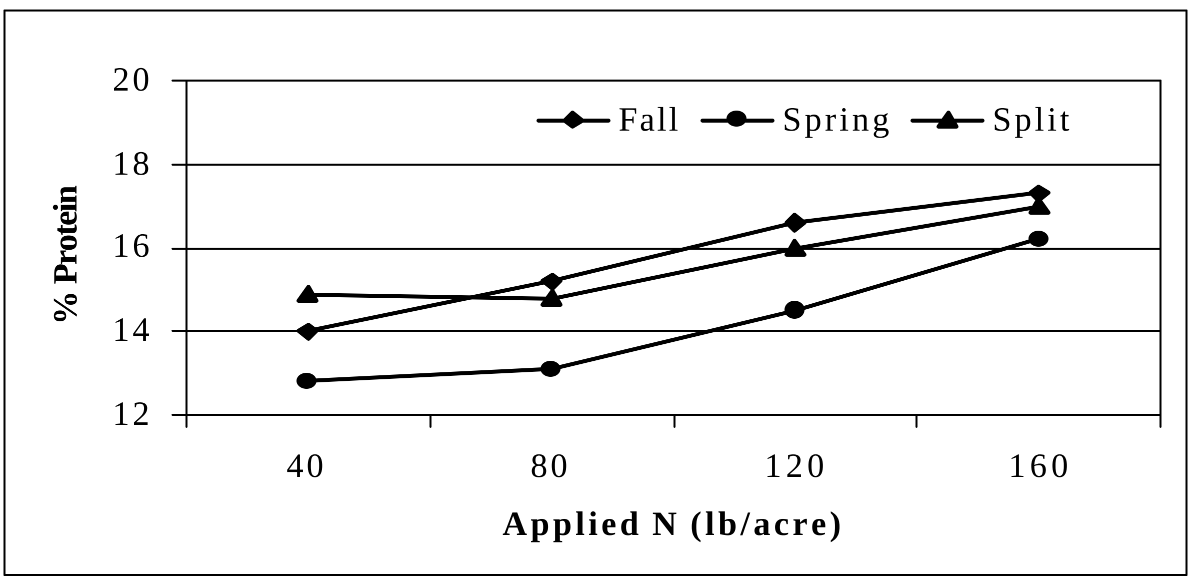

Figure 4. HRSW percent protein with increasing rates of nitrogen applied in the fall, spring and split between the fall and spring at Pullman, WA (20-inch annual precipitation) in 1988.

Hard Red Spring Wheat Yield and Protein Response To Nitrogen Timing, Adams County

Blankenship Farms

with Aaron Esser, WSU Cooperative Extension

Objective:

The objective of this study was to examine the yield, protein and profitability of Hard Red Spring Wheat (HRSW) when nitrogen fertilizer was applied in the fall, spring and split application, and compare it to soft white spring wheat (SWSW).

Study Location:

Location: about 2 miles north of Benge, WA.
Annual precipitation: 8-10 inches.
Soil type: Ritzville silt loam.

Soil Test Results:

Fall Soil Sample Collected on October 16, 1998

Soil pH = 6.5

Soil Depth	=	Moisture (inches/foot)	Sulfur (ppm)	Nitrogen (lb N/acre)
1’	=	0.45”	7	45
2’	=	0.53”	-	7
3’	=	0.48”	-	3
4’	=	0.54”	-	-
Total	=	2.00”	7	55

† Includes the 28 lb N/acre estimated released from 1.4% organic matter and 7 lbs N/acre estimated released from NH_4.

Treatments and Operations:

HRSW was fertilized at 3.6 lbs N/potential bushel with nitrogen being applied at three timings: mostly fall-applied nitrogen, all spring applied nitrogen, and nitrogen application split between the fall and spring. Soft white spring wheat was fertilized in the spring of the year at 2.3 lbs N/potential bushels. Nitrogen treatments were calculated using the fall soil sample results and a potential yield of 32 bu/acre for HRSW and 38 bu/acre for SWSW. Minimum tillage was used to establish the trial. The field was disked in the fall of the year and was fertilized with using a Yetter low disturbance applicator on 12-inch spacing. Aqua fertilizer was fall applied on December 16, 1998 and the spring applied three months later on March 16, 1999. An additional 7 lbs N/acre, 11 lbs P/acre, 0.10 lbs B/acre and 0.10 lbs Cl/acre was applied with the seed on all treatments. ‘Spillman’ HRSW and ‘Wawawai’ SWSW was seeded on April 4, 1999, at 80 lbs/acre with double disk drills on 7.5-row spacing. The trial was a randomized complete block design with 4 replications.

Nitrogen fertility treatment calculations:

		HRSW (34 bu/acre)			SWSW (38 bu/acre)
		T-1 (3.6)	T-2 (3.6)	T-3 (3.6)	T-4 (2.3)
Total N Needed		122	122	122	88
Cereal Straw Breakdown†	+	30	30	30	30
Organic Matter	-	28	28	28	28
Soil Test Results: NH_4 (1’)	-	7	7	7	7
NO_3 (3’)	-	20	20	20	20
Total N Applied	=	97	97	97	63
Total N Fall Applied		74	45	0	0
Total N Spring Applied		23	52	97	63

† Additional nitrogen was applied for incorporated cereal straw residue.

Spring Nitrogen Tests:

On the whole, very little of the fall applied fertilizer was accounted for in spring soil samples. Seventy-one percent was unaccounted for when 45 lbs N/acre was fall applied, and 67% was unaccounted for when 74 lbs N/acre was applied. Most of the nitrogen accounted for was in the form of ammonium nitrate (NH_4) in the 1st foot. Only an additional 3 lbs N/acre (NO_3) was available in the 2^{ed} and 3rd foot when fertilizer was applied in the fall.

Agronomic Results:

There was no significant difference in stand establishment between HRSW and SWSW, and the timing of nitrogen fertilizer (data not presented). Overall there was an average of 13.4 plants/ft^2. SWSW yielded 22.6 bu/acre, significantly higher than the three treatments of HRSW (Table 2). Within the HRSW the split nitrogen application treatment had significantly lower yield than the fall and spring applied nitrogen. HRSW yielded 19.0, 20.2 and 20.7 when nitrogen application was split, fall and spring applied, respectively.

All three HRSW treatments had less than 14% protein, but HRSW with spring applied nitrogen had 13.6% protein, significantly greater than fall or split applied nitrogen which had 13.1 and 13.2% protein. Overall, HRSW had greater protein than SWSW.

The trial was fertilized at 3.6 for 34 bu/acre HRSW and 2.3 lbs of nitrogen for 38 bu/acre SWSW (Table 3). However yield ranged from only19.0 to 20.7 bu/acre for HRSW and 22.6 bu/acre for SWSW. The actual rate of available nitrogen for a bushel of HRSW was 6.0, 5.9 and 6.9 lbs of nitrogen when applied in the fall, spring and split between fall and spring. None of the treatments reached the desired 14% protein content even though amount of available nitrogen was much higher than previous research has shown is required to reach this level.

Economic Results:

HRSW with spring only applied fertilizer had a gross return of $69.75/acre, significantly greater than the other two HRSW treatments and the SWSW (Table 4). SWSW had a gross return of $65.28/acre, significantly greater than the treatments of HRSW with fall applied fertilizer applications. There was no significant difference in gross return with fall-applied fertilizer ($63.61/acre) and a split application ($62.30/acre).

Net return was calculated taking the gross return minus costs (see introduction). Overall, SWSW had $5.53/acre higher net return than HRSW with spring applied fertilizer and over $12/acre than HRSW with fall and split nitrogen application. HRSW with spring applied nitrogen had almost $7.00/acre higher net return than fall and spring applied nitrogen application.

Conclusions:

Spring applied nitrogen with HRSW increased protein and economic returns over fall and split nitrogen application, but protein was still less than 14% even when there was at least 5.9 lbs N/bu available. Overall, SWSW produced greater yields and $5.53-$13.36/acre higher net returns above fertilizer, seed and interest costs than the three HRSW treatments.

Soil Test Data:

Table 1. Total available nitrogen in the spring of the year with different rates of fertilizer applied in the fall of the year in an on-farm test at Blankenship Farm's in 1999.

	Fall	Spring Soil Sample		
	Soil Sample	0 Fall Applied N	45 Fall Applied N	74 Fall Applied N
	------------------------------ lbs N/Acre Available ------------------------------			
O.M.	28	30	30	30
NH_4 (1’)	7	6	11	22
NO_3 (1’)	10	7	10	10
NO_3 (2’)	7	3	7	7
NO_3 (3’)	3	10	10	10
Total	55	56	68	79

Agronomic Data:

Table 2. Yield and protein of HRSW and SWSW with varied amounts of nitrogen application in an on-farm test at Blankenship farm's in 1999.

Treatment	Yield (bu/acre)	Protein (%)
T-1 HRSW Fall	20.2 b†	13.1 b
T-2 HRSW Spring	20.7 b	13.6 a
T-3 HRSW Split	19.0 c	13.2 b
T-4 SWSW	22.6 a	10.5 c
$LSD_{(0.05)}$	0.9	0.2
CV	2.1%	0.9%

† Treatment means within columns followed by the same letter are not significantly different at the 95% probability level ($P<0.05$).

Table 3. Potential and actual nitrogen per bushel of grain in an on-farm test at Blankenship farm's in 1999.

Treatment	Yield (bu/acre)	Total N Available	Lbs N/ Potential bu	Lbs N/ Actual bu
T-1 HRSW Fall	20.2	122	3.6	6.0
T-2 HRSW Spring	20.7	122	3.6	5.9
T-3 HRSW Split	19.0	122	3.6	6.4
T-4 SWSW	22.6	88	2.3	3.9

Economic Data:

Table 4. Gross and net returns above nitrogen costs per acre of HRSW and SWSW in an on-farm test at Blankenship Farm's in 1999

Treatment	Gross Return[†] ($/acre)	Cost ($/acre)			Return Above Cost ($/acre)
		Nitrogen[‡]	Seed[§]	Interest[¶]	
T-1 HRSW Fall	$63.61 c[#]	$19.40	$12.80	$0.78	$30.63 c
T-2 HRSW Spring	$69.75 a	$19.40	$12.80	-	$37.55 b
T-3 HRSW Split	$62.30 c	$19.40	$12.80	$0.39	$29.72 c
T-4 SWSW	$65.28 b	$12.60	$9.60	-	$43.08 a
LSD $_{(0.05)}$	$2.64				$2.64
CV	1.9%				3.5%

† Gross return was calculated using the FOB on September 14, 1999 at Ritzville Warehouse.
‡ Nitrogen costs were estimated at $0.20/lb of nitrogen.
§ Seed costs were estimated at $16/100 wt for HRSW and $12/100 wt for SWSW.
¶ Interest costs were estimated at 12% for fertilizer purchased 3 months in advance.
# Treatment means within columns followed by the same letter are not significantly different at the 95% probability level ($P<0.05$).

Hard Red Spring Wheat Yield and Protein Response To Nitrogen Timing and Application, Adams County

Jerry Knodel
with Aaron Esser, WSU Cooperative Extension

Objective:

The objective of this study was to examine the yield, protein and profitability of hard red spring wheat (HRSW) with fall fertilization and increasing rates of spring applied nitrogen and compare it to soft white spring wheat (SWSW).

