FINAL REPORT ON ORGANIC SPRING WHEAT WEED CONTROL RESEARCH –

Objective:

To identify and develop cultural practices for weed control in organically grown hard red spring wheat.

Background:

Organic crop production in the region has been primarily focused on one crop – soybeans. Organic certification requirements dictate that farmers must have acceptable crop rotations. Usually, a given crop can only be grown once every three years. Organic farmers are in great need of an acceptable, economically viable crop to rotate in a production system with soybeans. Hard red spring wheat (HRSW) is an excellent rotational crop in a system with soybeans. There appears to be reasonable market demand for organically grown HRSW. However, many organic farmers are reluctant to grow HRSW because of concerns about weed control.

In organic wheat production no herbicides can be used, so cultural practices, including variety selection, must be utilized to control weeds. To successfully grow HRSW organically a variety must be selected which will do well under lower fertility levels and will compete with the weeds, while giving acceptable yield and quality. A second important factor is the planting date. Early planting may give the wheat the competitive advantage of cooler weather conditions but there may be many flushes of weeds. Later planting of wheat would allow for the control of a first flush of weeds (harrowing or cultivation) before seeding the wheat. Warmer soil temperatures may help the wheat to germinate quickly and give the crop a head start.

The third aspect of weed control would be to harrow the wheat after planting. Any time a harrow or rotary hoe operation is made through the field we would expect that weeds are going to be controlled but also that some of the wheat plants are going to be uprooted. In order to compensate for the stand reduction a higher seeding rate of wheat may be used. Before this research we were not sure what percentage of the plants would be uprooted by harrow operations at different stages of wheat development.

Work Plan:

For the 2001 season the following research was done:

Experiment 1: Weed Control with 2 Planting Dates, 2 Varieties, and 3 Harrow Operations

Researchers names: Zach Fore forex002@umn.edu and Dr. Hans Kandel kande001@umn.edu

Cooperator:	Jim and Pat Todahl, Fertile, MN
Soil Type:	Light sandy loam
Tillage:	Chisel plow last fall (2000), cultivated once in the spring
Previous Crop:	Soybean
Planting Date:	14 May and 28 May 2001
Plot size:	6 rows x 8 inches x 550 feet
Fertilizer	3 ton turkey manure per acre, fall 2000
Harvest Date	20 August 2001
Experimental Design:	Randomized complete block design with 2 replicates

On a commercial farmer's field organic wheat was seeded at about 2.25 million seeds per acre. Two HRSW varieties were selected, Alsen and Reeder, that had good yield potential, good protein and baking quality characteristics, and good levels of resistance to fusarium head blight and common leaf diseases. There were two planting dates, May 14 and May 28. There were three different harrow treatments ranging from 3 to 6 passes with a 4 bar spring tooth harrow (see picture below). In total there were 12 treatments and 24 plots (two replicates x two planting dates x two varieties x three harrow treatments).

Stand counts were taken before and after each harrow operation to determine stand loss due to harrow operations at different stages of wheat development. Visual evaluations of weed control were taken prior to harvest. At maturity, plots were harvested and yield, moisture content, protein, and test weight data were obtained. The design was a randomized complete block, and all data was analyzed statistically.


4-bar spring tooth harrow used for the weed control study

Experiment 2: Wheat Variety Interaction With Weeds

Minnesota and North Dakota lead the nation in planted acreage and production of spring wheat (*Triticum aestivum* L. and *T. turgidum* L.), oats (*Avena sativa* L.), and other spring-sown, small grain crops. Organic acreage of small grain crops continues to increase in neighboring states. Currently, most low-input/organic farmers grow modern varieties that have been developed and selected in environments where synthetic fertilizers and pesticides are used