Study Location:

Location: about 5 miles East of Lind, WA.
Annual precipitation: 8-10 inches.
Soil type: Ritzville silt loam.
Previous crop: 55 bu/acre winter wheat

Soil Test Results:

Fall Soil Sample Collected on October 16, 1998

Soil pH = 6.9

Soil Depth	=	Moisture (inches/foot)	Sulfur (ppm)	Nitrogen (lb N/acre)
1'	=	0.59"	6	45
2'	=	0.61"	-	10
3'	=	0.75"	-	7
4'	=	0.85"	-	-
Total	=	2.79"	6	62

† Includes the 28 lb N/acre estimated released from 1.4% organic matter and 4 lbs N/acre estimated released from NH_4.

Spring Soil Sample Collected on March 5, 1999

Soil pH = 6.9

Soil Depth	=	Moisture (inches/foot)	Sulfur (ppm)	Nitrogen (lb N/acre)
1'	=	2.67"	2	56
2'	=	1.81"	-	10
3'	=	1.51"	-	13
4'	=	1.15"	-	-
Total	=	7.14"	2	79

† Includes the 26 lb N/acre estimated released from 1.3% organic matter and 17 lbs N/acre estimated released from NH_4.

Treatments and Operations:

Forty-two pounds of nitrogen were fall applied to the whole trial in late November with an aqua shank machine with 12-inch spacing. The trial was conventionally tilled in the spring. Fertilizer treatments were calculated at 2.6, 3.6 and 4.5 lbs N/potential bushel for HRSW and 2.3 lbs N/potential bushels for SWSW using the fall soil sample results and a potential yield of 32 bu/acre for HRSW and 36 bu/acre for SWSW. The four treatments, an additional 0, 40 and 70 lbs N/acre for HRSW and 0 lbs N/acre of SWSW, were applied in the spring with an anhydrous shank machine. An additional 10 lbs N/acre was applied with the seed on all treatments. No sulfur or phosphorous was applied. 'Scarlet' HRSW and 'Wawawai' SWSW were seeded on March 13, 1999, at 80 lbs/acre with disk drills on 7.5 inch-row spacing. The trial was a randomized complete block design with 4 replications.

Nitrogen fertility treatment calculations:

			HRSW (32 bu/acre)		SWSW (36 bu/acre)
		T-1 (2.6)	T-2 (3.6)	T-3 (4.5)	T-4 (2.3)
Total N Needed		84	114	144	84
Cereal Straw Breakdown†	+	30	30	30	30
Organic Matter	-	28	28	28	28
Soil Test Results: NH_4 (1')	-	4	4	4	4
NO_3 (3')	-	30	30	30	30
Total N Applied	=	52	82	112	52
Total N Fall Applied		42	42	42	42
Total N Spring Applied		10	40	70	10

† Additional nitrogen was applied for incorporated cereal straw residue.

Spring Nitrogen Tests:

On the whole, only 17 lbs N/acre was accounted for between the spring and fall soil sampling. The fall-applied fertilizer that was accounted for was mostly in the form of ammonium nitrogen (NH_4) in the first foot (13 lbs additional N/acre). An additional 6 lbs N/acre was available in the form of nitrate (NO_3) in the third foot, and there was no additional available nitrogen in the first and second foot in the form of nitrate.

Agronomic Results:

Plant population and tillers/plant were not significantly different (Table 1). There was an average of 20.7 plants/ft^2 and 2.5 tillers per plant. There was no significant difference in seed yield among the three HRSW treatments and the SWSW treatment (Table 2). Overall, the average yield was 32.0 bu/acre. Applying 112 lbs N/acre had 12.0% protein, significantly greater than 11.1 and 10.6% protein when only 82 and 52 lbs N/acre was applied respectively. All three HRSW treatments had greater protein than SWSW.

The trial was fertilized at 2.6, 3.6 and 4.5 lbs of nitrogen for 32bu/acre HRSW and 2.3 lbs of nitrogen for 36 bu/acre SWSW (Table 3). Yield ranged from 30.3 to 33.5 bu/acre. The rate of available nitrogen for a potential bushel of grain was close to the available nitrogen for an actual bushel of grain. Available nitrogen for an actual bushel of grain was 2.7, 3.6 and 4.3 lbs of nitrogen for the three HRSW treatments and 2.6 lbs of nitrogen for the SWSW. Protein content with 4.3 lbs N/bu of HRSW was significantly higher than the other two treatments, but protein was well below 14.0%, the desired level.

Economic Results:

Soft white spring wheat had a gross return of $92.33/acre, significantly greater than the three HRSW treatments (Table 4). Significant differences were detected within the three HRSW treatments. Applying 112, 82, and 52 lbs N/acre had gross returns of $84.66, $71.24 and $62.62/acre, respectively. Net return was calculated by subtracting the gross return less seed and nitrogen fertilizer costs. Soft white spring wheat had a net return of $72.33/acre, also significantly greater than the three HRSW treatments. Within the HRSW treatments, applying 112 lbs N/acre had a net return of $49.46/acre, significantly greater than the $39.42/acre when only 52 lbs N/acre was applied. Applying 82 lbs N/acre produced a net return of $49.46/acre.

Conclusions:

Applying 42 lbs N/acre in the fall increased the total available nitrogen in the spring of the year by only 17 lbs N/acre. One potential reason for the large amount of nitrogen unaccounted for may be in the soil sampling procedure used in the spring of the year given the conditions. Late fall fertilization combined with cold soil conditions in the spring of the year restricted fertilizer movement both vertically and horizontally in the soil profile.

Increased nitrogen application with HRSW increased protein and economic returns, but protein was still much less than 14% even when there was at least the recommend 3.6 lbs N/bushel of grain available. Overall SWSW had greater gross and net returns above fertilizer and seed costs than any of the three HRSW treatments with similar yields. When HRSW had additional nitrogen fertilizer inputs, it had over $22/acre less net returns than SWSW, and when HRSW had similar nitrogen fertilizer inputs as SWSW, it had nearly $33/acre less net returns.

Agronomic Data:

Table 1. Plant population and tillers per plant with varied amounts of nitrogen application on HRSW and SWSW in an on-farm test at Jerry Knodel's in 1999.

Treatment	Population (plants/ft^2)	Tiller Count (tiller/plant)
T-1 HRSW 52 lbs N/acre	20.9	2.4
T-2 HRSW 82 lbs N/acre	19.5	2.6
T-3 HRSW 112 lbs N/acre	21.9	2.7
T-4 SWSW 52 lbs N/acre	20.4	2.3
LSD $_{(0.05)}$	n.s.	n.s.
CV	23.1%	29.8%

Table 2. Yield and protein of HRSW and SWSW with varied amounts of nitrogen application in an on-farm test at Jerry Knodel's in 1999.

Treatment	Yield (bu/acre)	Protein (%)
T-1 HRSW 52 lbs N/acre	30.3	10.6 b†
T-2 HRSW 82 lbs N/acre	31.5	11.1 b
T-3 HRSW 112 lbs N/acre	33.5	12.0 a
T-4 SWSW 52 lbs N/acre	32.5	9.2 c
LSD $_{(0.05)}$	n.s.	
CV	4.9%	

† Treatment means within columns followed by the same letter are not significantly different at the 95% probability level (P<0.05).

Table 3. Potential and actual nitrogen per bushel of grain in an on-farm test at Jerry Knodel's in 1999.

Treatment	Yield (bu/acre)	Total N Available	Lbs N/ Potential bu	Lbs N/ Actual bu
T-1 HRSW 52 lbs N/acre	30.3	84	2.6	2.7
T-2 HRSW 82 lbs N/acre	31.5	114	3.6	3.6
T-3 HRSW 112 lbs N/acre	33.5	144	4.4	4.3
T-4 SWSW 52 lbs N/acre	32.5	84	2.3	2.6

Economic Data:

Table 4. Gross and net returns above nitrogen costs per acre of HRSW and SWSW in an on-farm test at Jerry Knodel's in 1999.

Treatment	Gross Return[†] ($/acre)	Nitrogen Costs[‡] ($/acre)	Seed Cost[§] ($/acre)	Return Above Cost ($/acre)
T-1 HRSW 52 lbs N/acre	$62.62 d[¶]	$10.40	$12.80	$39.42 c
T-2 HRSW 82 lbs N/acre	$71.24 c	$16.40	$12.80	$42.04 bc
T-3 HRSW 112 lbs N/acre	$84.66 b	$22.40	$12.80	$49.46 b
T-4 SWSW 52 lbs N/acre	$92.33 a	$10.40	$9.60	$72.33 a
LSD $_{(0.05)}$	$8.32			$8.32
CV	5.0%			7.7%

[†] Gross return was calculated using the FOB on September 14, 1999 at Ritzville Warehouse.
[‡] Nitrogen costs was estimated at $0.20/lb of nitrogen.
[§] Seed cost was estimated at $16/100 wt for HRSW and $12/100 wt for SWSW.
[¶] Treatment means within columns followed by the same letter are not significantly different at the 95% probability level (P<0.05).

Hard Red Spring Wheat Yield and Protein Response To Nitrogen Timing and Application, Adams County

Ross Heimbigner
with Aaron Esser, WSU Cooperative Extension

Objective:

The objective of this study was to examine the yield, protein and profitability of hard red spring wheat (HRSW) with fall fertilization and increasing rates of spring applied nitrogen.

Study Location:

Location: about 7 miles northwest of Ritzville, WA.
Annual precipitation: 11-13 inches.
Soil type: Ritzville silt loam.
Previous crop: yellow mustard

Soil Test Results:

Fall Soil Sample Collected on September 19, 1998

Soil pH = 6.9

Soil Depth	=	Moisture (inches/foot)	Sulfur (ppm)	Nitrogen (lb N/acre)
1’	=	0.62”	2	42
2’	=	0.75”	-	10
3’	=	1.12”	-	10
4’	=	1.05”	-	-
Total	=	3.54”	2	62

† Includes the 28 lb N/acre estimated released from 1.4% organic matter and 4 lbs N/acre estimated released from NH_4.

Spring Soil Sample Collected on March 10, 1999

Soil pH = 6.9

Soil Depth	=	Moisture (inches/foot)	Sulfur (ppm)	Nitrogen (lb N/acre)
1’	=	2.36”	5	93
2’	=	1.84”	-	10
3’	=	1.58”	-	13
4’	=	1.28”	-	-
Total	=	7.06”	5	116

† Includes the 26 lb N/acre estimated released from 1.3% organic matter and 51 lbs N/acre estimated released from NH_4.

Treatments and Operations:

Sixty-three pounds of nitrogen was fall applied to the whole trial in September with an aqua shank machine with 12-inch spacing. The trial was conventionally tilled in the spring. Fertilizer treatments were calculated at 3.0, 3.6 and 4.2 lbs N/potential bushel using the fall soil sample results and a potential yield of 37 bu/acre. The three treatments, an additional 0, 22 and 44 lbs N/acre, were applied in the spring with an aqua shank machine. One hundred pounds per acre of 16-20-0-14 dry starter fertilizer (an additional 16 lbs N/acre) was applied with the seed on all three treatments to reach the total amount of required nitrogen. 'Spillman' HRSW was seeded on March 20, 1999, at 80 lbs/acre with double disk drills on 7½-row spacing. The trial was a randomized complete block design with 4 replications.

Nitrogen fertility treatment calculations:

			Lbs N for a potential yield of 37 bu/acre		
			T-1 (3.0)	T-2 (3.6)	T-3 (4.2)
Total N Needed			111	133	155
Cereal Straw Breakdown†		+	30	30	30
Organic Matter		-	28	28	28
Soil Test Results:	NH_4 (1')	-	4	4	4
	NO_3 (3')	-	30	30	30
Total N Applied		=	79	101	123
Total N Fall Applied			63	63	63
Total N Spring Applied			16	38	60

† Additional nitrogen was applied for incorporated cereal straw residue.

Spring Nitrogen Tests:

On the whole, all but 9 lbs N/acre was unaccounted for between the spring and fall soil sampling. Most of the fall-applied fertilizer was accounted for in the form of ammonium nitrogen (NH_4) in the first foot (47 lbs N/acre). An additional 6 lbs N/acre was available in the form of nitrate (NO_3) in the top foot, and only an additional 3 lbs N/acre was present in the second and third foot.

Agronomic Results:

Plant population and tillers/plant were not significantly different with increasing rates of nitrogen fertilizer (Table 1). There was an average of 16.2 plants/ft^2 and 2 tillers per plant. Applying 123 lbs N/acre yielded 25.0 bu/acre, significantly greater than 21.7 and 22.1 bu/acre when 101 and 79 lbs N/acre was applied (Table 2). Protein content was not increased with additional fertilizer application.

The trial was fertilized at 3.0, 3.6 and 4.2 lbs of nitrogen for a potential yield of 37 bu/acre (Table 3). However, yield ranged from only 21.7 to 25.0 bu/acre. Actual rate of available nitrogen for a bushel of grain was 5.0, 6.1 and 6.2 lbs of nitrogen. All treatments reached the desired 14% protein content but the nitrogen application was much higher than previous research has shown is required.

Economic Results:

Applying 123 lbs N/acre had a gross return of $97.11/acre, significantly greater than $84.19 and $85.58/acre with the application of 101 and 79 lbs N/acre, respectively (Table 4). However, there was no significant difference within any of the treatments in net return above fertilizer cost. Net return above fertilizer cost averaged $68.76/acre.

Conclusions:

Fall fertilizer application increased the total nitrogen available in the spring of the year, but most of the fertilizer applied in the fall was accounted for in the 1st foot of the soil profile in the spring. Increasing nitrogen application did not effect protein content; however, fertilizer application at the lowest nitrogen application was much higher than current recommendations at 5.0 lbs N/bushel of grain. Applying 123 lbs of total nitrogen increased yield and gross returns, but did not significantly increase gross returns over applying only 79 and 101 lbs N/acre.

Agronomic Data:

Table 1. Plant population and tillers per plant with varied amounts of nitrogen application on HRSW in an on-farm test at Ross Heimbigner's in 1999.

Treatment	Population (plants/ft^2)	Tiller Count (tiller/plant)
T-1 79 lbs N/acre	17.5	2.0
T-2 101 lbs N/acre	16.1	1.8
T-3 123 lbs N/acre	15.2	2.3
LSD $_{(0.05)}$	n.s.	n.s.
CV	22.8%	58.44%

Table 2. Yield and protein of HRSW with varied amounts of nitrogen application in an on-farm test at Ross Heimbigner's in 1999.

Treatment	Yield (bu/acre)	Protein (%)
T-1 79 lbs N/acre	22.1 b[†]	14.9
T-2 101 lbs N/acre	21.7 b	14.7
T-3 123 lbs N/acre	25.0 a	14.7
LSD $_{(0.05)}$	2.0	n.s.
CV	5.1%	2.1%

[†] Treatment means within columns followed by the same letter are not significantly different at the 95% probability level (P<0.05).

Table 3. Potential and actual nitrogen per bushel of grain in an on-farm test at Ross Heimbigner's in 1999.

Treatment	Yield (bu/acre)	Total N Available	Lbs N/ Potential bu	Lbs N/ Actual bu
T-1 79 lbs N/acre	22.1	111	3.0	5.0
T-2 101 lbs N/acre	21.7	133	3.6	6.1
T-3 123 lbs N/acre	25.0	155	4.2	6.2

Economic Data:

Table 4. Gross and net returns above nitrogen costs per acre of HRSW in an on-farm test at Ross Heimbigner in 1999.

Treatment	Gross Return[†] ($/acre)	Nitrogen Costs[‡] ($/acre)	Return above N ($/acre)
T-1 79 lbs N/acre	$85.58 b[§]	$15.80	$69.78
T-2 101 lbs N/acre	$84.19 b	$20.20	$63.99
T-3 123 lbs N/acre	$97.11 a	$24.60	$72.51
LSD $_{(0.05)}$	$7.80		n.s.
CV	5.1%		5.3%

[†] Gross return was calculated using the FOB on September 14, 1999 at Ritzville Warehouse.
[‡] Nitrogen costs was estimated at $0.20/lb of nitrogen.
[§] Treatment means within columns followed by the same letter are not significantly different at the 95% probability level (P<0.05).

Hard Red Spring Wheat Yield and Protein Response to Nitrogen Application, Northern Lincoln County

Mark Sheffels
with Aaron Esser, WSU Cooperative Extension

Objective:

Past research has shown that hard red spring wheat (HRSW) requires approximately 3.6 lbs N/bu to obtain 14% protein. The objective of this study was to examine the yield and protein of HRSW to increased rates of nitrogen application.

Study Location:

Location: about 5 miles west of Wilbur, WA.
Annual precipitation: 12 inches.
Soil type: Bagdad silt loam.
Previous crop: spring barley

Soil Test Results:

Soil pH = 6.3

Soil Depth	=	Moisture (inches/foot)	Sulfur (ppm)	Nitrogen (lb N/acre)
1’	=	2.57	6	64†
2’	=	2.36	-	10
3’	=	2.07	-	16
4’	=	2.27	-	
Total	=	9.27	6	90

† Includes the 37 lb N/acre estimated released from 1.9% organic matter and 14 lbs N/acre estimated released from NH_4.

Treatments and Operations:

Roundup® was applied 16 days prior to seeding at 16 oz/acre. ‘Westbred 333’ HRSW was seeded on April 19, 1999 at 70 lbs/acre. The trial was seeded with a Flexicoil 5000 direct seed drill with Anderson openers on 12-inch paired rows. Three rates of nitrogen, in the form of aqua, were applied 2 inches below the seed, and seventy-two pounds per acre of 16-20-0-14 dry starter fertilizer was applied with the seed. Nitrogen treatments were applied at 60, 90 and 120 lbs N/acre, and starter fertilizer was held constant over all 3 treatments. The trial was a randomized complete block design with 4 replications.

Nitrogen fertility treatment calculations:

		Lbs N for a potential yield of 50 bu/acre		
		3.0	3.6	4.2
Total N Needed		150	180	210
Cereal Straw Breakdown†	+	0	0	0
Organic Matter	-	37	37	37
Soil Test Results: NH_4 (1')	-	14	14	14
NO_3 (3')	-	39	39	39
Total N Applied	=	60	90	120

† No additional nitrogen was applied since cereal straw residue was not incorporated.

Agronomic Results:

There were no differences in plant population or tillers per plant within the 3 fertility treatments (Table 1). Over all 3 treatments, there was an average of 10.6 plants/ft^2 and 2.7 tillers/plant.

Applying 120 lbs N/acre on HRSW had significantly higher yield than applying only 60 lbs N/acre with a yield 42.1 bu/acre, compared to only 39.6 bu/acre (Table 2). Applying 90 lbs N/acre yielded 41.2 bu/acre, not significantly different from applying both 60 and 120 lbs N/acre. Percent protein content, like yield, has a big impact on the profitability of HRSW production. Each 30 lb/acre increment of nitrogen fertilizer significantly increased protein as the application of 60, 90 and 120 lbs N/acre had protein contents of 12.8, 13.6 and 14.3% respectively (Table 2).

The trial was fertilized at 3.0, 3.6 and 4.2 lbs of nitrogen for a potential yield of 50 bu/acre (Table 3). However, yield ranged from only 39.6 to 42.1 bu/acre. The actual rate of available nitrogen for a bushel of grain was 3.8, 4.4 and 5.0 lbs of nitrogen. Applying 5.0 lbs of nitrogen/bu was the only treatment to reach the desired 14% protein content, much higher than previous research has shown.

It should be noted that the surrounding field of HRSW was fertilized at a rate of 90 lbs N/acre and had a percent protein of 14.2%. The trial was harvested about 14 days later then the surrounding field, and during this period about 1 inch of precipitation fell and may of reduced percent protein on all three treatments.

Economic Results:

Applying 120 lbs N/acre had an estimated nitrogen fertilizer cost of $24.00/acre, but still produced significantly higher a gross economic return of $156.67/acre and significantly higher return above nitrogen fertilizer cost of $132.67/acre (Table 3). Applying 60 lbs N/acre had a nitrogen fertilizer cost of only $12.00/acre but had the lowest gross and net returns above nitrogen fertilizer cost of $120.19 and $108.19/acre. Applying 90 lbs N/acre had an estimated nitrogen fertilizer cost of $18.00/acre and produced a gross economic return of $147.27 and a return above nitrogen fertilizer cost of $123.27/acre.

HRSW vs. SWSW:

How many bushels of soft white spring wheat (SWSW) would it have take to make the same net return above seed and fertilizer costs as HRSW? This analysis assumes both classes of wheat are seeded at 80 lbs/acre and 60 lbs applied N/acre for SWSW. Table 5 summarizes the returns above seed and fertilizer costs of HRSW with varied rates of nitrogen.

Table 6 shows the estimated SWSW yields needed to have economic returns above seed and fertilizer costs equal to the 3 HRSW treatments. When 60 lbs N/acre was applied to both classes of wheat, the yield of HRSW is within 1 bu/acre of the estimated SWSW yield of 40.5 bu/acre to net the same economic returns. To have equal economic returns when 90 lbs N/acre was applied to HRSW, it would take an estimated 45.7 bu/acre of SWSW, over 4 bu/acre more than HRSW. When 120 lbs N/acre was applied to HRSW, an estimated 49.0 bu/acre of SWSW is needed, almost 7 bu/acre more than HRSW.

Figure 1 shows the mean yield between 1997 and 1999 of 4 commercial SWSW and HRSW varieties averaged over 3 locations in similar rainfall zones. Averaged over the 3 locations between 1997 and 1999, SWSW yielded an average of 56.2 bu/acre, or 7.2 bu/acre more than the 4 commercial HRSW varieties.

Conclusions:

Applying 120 lbs N/acre was the only treatment with greater than 14% protein content. Overall, higher nitrogen rates increased yield, protein, gross economic returns and returns above nitrogen fertilizer cost.

This study needed greater amounts of nitrogen fertilizer than previous research has shown to reach a desired protein content of 14%. Further research needs to continue to examine how many pound of nitrogen per bushel of grain is needed to consistently make protein in the northern Lincoln County area, and continue to examine the long-term economic feasibility of this class of wheat in this area. Further research also needs to look at protein content in regards to time of harvest and precipitation during maturity.

In this on-farm test applying 120 lbs N/acre was the most profitable treatment and it was estimated it would take an additional 7 bu/acre of SWSW to produce equal economic returns. Consequently, average yield between 1997-1999 for SWSW was 7 bu/acre more than HRSW at 3 locations in similar rainfall zones.

Agronomic Data:

Table 1. Plant population and tillers per plant with varied amounts of nitrogen application on HRSW in an on-farm test at Mark Sheffels' in 1999.

Treatment	Population (plants/ft^2)	Tiller Count (tiller/plant)
60 lbs N/acre	9.7 a†	3.0 a
90 lbs N/acre	11.2 a	2.8 a
120 lbs N/acre	10.9 a	2.3 a
LSD $_{(0.05)}$	3.1	1.6
CV	14.6%	34.1%

† Treatment means within columns followed by the same letter are not significantly different at the 95% probability level (P<0.05).

Table 2. Yield and protein of HRSW with varied amounts of nitrogen application in an on-farm test at Mark Sheffels' in 1999.

Treatment	Yield (bu/acre)	Protein (%)
60 lbs N/acre	39.6 b†	12.8 c
90 lbs N/acre	41.2 ab	13.6 b
120 lbs N/acre	42.1 a	14.3 a
LSD $_{(0.05)}$	1.4	0.4
CV	2.0%	1.9%

† Treatment means within columns followed by the same letter are not significantly different at the 95% probability level (P<0.05).

Table 3. Potential and actual nitrogen per bushel of grain in an on-farm test at Mark Sheffels' in 1999.

Treatment	Yield (bu/acre)	Total N Available	Lbs N/ Potential bu	Lbs N/ Actual bu
60 lbs N/acre	39.6	150	3.0	3.8
90 lbs N/acre	41.2	180	3.6	4.4
120 lbs N/acre	42.1	210	4.2	5.0

Economic Data:

Table 3. Gross and net returns above nitrogen costs per acre of HRSW in an on-farm test at Mark Sheffels' in 1999.

Treatment	Gross Return[†] ($/acre)	Nitrogen Costs[‡] ($/acre)	Return above N ($/acre)
60 lbs N/acre	$120.19 c[§]	$12.00	$108.19 c
90 lbs N/acre	$141.27 b	$18.00	$123.27 b
120 lbs N/acre	$156.67 a	$24.00	$132.67 a
LSD $_{(0.05)}$	$8.84		$8.84
CV	3.7%		4.2%

† Gross return was calculated using the FOB on September 14, 1999 at Ritzville Warehouse.
‡ Nitrogen costs was estimated at $0.20/lb of nitrogen.
§ Treatment means within columns followed by the same letter are not significantly different at the 95% probability level (*P*<0.05).

HRSW vs. SWSW:

Table 5. Returns above HRSW seed and nitrogen fertilizer costs in an on-farm test at Mark Sheffels' in 1999.

Treatments	Gross Return ($/acre)	HRSW Seed Costs ($/acre)	HRSW N Fert. Costs ($/acre)	Return Above Cost ($/acre)[†]
60 lbs N/acre	$120.19	$12.80	$12.00	$95.39
90 lbs N/acre	$141.27	$12.80	$18.00	$110.47
120 lbs N/acre	$156.67	$12.80	$24.00	$119.87

† Return above nitrogen fertilizer and seed costs only.

Table 6. Estimated soft white spring wheat yield needed to have economic returns above seed and nitrogen fertilizer costs equal to 3 HRSW treatments with varied nitrogen in an on-farm test at Mark Sheffels' in 1999.

Treatments	HRSW Yield (bu/acre)	Return Above Costs ($/acre)	Estimated SWSW Yield (bu/acre)[†]
60 lbs N/acre	39.6	$95.39	40.5
90 lbs N/acre	41.2	$110.47	45.7
120 lbs N/acre	42.1	$119.87	49.0

† Assumes a SWSW seed cost of $9.60/acre and a selling price of $2.89/bu, the FOB price at Ritzville Warehouse on September 15, 1999. This calculation also assumes 60 lbs applied N/acre for SWSW and equal seeding rates for both wheat classes.

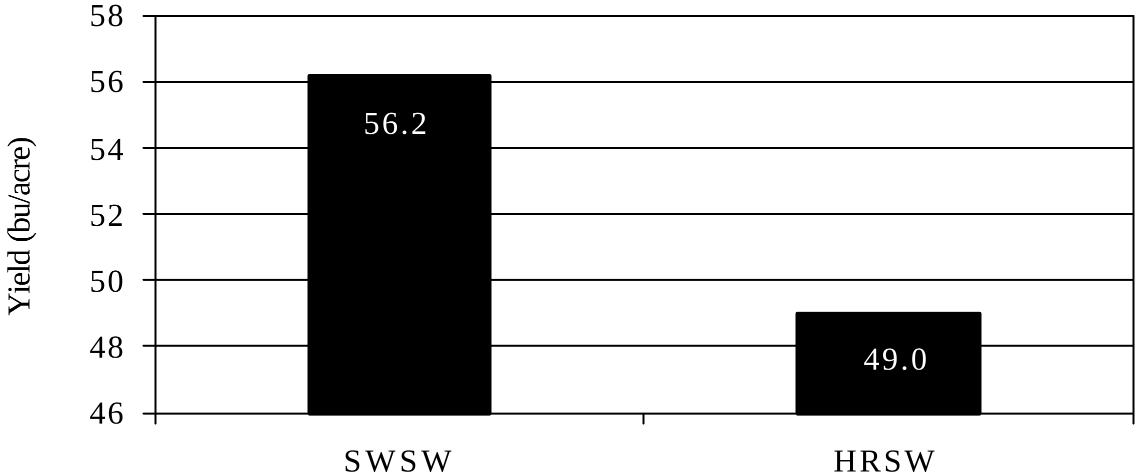

Figure 1. Mean yield between 1997 and 1999 of 4 commercial SWSW and HRSW varieties averaged over 3 locations in 11-15” average rainfall zones. Source: Washington State University variety testing program (http://variety.wsu.edu).

Hard Red Spring Wheat Yield and Protein Response to Sulfur Application, Adams County

Jerry and Les Snyder
with Aaron Esser, WSU Cooperative Extension

Objective:

Sulfur has long been recognized as essential for wheat growth, however, little research has looked at sulfur application and its relationship with protein management in hard red spring wheat (HRSW) production. The objective of this study was to examine the yield and protein of HRSW to increase rates of sulfur application.

Study Location:

Location: about 8 miles southeast of Ralston, WA.
Annual precipitation: 11-12 inches.
Soil type: Ritzville silt loam.
Previous crop: spring barley.

Soil Test Results:

Soil pH = 6.6

Soil Depth	=	Moisture (inches/foot)	Sulfur (ppm)	Nitrogen (lb N/acre)
1’	=	1.81	8	39†
2’	=	1.65	-	7
3’	=	1.34	-	3
4’	=	1.22	-	-
Total	=	6.02	8	49

† Includes the 22 lb N/acre estimated N released from 1.1% organic matter and 10 lb/acre estimated N released from NH_4.

The University of Idaho Northern Idaho Fertilizer Guide for Spring Wheat (CIS 921) reports a soil testing less than 10 ppm SO_4-S should receive 15 to 20 lb S/acre.

Treatments and Operations:

Roundup® was applied 10 days prior to seeding at 16 oz/acre. ‘Laura’ HRSW was seeded on March 26, 1999 at 80 lb/acre. The trail was seeded with a McGregor direct seed drill with 12-inch row spacing. Nitrogen, in the form of aqua, and sulfur, in the form of thiosul, was applied 5 inches below the seed with a Yetter coulter. Liquid phosphorus was applied with the seed at a rate of 15 lb/acre on all treatments. The trial was a randomized complete block design with 4 replications.

Fertility treatments are as follows:

Treatment	Nitrogen (lb/acre)	Sulfur (lb/acre)	N:S Ratio
T-1	55	10	5.5 : 1
T-2	55	15	3.7 : 1
T-3	55	20	2.8 : 1

Agronomic and Economic Results:

The trial was uniform in both plant populations and tillers per plant (Table 1). Overall there was an average of 10.6 plants/ft^2 and 2.7 tillers/plant. There was also no significant difference in seed yield and protein with 10, 15 or 20 lb applied sulfur/acre (Table 2). Seed yield averaged 22.7 bu/acre and protein averaged 13.4%. Seed quality was also not significantly effected by sulfur application as test weight averaged 60.3 lb/bu (data not shown).

Gross net returns were estimated at $75.01/acre for all three treatments and net returns above sulfur was $72.51, $71.26 and $70.01/acre with the application of 10, 15 and 20 lb S/acre.

Conclusions:

Although there was no significant differences among all three treatments, there was a trend for greater yield and protein with increased sulfur application and requires further investigation.

Agronomic Data:

Table 1. Plant population and tillers per plant with varied amounts of sulfur application on HRSW in an on-farm test at Jerry and Les Snyder's in 1999.

Treatment	Population (plants/ft^2)	Tiller Count (tiller/plant)
T-1	9.7	3.0
T-2	11.2	2.8
T-3	10.9	2.3
LSD $_{(0.05)}$	3.1	1.6
CV	14.6%	34.1%

Table 2. Yield and protein of HRSW with varied amounts of sulfur application in an on-farm test at Jerry and Les Snyder's in 1999.

Treatment	Yield (bu/acre)	Protein (%)
T-1	21.7	13.1
T-2	22.4	13.7
T-3	23.9	13.4
LSD $_{(0.05)}$	1.6†	0.6†
CV	4.1%	2.5%

† Means were not significantly different at the P<0.05 level.

Economic Data:

Table 3. Gross and net returns above sulfur costs per acre of HRSW in an on-farm test at Jerry and Les Snyder's in 1999.

Treatment	Gross Return† ($/acre)	Return above S ‡ ($/acre)
T-1	$75.01	$72.51
T-2	$75.01	$71.26
T-3	$75.01	$70.01

† Gross return was calculated using the FOB on August 9, 1999 at Ritzville Warehouse.
‡ Returns above sulfur was estimated using a cost of $0.25/lb of sulfur.

Direct Seeded Hard Red Spring Wheat Variety Trial, Southern Adams County

LeRoy Watson
with Aaron Esser, WSU Cooperative Extension

Objective:

The objective of this research was to examine four direct seeded hard red spring wheat (HRSW) varieties for yield, protein and profitability in southern Adams County.

Study Location:

Location: about 15 miles south of Lind, WA.
Annual precipitation: 7-10 inches.
Soil type: Ritzville silt loam.
Previous crops: 19 bu 'Alpowa' spring wheat (1998), CRP (1997).

Soil Test Results:

Soil pH = 7.1

Soil Depth	=	Moisture (inches/foot)	Sulfur (ppm)	Phosphorous	Nitrogen (lbs N/acre)
1'	=	1.97	3	12	56†
2'	=	1.41	-	-	38
3'	=	0.86	-	-	03
4'	=	0.53	-	-	-
Total	=	4.77	3	12	97

† Includes the 29 lbs N/acre estimated N released from 1.17 % organic matter and 12 lbs/acre estimated N released from NH_4.

Treatments and Operations:

Roundup® was applied at 14oz/acre 17 days prior to planting. HRSW was seeded on March 30, 1999 with a JD 750 direct seed drill with 71/2-inch row spacing. All varieties were seeded at 80 lb/acre, and a depth of approximately 2-inches. Anhydrous ammonia fertilizer, applied at 45 lb N/acre, was placed below the seed. Liquid sulfur and phosphorous was applied at a rate of 6 and 10 lb/acre each with the seed. The study was a randomized complete block design with 4 replications. The four HRSW varieties are as follows:

1. 'Kulm'
2. 'Scarlet'
3. 'Spillman'
4. 'Westbred 926'

Agronomic Results:

Cold spring conditions delayed emergence and early growth and development of all 4 HRSW varieties in the on-farm test (Table 1). Overall, Westbred 926 appeared to be more frost sensitive as it had significantly lower stand establishment with only 8.2 plants/ft^2. There was no difference in stand establishment between Kulm, Scarlet and Spillman with 14.8, 12.0 and 13.2 plants/ft^2. Cold conditions also appeared to reduce the number of tillers, however, Westbred 926 and Scarlet, 2.5 and 2.3 tillers/plant, had significantly more tillers than Kulm with only 1.8 tillers/plant. There was no difference it tillers between Spillman, 2.1 tillers/plant, and the other 3 HRSW varieties.

Overall, Spillman had the greatest yield in the on-farm test with 21.8 bu/acre, significantly greater than the other three HRSW wheat varieties (Table 2). Scarlet also had a greater yield than both Kulm and Westbred 926 with 19.2 bu/acre. There was no significant difference in yield between Kulm, 14.9 bu/acre, and Westbred 926, 14.3 bu/acre.

End use quality is very important for profitable HRSW wheat production (Table 3). Westbred 926 had the greatest protein content with 16.4%. Kulm had a protein content of 16.1%, significantly greater than Scarlet with 15.9% protein. Spillman had the lowest protein content at only 15.2%. Spillman also had lower test weight than both Kulm and Scarlet with only 57.3 lb/bu Kulm had the heaviest test weight at 58.4 lb/bu, and Scarlet had a test weight of 57.8 lb/bu Westbred 926 had a test weight of 57.4 lb/bu, not significantly different from Scarlet and Spillman.

Economic Results:

Overall, Spillman and Scarlet had the lowest market price at only $3.95/bu and $4.16/bu, but they had significantly higher gross return than both Kulm and Westbred 926 at $86.78/acre and $79.82/acre respectively. Kulm had a market price of $4.23/bu and Westbred 926 had a market price of $4.32, however, there was no significant difference in gross return at $63.15/acre and $61.78/acre.

HRSW vs. SWSW:

How many bushels of soft white spring wheat (SWSW) would it have taken to make the same net return above seed cost as HRSW? In this analysis it assumes an equal seeding rate and fertilizer treatments. Seed cost was estimated at $16.00/cwt wt for all 4 HRSW varieties (Table 5), and SWSW seed was estimated at only $12.00/cwt wt. The market price for SWSW was $2.89/bu at Ritzville Warehouse’s on September 14, 1999.

Overall, it would of taken an estimated 7 bu/acre more SWSW to produce the same net return above seed cost as each of the 4 HWSW varieties (Table 6). Spillman and Scarlet had a yield of 21.and 19.2 bu/acre, and it would take approximately 28.7 and 26.5 bu/acre of SWSW. Only 20.8 and 20.3 bu/acre of SWSW would be required to produce the same net return above seed cost as Kulm and Westbred 926, which yielded 14.9 and 14.3 bu/acre.

Conclusions:

Much like other cereal grains produced in the dryland area, variety selection is very important for profitability of HRSW production. Overall, Spillman and Scarlet were higher yielding than Kulm and Westbred 926 and they ultimately had higher gross economic returns. Protein is also very important part of the equation for HWSW profitability, however Westbred 926 and Kulm had very good protein content, but still had less gross economic returns due to reduced yields.

Agronomic Data:

Table 1. Stand establishment and tillers per plant of four varieties of direct seeded HRSW in an on-farm test at LeRoy Watson's in 1999.

Treatments	Establishment (plants/ft^2)	Tillers (tillers/plant)
Kulm	14.8 a†	1.8 b
Scarlet	12.0 a	2.3 a
Spillman	13.2 a	2.1 ab
Westbred 926	8.2 b	2.5 a
LSD $_{(0.05)}$	4.8	0.5
CV	24.7%	10.8%

† Treatment means within columns followed by the same letter are not significantly different at the 95% probability level (*P*<0.05).

Table 2. Yield (bu/acre) of four varieties of direct seeded HRSW in an on-farm test at LeRoy Watson's in 1999.

Treatments	Rep I	Rep II	Rep III	Rep IV	Average
Kulm	15.3	14.5	14.1	15.8	14.9 c†
Scarlet	19.5	17.8	19.5	19.9	19.2 b
Spillman	24.1	21.2	22.4	19.5	21.8 a
Westbred 926	15.3	14.1	13.7	14.1	14.3 c
LSD $_{(0.05)}$					1.8
CV					4.7%

† Treatment means within columns followed by the same letter are not significantly different at the 95% probability level (*P*<0.05).

Table 3. Seed quality, protein and test weight, of four varieties of direct seeded HRSW in an on-farm test at LeRoy Watson's in 1999.

Treatments	Protein (%)	Test Weight (lb/bu)
Kulm	16.1 b[†]	58.4 a
Scarlet	15.9 c	57.8 b
Spillman	15.2 d	57.3 c
Westbred 926	16.4 a	57.4 bc
LSD $_{(0.05)}$	0.3	0.4
CV	0.8%	0.4%

[†] Treatment means within columns followed by the same letter are not significantly different at the 95% probability level (P<0.05).

Economic Data:

Table 4. Yield, protein, market price and gross return of four HRSW wheat varieties in an on-farm test at LeRoy Watson's in 1999.

Treatments	Yield (bu/acre)	Protein (%)	Price ($/bu)[†]	Gross Return ($/acre)
Kulm	14.9	16.1	$4.23	$63.15 b
Scarlet	19.2	15.9	$4.16	$79.82 a
Spillman	21.8	15.2	$3.95	$86.03 a
Westbred 926	14.3	16.4	$4.32	$61.78 b
LSD $_{(0.05)}$				$6.95
CV				4.3%

[†] The FOB market price for specific HRSW protein content at Ritzville Warehouse on September 14, 1999.

HRSW vs. SWSW:

Table 5. Returns above HRSW seed cost in an on-farm test at LeRoy Watson's in 1999.

Treatments	Gross Return ($/acre)	Estimated HRSW Seed Cost ($/acre)†	Return Above HRSW Seed Cost ($/acre)
Kulm	$63.15	$12.80	$50.35
Scarlet	$79.82	$12.80	$67.02
Spillman	$86.03	$12.80	$73.23
Westbred 926	$61.78	$12.80	$48.98

† This calculation assumes all four HRSW seed varieties have the same seed cost.

Table 6. Estimated SWSW yield needed to have economic returns above seed costs equal to four HRSW wheat varieties in an on-farm test at LeRoy Watson's in 1999.

Treatments	HRSW Yield (bu/acre)	Return Above HRSW Seed Costs ($/acre)	Estimated SWSW Yield (bu/acre)†
Kulm	14.9	$50.35	20.7
Scarlet	19.2	$67.02	26.5
Spillman	21.8	$73.23	28.7
Westbred 926	14.3	$48.98	20.3

† Assumes a SWSW seed cost of $9.60/acre and a selling price of $2.89/bu, the FOB price at Ritzville Warehouse on September 15, 1999. This calculation also assumes equal seeding and fertilizer rates for both classes of wheat.

Hard Red Spring Wheat Conclusions

By Aaron Esser

Fall applied fertilizer did not greatly increase the amount of available fertilizer in the 2nd and 3rd foot in the soil in these on-farm tests, and consequently, did not appear to positively impact yield, protein and economic returns in HRSW production in 1999. On the whole, very little of the fall applied fertilizer was accounted for in spring soil samples when nitrogen was applied in November and December and the bulk of the nitrogen accounted for remained in the 1st foot in the soil profile. At the location near Benge, over 67% of the fall-applied fertilizer was unaccounted for. Most of the nitrogen that was accounted for was in the form of NH_4 (ammonium nitrate) in the 1st foot. Only an additional 3-lb NO_3-N/acre (nitrate) was available in the 2nd and 3rd foot when fertilizer was applied in the fall. At the location near Lind, applying 42 lb N/acre in the fall increased the total available nitrogen in the spring of the year by only 17 lb N/acre. The fall-applied fertilizer that was accounted for was mostly in the form of NH_4 nitrogen in the first foot (13 lb additional N/acre). An additional 6 lb N/acre was available in the form of NO_3 in the third foot, and there was no additional available nitrogen in the first and second foot in the form of NO_3. One potential reason for the large amount of nitrogen unaccounted for at these locations may be in the soil sampling procedure used in the spring of the year given the conditions. Late fall fertilization combined with cold soil conditions in the spring of the year restricted fertilizer movement both vertically and horizontally in the soil profile. A systematic soil sampling method (Figure 1), as defined in the University of Idaho Extension Publication 704, was used which takes soil samples (20 soil cores to form a composite sample) perpendicular to the band row beginning in the edge of the adjacent band. A more appropriate spring soil sampling method may have been to pull soil cores only from the shank marks or use a random sampling method taking 40 to 60 random soil cores to form a composite sample.

At the location near Ritzville when nitrogen fertilization was earlier in the fall, all but 9 lb N/acre was unaccounted for between the spring and fall soil sampling using the systematic soil sampling method. Most of the fall-applied fertilizer was still accounted for in the form of NH_4 in the first foot (47 lb N/acre). An additional 6 lb N/acre was available in the form of NO_3 in the top foot, and only an additional 3 lb N/acre was present in the second and third foot.

<u>How much nitrogen is needed for profitable HRSW production?</u>

Under similar market price structures, do not reduce the amount of nitrogen and sulfur fertilizer with HRSW production. On-farm tests yield potentials were not achieved in most cases, therefore, greater than recommended fertilizer was available, and protein levels were still below the goal of 14% with all treatments in three of the on-farm tests. However, in all the on-farm tests, the higher rates of inputs were more economical or were not less economical than lower inputs. For example, the trial near Wilbur was fertilized at 3.0, 3.6 and 4.2 lb of nitrogen for a potential yield of 50 bu/acre. However, yield ranged from only 39.6 to 42.1 bu/acre. The actual rate of available nitrogen for a bushel of grain was 3.8, 4.4 and 5.0 lb of nitrogen (Table 1). Applying 5.0 lb of nitrogen/bu was the only treatment to reach the desired 14% protein content, much higher than previous research has shown.

Field Selection:

Field selection and proper soil sampling is very important in HRSW production. Proper soil sampling may be more economically feasible than applying fall nitrogen fertilizer and relying on fall and early spring moisture to move nitrogen into the soil profile. For example, select fields with large amounts of available nitrogen in the 2nd and 3rd foot. If two fields both have 75 lb N/acre available but field A has only 13 lb N/acre available in the 2nd and 3rd foot and field B has 32 lb N/acre available, field B may be more desirable for profitable HRSW production without fall fertilization.

Soil sampling is also important following HRSW production. With increased nitrogen application, there is a greater chance to have a larger amount of available nitrogen after HRSW, and rates for following crops should be adjusted accordingly. It should also be important to monitor where the nitrogen is at in the soil profile and choose crops according to their ability to utilize nitrogen deeper in the soil profile.

Profitable HRSW Production:

Profitability between HRSW and SWSW will depend greatly on the market price differential between the 2 classes of wheat and the HRSW protein premium/discount. Variety selection is also very important in profitable HRSW production. At the current protein premiums/discounts selecting a variety with greater yield potential with good protein content can be more profitable than a variety with lower yield potentials but high protein content. For example at the trial in southern Adams County, 14 bu/acre ‘Kulm’ would require a 19.9% protein content to have the same gross return ($80/acre) as the variety ‘Scarlet’ that yielded 19 bu/acre and 15.9% protein.

Summary for Profitable HRSW production:

1. Timely harvest to reduce weather risk.
2. Understand the market price differential between HRSW and SWW.
3. Understand protein premiums/discounts and make management decisions accordingly.
    - There is less risk associated with top-dressing for higher protein content with high premiums/discounts.
4. Choose a variety that has performed well in your area, and remember protein content is important but it is often difficult to beat yield.
5. Proper soil sampling prior to and after HRSW.
6. Do not use reduced rates of N and S fertilizer. Additional fertilizer will not guarantee protein contents of 14%, but, on-farm tests in 1999 showed that the additional investment was recovered with greater yields and increased protein contents

Table 1. Potential and actual nitrogen required per bushel of HRSW at a 50 bu/acre yield potential in an on-farm test near Wilbur, WA in 1999.

Treatment	Potential N required (lb/acre)	Yield (bu/acre)	Lb Available Nitrogen/bu†	Percent Protein
60 lb Applied N/acre	3.0	39.6	3.8	12.8
90 lb Applied N/acre	3.6	41.2	4.4	13.6
120 lb Applied N/acre	4.2	42.1	5.0	14.3

† Calculation does not consider nitrogen remaining after harvest.

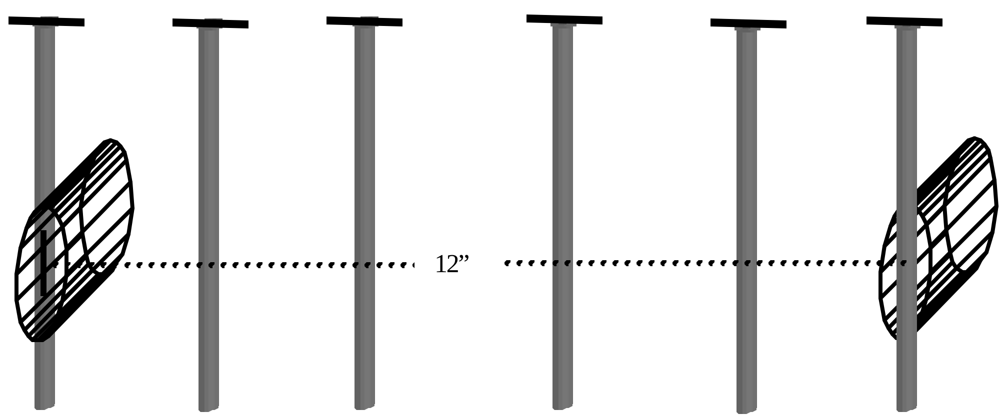

Figure 1. Systematic soil sampling method in a field where fertilizer had been banded with 12-inch shank spaces. Source: Soil Sampling, University of Idaho, Bulletin 704.

Figure 2. Understanding both the agronomic and economic factors is important with hard red spring wheat production.

Hard White Spring Wheat Yield and Protein Response to Nitrogen Application, Lincoln County

Loren Houger
with Aaron Esser, WSU Cooperative Extension

Objective:

Little research has been done on hard white spring wheat (HWSW), and like other classes of wheat, the marketability and market price structure will depend on protein content. The objective of this study was to examine the yield and protein of HWSW to increase rates of nitrogen application.

Study Location:

Location: about 2 miles west of Creston, WA.
Annual precipitation: 12-15 inches.
Soil type: silt loam

Soil Test Results:

Soil pH = 6.4

Soil Depth	=	Moisture (inches/foot)	Sulfur (ppm)	Nitrogen (lb N/acre)
1’	=	3.64	18	78†
2’	=	3.57	-	7
3’	=	2.83	-	7
4’	=	2.28	-	
Total	=	12.32	6	92

† Includes 47 lbs. N/acre estimated released from 2.4% organic matter and 19 lbs. N/acre estimated released from NH_4.

Treatments and Operations:

Three rates of nitrogen: 60, 90 and 120 lbs. applied N/acre, were calculated at 2.4, 3.0 and 3.6 lbs. N/potential bushel using the soil sample results and a potential yield of 50 bu/acre. Aqua was shanked in 5 inches with a field cultivator 1-week prior to seeding, and 10-10-0-12 liquid starter fertilizer was applied with the seed. Starter fertilizer was held constant over all 3 treatments. ‘ID 377S’ HWSW was seeded on April 21, 1999 at 75 lbs./acre. The trail was seeded with International hoe drills with 10-inch roe spacing. The trial was a randomized complete block design with 4 replications.

Nitrogen fertility treatment calculations:

		Lbs. N for a potential yield of 50 bu/acre		
		2.4	3.0	3.6
Total N Needed		120	150	180
Cereal Straw Breakdown†	+	30	30	30
Organic Matter	-	47	47	47
Soil Test Results: NH_4 (1')	-	19	19	19
NO_3 (3')	-	24	24	24
Total N Applied	=	60	90	120

† Additional nitrogen was applied since cereal straw residue was incorporated.

Agronomic Results:

There were no differences in plant population or tillers per plant within any of the 3 fertility treatments (Table 1). Over all 3 treatments, there was an average of 14.7 plants/ft^2 and 2.4 tillers/plant.

Applying each increment of 30 lbs. N/acre significantly increased seed yield and protein (Table 2). Applying 120 lbs. N/acre on DNS yielded 54.2 bu/acre, compared to only 50.9 and 46.1 bu/acre when 90 and 60 lbs. N/acre was applied. Protein content was 10.7, 9.6 and 8.5% protein when nitrogen was applied at 120, 90 and 60 lbs./acre

The trial was fertilized at 2.4, 3.0 and 3.6 lbs. of nitrogen for a potential yield of 50 bu./acre (Table 3). Actual yield was close to the potential yield, as it took 2.6, 2.9 and 3.3 lbs. of nitrogen (less residual nitrogen remaining after harvest) for each bushel of grain.

Economic Results:

Nitrogen fertilizer cost was estimated at $0.20 lb of nitrogen, and total nitrogen cost was estimated at $12.00, $18.00 and $24.00/acre when nitrogen was applied at 60, 90 and 120 lbs. N/acre (Table 4). Overall, gross return and net return above nitrogen cost can not be calculated at this time as the market price for each protein content has not yet been determined.

HRSW vs. SWSW vs. HWSW:

In an 11-15" precipitation zone between 1998 and 1999, the mean yield of 4 varieties of DNS has yielded 2.4 bu/acre more than the mean yield of 4 common commercial varieties soft white spring wheat (HWSW) and almost 8 bu/acre more than 4 common commercial varieties of hard red spring wheat (HRSW). This data is presented in Figure 1.

Conclusions:

Hard white spring wheat yield and protein increased with higher rates of nitrogen fertilizer and higher rates of nitrogen did not effect stand establishment or tillers/plant. Yield potential was reached with 90 lbs. N/acre and was succeeded with the application of 120 lbs./acre, but protein levels were still far below anticipated levels even with the high rate of nitrogen application.

Agronomic Data:

Table 1. Plant population and tillers per plant with varied amounts of nitrogen application on HWSW in an on-farm test at Loren Houger's in 1999.

Treatment	Population (plants/ft^2)	Tiller Count (tiller/plant)
60 lbs. N/acre	19.6	2.1
90 lbs. N/acre	21.4	2.6
120 lbs. N/acre	22.1	2.5
LSD $_{(0.05)}$	n.s.	n.s.
CV	18.3%	27.4%

† Treatment means within columns followed by the same letter are not significantly different at the 95% probability level (*P*<0.05).

Table 2. Yield and protein of HWSW with varied amounts of nitrogen application in an on-farm test at Loren Houger's in 1999.

Treatment	Yield (bu./acre)	Protein (%)
60 lbs. N/acre	46.2 c†	8.5 c
90 lbs. N/acre	50.9 b	9.6 b
120 lbs. N/acre	54.1 a	10.7 a
LSD $_{(0.05)}$	1.5	0.6
CV	1.7%	3.4%

† Treatment means within columns followed by the same letter are not significantly different at the 95% probability level (*P*<0.05).

Table 3. Potential and actual nitrogen per bushel of grain in an on-farm test at Loren Houger's in 1999.

Treatment	Yield (bu./acre)	Total N Available	Lbs. N/ Potential bu.	Lbs. N/ Actual bu.†
60 lbs. N/acre	46.2	120	2.4	2.6
90 lbs. N/acre	50.9	150	3.0	2.9
120 lbs. N/acre	54.1	180	3.6	3.3

† Residual nitrogen after harvest is not considered.

Economic Data:

Table 3. Estimated nitrogen cost per acre for HWSW in an on-farm test at Loren Houger's in 1999.

Treatment	Nitrogen Cost† ($/acre)
60 lbs. N/acre	$12.00
90 lbs. N/acre	$18.00
120 lbs. N/acre	$24.00

† Nitrogen costs was estimated at $0.20/lb. of nitrogen.

HWSW, SWSW and HRSW Data:

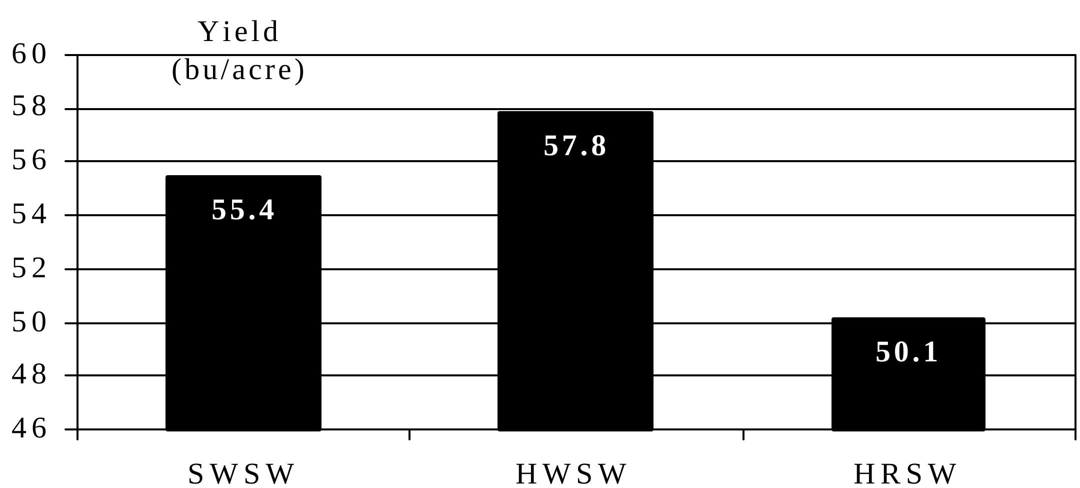

Figure 1. Mean yield between 1998 and 1999 of 4 commercial SWSW and HRSW varieties and 4 varieties of HWSW averaged over 3 locations in 11-15" average rainfall zones. Source: Washington State University variety testing program (http://variety.wsu.edu).

Increased Seeding Rates in Direct Seeded Barley, Northern Lincoln County

Rick Brunner
with Aaron Esser, WSU Cooperative Extension

Objective:

The objective of this study was to examine the impact on stand establishment, tillers per plant and yield with increased seeding rates in direct seeded spring barley.

Study Location:

Location: about 6 miles north of Almira, WA.
Annual precipitation: 12-14 inches.
Soil type: Bagdad silt loam.
Previous crop: winter wheat.

Treatments and Operations:

Baroness spring barley was seeded on April 27, 1999 at 70, 80 and 90 lbs./acre. Roundup® was applied 10 days prior to seeding at 14 oz/acre. The trail was seeded with a Conserva Pak® direct seed hoe-type drill with 12-inch row spacing. Nitrogen and sulfur, in the form of solution 32 was applied 2 inches below the seed at 70 lb N/acre and 10 lb S/acre. An additional dry blend starter fertilizer was applied with the seed at a rate of 3.6 lb N/acre, 6 lb S/acre, 12 lb P/acre and a trace of B and Zn. The trial was a randomized complete block design with 4 replications.

Agronomic and Economic Results:

Increased seeding rate increased stand establishment but did not significantly effect tillers per plant (Table 1). Overall, seeding at 70 lb/acre produced 10 plants/ft^2, significantly less than the 13.8 plants/ft^2 when the barley was seeded at 90 lb/acre. Seeding at 80 lb/acre produced 12.1 plants/ft^2, which was not significantly different from stands established seeding at both 70 and 90 lb/acre. Only 3 replications were harvested. Increased seeding rates did not increase seed yield (Table 2). Seed yield averaged 1.68 ton/acre.

Gross net returns were calculated using $75/ton, the FOB price at Ritzville Warehouse on September 15, 1999. Net returns above Baroness seed cost were calculated using a seed cost of $0.148/lb. Gross return was estimated at $126.00/acre for all three treatments, and net returns above seed cost was $115.65, $114.16 and $112.68/acre with a seeding rate of 70, 80 and 90 lb/acre.

Conclusions:

Increased seeding rate improved stand establishment of Baroness spring barley; however, increased stand establishment had no significant effect on seed yield at this trial in 1999. Further investigation is needed to see if similar results can be obtained over years.

Agronomic Data:

Table 1. Baroness barley plant population and tillers per plant with varied seeding rates in an on-farm test at Rick Brunner's in 1999. The trial was seeded with a Conserva Pak® direct seed drill with 12-inch row spacing.

Treatment	Population (plants/ft^2)	Tiller Count (tiller/plant)
70 lbs./acre	10.0 b†	4.7 a
80 lbs./acre	12.1 ab	3.8 a
90 lbs./acre	13.8 a	4.0 a
LSD $_{(0.05)}$	2.2	1.4
CV	26.2%	47.9%

† Treatment means within columns followed by the same letter are not significantly different at the 95% probability level (*P*<0.05).

Table 2. Baroness barley yield (tons/acre) with varied seeding rates in an on-farm test at Rick Brunner's in 1999. The trial was seeded with a Conserva Pak® direct seed drill with 12-inch row spacing.

Treatment	Rep I	Rep II	Rep III	Mean
70 lbs./acre	1.65	1.64	1.72	1.67 a†
80 lbs./acre	1.74	1.65	1.65	1.68 a
90 lbs./acre	1.64	1.63	1.78	1.68 a
LSD $_{(0.05)}$				0.12
CV				7.4%

† Treatment means within columns followed by the same letter are not significantly different at the 95% probability level (*P*<0.05).

Economic Data:

Table 3. Gross and net returns above Baroness barley seed costs per acre in an on-farm test at Rick Brunner's in 1999. The trial was seeded with a Conserva Pak® direct seed drill with 12-inch row spacing.

Treatment	Gross Return ($/acre)†	Return above Seed Cost ($/acre) ‡
70 lbs./acre	$126.00	$115.65
80 lbs./acre	$126.00	$114.16
90 lbs./acre	$126.00	$112.68

† Gross return was calculated using the FOB on September 15, 1999 at Ritzville Warehouse.
‡ Returns above Baroness seed cost was estimated using a cost of $0.148/lb of seed.

Increasing Rates of Nitrogen in Direct Seeded Spring Barley, Northern Lincoln County

Tim and Dennis Herdrick
with Aaron Esser, WSU Cooperative Extension

Objective:

The objective of this study was to further examine increasing rates of nitrogen's effect on seed yield and overall profitability in direct seeded spring barley. A similar study was completed in 1998.

Study Location:

Location: about 12 miles northwest of Wilbur, WA.
Annual precipitation: 12 inches.
Soil type: Bagdad silt loam.
Previous crop: spring barley.

Soil Test Results:

Soil pH = 6.4

Soil Depth	=	Moisture (inches/foot)	Sulfur (ppm)	Nitrogen (lb N/acre)
1'	=	2.18	9	85†
2'	=	2.11	7	20
3'	=	1.94	10	16
4'	=	1.97	-	10
Total	=	8.20	26	131

† Includes the 42 lb N/acre estimated released from 2.1% organic matter and 17 lbs. N/acre estimated released from NH_4.

Treatments and Operations:

Roundup® was applied 12 days prior to seeding at 14 oz/acre. Baroness spring barley was seeded on April 23, 1999 at 80 lbs./acre. The trial was seeded with a Flexicoil 820 direct seed drill with Stealth® openers on 9-inch paired rows. Three rates of nitrogen, in the form of Solution 32, were applied 2 inches below the seed, and 50 pounds per acre of 16-20-0-14 dry starter fertilizer was applied with the seed. An additional 7 lbs S and P/acre was applied with the Solution 32. Nitrogen treatments were applied at 50, 70 and 90 lbs. N/acre, and starter fertilizer was held constant over all 3 treatments. The trial was a randomized complete block design with 4 replications.

Agronomic Results:

There were no differences in plant population or tillers per plant within the 3 fertility treatments (Table 1). Over all 3 treatments, there was an average of 7.4 plants/ft^2 and 6.6 tillers/plant. Yield data was not collected on this trial because of severe hail damage. In 1998, similar plant population and tillers/plant results were obtained with the application of 50, 70 and 90 lbs. N/acre, and yield was not significantly increased, averaging 1.73 tons/acre.

Conclusions:

Further data needs to be collected on direct seed nitrogen fertilization in spring barley. Current spring barley fertilizer guides were developed using conventional broadcast fertilization and planting methods that involved incorporating cereal straw that requires additional nitrogen for breakdown. For example, one ton of residue is produced for about each 20 bu of wheat or 1,400 lb of barley grain produced, and 1 ton of residue requires and additional 15 lbs. N/acre for cereal straw breakdown. In a direct seed system cereal residue is unincorporated, and fertilizer is often placed near the seed, potentially more available to the crop.

Agronomic Data:

Table 1. Plant population and tillers per plant with varied amounts of nitrogen application on direct seed spring barley in an on-farm test at Tim and Dennis Herdrick's in 1999.

Treatment	Population (plants/ft^2)	Tiller Count (tiller/plant)
60 lbs. N/acre	7.0 a†	6.4 a
90 lbs. N/acre	7.6 a	6.8 a
120 lbs. N/acre	7.7 a	6.7 a
$LSD_{(0.05)}$	1.8	4.4
CV	13.8%	38.3%

† Treatment means within columns followed by the same letter are not significantly different at the 95% probability level ($P<0.05$).

Nitrogen Fertilizer for Direct Seeded Yellow Mustard, Lincoln County

Rob Dewald
with Aaron Esser, WSU Cooperative Extension

Objective:

The objective of this research was to examine nitrogen rates for effect on seed yield and profitability of direct seeded yellow mustard.

Study Location:

Location: About 5 miles north of Davenport, WA.
Annual precipitation: 13-15 inches.
Soil type: silt loam.

Treatments and Operations:

Roundup® was applied prior to seeding. Yellow mustard was seeded on May 11, 1999 with a McGregor direct seed drill with 12-inch row spacing. Yellow mustard was seeded at a rate of 12 lb/acre, and a depth of approximately 1-inches. Anhydrous ammonia fertilizer was placed 2-inches below the seed. Liquid sulfur and phosphorous was applied at a rate of 10 lb/acre each for all treatments. The study was a randomized complete block design with 4 replications. Fertility treatments are as follows:

Treatment	N Applied (lb/acre)
T-1	70
T-2	90
T-3	110

Results and Conclusions:

There was no significant difference in seed yield with the application of 70, 90 and 110 lbs N/acre (Table 1). Yield averaged 729 lbs/acre.

Economic returns were calculated using a market price of $0.105/lb and a nitrogen cost of $0.18/lb (Table 2). Gross economic return was estimated at 76.55/acre for all three treatments. Applying 70 lb/acre of nitrogen produced returns above nitrogen fertilizer cost of $63.95/acre. Applying 90 and 110 lb N/acre of nitrogen fertilizer had returns above nitrogen fertilizer cost of $60.35 and $56.75/acre, respectively.

Agronomic Data:

Table 1. Yield (lb/acre) of direct seeded yellow mustard produced with the application of 70, 90 and 110 lb/acre of nitrogen in an on-farm test at Rob and John Dewald's Davenport farm in 1999.

Treatments	Rep I	Rep II	Rep III	Rep IV	Average
T-1	709	566	700	868	711 a[†]
T-2	610	703	761	804	719 a
T-3	502	732	793	1005	758 a
LSD $_{(0.05)}$					169
CV					13.4%

[†] Treatment means within columns followed by the same letter are not significantly different at the 95% probability level (*P*<0.05).

Economic Data:

Table 3. Returns above nitrogen fertilizer cost of applying 50, 70, and 90 lb N/acre on direct seeded yellow mustard in an on-farm test at Rob and John Dewald's Davenport farm in 1999.

Treatments	Gross Returns @ $10.5/bu[†]	Net Cost of N Fertilizer @ 18 cents/lb of N	Returns above N Fertilizer Cost
T-1	$76.55	$12.60	$63.95
T-2	$76.55	$16.20	$60.35
T-3	$76.55	$19.80	$56.75

Wild Oat Populations in Direct Seed and Conventional Planted Spring Barley, Northern Lincoln County

Rick and Roxanne Jones
with Aaron Esser, WSU Cooperative Extension

Objective:

The objective of this study is to examine conventional planted spring barley in comparison with direct seeded planted spring barley with and without triallate (Far-Go®) application in hopes of controlling wild oat and helping reduce the learning curve associated with direct seeded annual cropping. Triallate is a preplant incorporated herbicide and control in direct seeding situations is not well understood.

Study Location:

Location: about 5 miles northwest of Wilbur, WA.
Annual precipitation: 14 inches.
Soil type: Bagdad silt loam.
Previous crop: spring barley.

Soil Test Results:

Soil pH = 6.7

Soil Depth	=	Moisture (inches/foot)	Sulfur (ppm)	Nitrogen (lb N/acre)
1'	=	3.34	5	57
2'	=	3.19	5	10
3'	=	3.11	8	10
4'	=	2.45	-	7
Total	=	12.09	18	84

† Includes the 38 lb N/acre estimated released from 1.9% organic matter and 6 lbs. N/acre estimated released from NH_4.

Treatments and Operations:

The trial was a randomized complete block design with 4 replications, and treatments are as follows:

- T-1: Conventional seeded spring barley with no wild oat control.
- T-1: Direct seeded spring barley with no wild oat control.
- T-3: Direct seeded spring barley with triallate application for wild oat control.

Time-line of treatment operations:

- April 22, 1999: Roundup® was applied to both direct seed pots at 16oz/acre.
- April 28, 1999: applied triallate treatments with a harrow to direct seed treatment.
- May 1, 1999: direct seed and conventional Baroness spring barley at 70 lb/acre.

The direct seed treatments were planted with a Concord™ high disturbance direct seed drill with 10-inch paired-row spacing, which provided additional triallate incorporation. Nitrogen, in the form of aqua was applied with a cultiweeder in the conventional system and anhydrous was applied at seeding with the direct seed system. All three treatments received 70 lb N/acre and an additional 100 lb/acre of 16-20-0-14 starter fertilizer was applied with the seed. No wild oat herbicide was applied to the conventional system or the direct seed without triallate application.

Agronomic Results:

Differences were detected in the agronomic performance of direct seed and conventional spring barley at Rick and Roxanne Jones. Both direct seeded spring barley treatments had significantly more plants than conventional seeded barley with 14.1 and 14.4 plants/ft^2 compared to only 11.5 plants/ft^2 (Table 1). There was no significant difference in the amount of tillers/plant among all three treatments with 3.6 tillers/plant.

Wild oat counts were not different do to a high degree of variability throughout the field even though direct seed with triallate averaged 1.4 wildoats/ft^2 and direct seeded without triallate averaged 13.7 wildoats/ft^2 (Table 2). However, the application of triallate significantly reduced the amount of tillers/wildoat plant with an average of only 0.3 tillers/plant. Direct seed without triallate averaged 1 tiller/plant, significantly less than 2.3 tillers/plant averaged in conventional planted barley.

Triallate incorporated in a direct seed system increased barley yield by 0.47 tons/acre (Table 3). There was no significant difference in seed yield between direct seeded and conventional seeded spring barley.

Economic Results:

Gross economic returns were calculated by multiplying the yield by $75/ton, the FOB price at Ritzville Warehouse on September 15, 1999 (Table 4). Direct seed with triallate had a gross return of $115.50/acre, direct seed less triallate had a gross return of only $80.25/acre and conventional seeded barley produced a gross return of $99.75/acre.

Table 5 summarizes the input costs for each of the three treatments. Conventional seeded barley had the lowest input costs at only $42.69/acre. Direct seed had input costs of $50.02/acre and direct seed with triallate had input costs of $66.52/acre.

Ownership and operating costs were estimated using MACHCOST, machinery cost analysis program developed by the University of Idaho. Direct seed ownership costs were estimated at only $3.12/acre and $3.13/acre with triallate application, opposed to an estimated $10.44/acre for conventional ownership costs (Table 6). Operating costs were much different than ownership cost as direct seed-operating costs were estimated at $17.11/acre and $17.46/acre with triallate application, and conventional operating costs were estimated at only $9.39/acre (Table 7).

Total establishment costs are comprised as the total input product, ownership, and operating costs. Total returns above establishment costs are calculated by subtracting net returns from total establishment costs. Conventional seeded barley had the lowest estimated total establishment cost of only $62.52/acre and an estimated return above establishment cost of $37.23/acre (Table 8). Direct seed had an establishment cost of $70.25/acre and estimated returns above establishment costs of $10.00/acre. Direct seed with triallate had an estimated total establishment cost of $87.11/acre and returns above establishment cost of an estimated $28.39/acre.

Estimated time to establish 500 acres of spring barley using current operations with estimated field speeds and efficiencies for all three treatments are summarized in Tables 9 (conventional), 10 (direct seed w triallate) and 11 (direct seed). Overall, an estimated 836 acres could be planted using direct seed with triallate application is the 10.7 days it takes to prepare and plant 500 acres of conventional planted spring barley.

Conclusions:

Triallate application, although it did not significantly decrease wild oat populations, did increase yield, and the results are promising enough to require further studies to enhance wild oat control. Other agronomic comparisons between direct seed and conventional seeded barley were close in 1999, much like in 1998.

Economic comparisons between direct seeded and conventional seeded barley were also similar to 1998 trial results. Direct seed required more input cost and operating cost because of Roundup® application and equipment rental, and conventional seeded barley had larger ownership costs associated with tillage equipment. Time is one factor that may greatly impact both the agronomic and economic efficiency between direct seeded and conventional seeded barley systems. Time, however, was not realized in this study (the trial was planted on the same day) and is difficult to assign either an agronomic or economic value too.

Agronomic Data:

Table 1. Baroness barley plant population and tillers per plant seeded conventional, direct seed and direct seed with triallate application in an on-farm test at Rick and Roxanne Jones in 1999. The direct seed treatments were seeded with a Concord high disturbance drill with 10-inch paired rows.

Treatment	Population (plants/ft^2)	Tiller Count (tiller/plant)
Conventional	11.5 b†	3.9 a
Direct Seed	14.4 a	2.7 a
Direct Seed w triallate	14.1 a	4.3 a
LSD $_{(0.05)}$	2.5	2.0
CV	10.7%	32.4%

† Treatment means within columns followed by the same letter are not significantly different at the 95% probability level (P<0.05).

Table 2. Wild oat plant population and tillers per plant seeded conventionally, direct seed and direct seed with triallate application in an on-farm test at Rick and Roxanne Jones in 1999. The direct seed treatments were seeded with a Concord high disturbance with 10-inch paired rows.

Treatment	Population (plants/ft^2)	Tiller Count (tiller/plant)
Conventional	9.9 a†	2.3 a
Direct Seed	13.7 a	1.0 b
Direct Seed w triallate	1.4 a	0.3 c
LSD $_{(0.05)}$	12.4	0.6
CV	86.2%	30.2%

† Treatment means within columns followed by the same letter are not significantly different at the 95% probability level (P<0.05).

Table 3. Baroness barley yield (tons/acre) seeded conventionally, direct seed and direct seed with triallate application in an on-farm test at Rick and Roxanne Jones in 1999. The direct seed treatments were seeded with a Concord high disturbance drill with 10-inch paired rows.

Treatment	Rep I	Rep II	Rep III	Rep IV	Mean
Conventional	1.75	1.33	1.21	1.02	1.33 ab†
Direct Seed	1.01	1.04	1.18	1.06	1.07 b
Direct Seed w triallate	1.95	1.48	1.35	1.38	1.54 a
LSD $_{(0.05)}$					0.35
CV					15.5%

† Treatment means within columns followed by the same letter are not significantly different at the 95% probability level (*P*<0.05).

Economic Data:

Table 4. Gross returns per acre of direct seed and conventional spring barely with an average yield of 1.70 ton/acre in an on-farm test at Rick and Roxanne Jones in 1998.

Treatment	Average Yield (tons/acre)	Price† ($/ton)	Gross Returns ($/acre)
Conventional	1.33	$75	$99.75
Direct Seed	1.07	$75	$80.25
Direct Seed w triallate	1.54	$75	$115.50

† Gross return was calculated using the FOB on September 15, 1999 at Ritzville Warehouse.

Table 5. Total input costs per acre for each of the three treatments of spring barley in an on-farm test at Rick and Roxanne Jones in 1999.

Input	Rate/acre	Cost/unit	Conventional ($/acre)	Direct Seed ($/acre)	Direct Seed w triallate ($/acre)
Roundup®	16 oz	$0.305	$0.00	$4.88	$4.88
2,4-D Amine	1 pint	$2.18	$2.18	$2.18	$2.18
triallate	15 lbs.	$1.10†	$0.00	$0.00	$16.50
Baroness Seed	70 lbs.	$0.148	$10.36	$10.36	$10.36
16-20-0-14	100 lbs.	$0.165	$16.50	$16.50	$16.50
Aqua	70 lbs. N	$0.195	$13.65	$0.00	$0.00
Anhydrous	70 lbs. N	$0.230	$0.00	$16.10	$16.10
Total			$42.69	$50.02	$66.52

† Includes the cost of harrow applicator.

Table 6. Estimated ownership costs of each operation used to establish conventional and direct seed spring barley in an on-farm test at Rick and Roxanne Jones in 1999.

Operation	Equipment	Conventional ($/acre)	Direct Seed ($/acre)	Direct Seed w triallate ($/acre)
Harrow	285HP-WT, 85’ harrow	$0.77	$0.77	$0.77
Harrow	285HP-WT, 85’ harrow	$0.77	$0.77	$0.00
Harrow/triallate	285HP-WT, 60’ applicator	$0.00	$0.00	$0.78†
Roundup	285HP-WT, 80’ sprayer	$0.00	$0.53	$0.53
Sweep	285HP-WT, 33’ sweep	$2.39	$0.00	$0.00
Cultiweed/Fertilize	285HP-WT, 36’ cultiweeder	$1.74	$0.00	$0.00
Seed	285HP-WT, 40’ hoe drills	$4.77	$0.00	$0.00
Seed & Fertilize	285HP-WT, 33’ direct seed drill	$0.00	$1.05†	$1.05†
2,4-D Amine	Aerial applied	$0.00	$0.00	$0.00
Total Ownership Costs		$10.44	$3.12	$3.13

† Ownership cost for tractor only.

Table 7. Estimated operating costs of each operation used to establish conventional and direct seed spring barley in an on-farm test at Rick and Roxanne Jones in 1999.

Operation	Equipment	Conventional ($/acre)	Direct Seed ($/acre)	Direct Seed w triallate ($/acre)
Harrow	285HP-WT, 85’ harrow	$0.29	$0.29	$0.29
Harrow	285HP-WT, 85’ harrow	$0.29	$0.29	$0.00
Harrow/triallate	285HP-WT, 60’ harrow	$0.00	$0.00	$0.64
Roundup	285HP-WT, 80’ sprayer	$0.00	$1.63	$1.63
Sweep	285HP-WT, 33’ sweep	$1.08	$0.00	$0.00
Cultiweed/Fertilize	285HP-WT, 36’ cultiweeder	$2.22	$0.00	$0.00
Seed	285HP-WT, 40’ hoe drills	$1.51	$0.00	$0.00
Seed & Fertilize	285HP-WT, 33’ direct seed drill	$0.00	$10.90†	$10.90†
2,4-D Amine	Aerial applied	$4.00‡	$4.00‡	$4.00‡
Total Operating Costs		$9.39	$17.11	$17.46

† Cost included drill rental and tractor operating expense.
‡ Cost to aerial apply herbicide.

Table 8. Estimated returns per acre above establishment cost per acre of conventional, direct seed and direct seed with triallate applied in an on-farm test at Rick and Roxanne Jones in 1999.

Treatment	Input Costs	Ownership Costs	Operating Costs	Total Establishment Costs	Gross Returns	Returns above Establishment Costs
Conventional	$42.69	$10.44	$9.39	$62.52	$99.75	$37.23
Direct Seed	$50.02	$3.12	$17.11	$70.25	$80.25	$10.00
Direct Seed w triallate	$66.52	$3.13	$17.46	$87.11	$115.50	$28.39

Table 9. Estimated 10-hour days to establish 500 acres of spring barley crop in a conventional tillage system at Rick and Roxanne Jones in 1999.

Operation	Implement Width	Field Speed	Field Efficiency	Hours/Operation	10 hour Days
Harrow	85	6.5	95%	7.84	0.8
Harrow	85	6.5	95%	7.84	0.8
Sweep	33	5.5	95%	23.86	2.4
Cultiweed	36	4.5	70%	33.10	3.3
Seed	40	4.0	70%	33.52	3.4
Total 10 Hour Days					10.7

Table 10. Estimated 10-hour days to establish 500 acres of spring barley crop in a direct seed system at Rick and Roxanne Jones in 1999.

Operation	Implement Width	Field Speed	Field Efficiency	Hours/Operation	10 hour Days
Harrow	85	6.5	95%	7.84	0.8
Harrow	85	6.5	95%	7.84	0.8
Spray	80	6.5	70%	10.31	1.0
Fertilize/Seed	33	5.0	70%	32.50	3.3
Total 10 Hour Days					5.9

Table 13. Estimated 10-hour days to establish 500 acres of spring barley crop in a direct seed system with triallate application at Rick and Roxanne Jones in 1999.

Operation	Implement Width	Field Speed	Field Efficiency	Hours/Operation	10 hour Days
Harrow	85	6.5	95%	7.84	0.8
Harrow/triallate	60	6.5	80%	12.69	1.3
Spray	80	6.5	70%	10.31	1.0
Fertilize/Seed	33	5.0	70%	32.50	3.3
Total 10 Hour Days					6.4

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Aaron D. Esser
On-Farm Testing Associate
Washington State Cooperative Extension
210 W. Broadway
Ritzville, WA 99169
Phone: (509) 659-3210
Fax: (509) 659-3303
e-mail: aarons@wsu.edu

Cover photos were taken at Jerry and Les Snyder's near Ritzville, WA (tractor), Ross Heimbigner's near Ritzville, WA (sign), and Dick and Shep Douglas' near Wilbur, WA (peas).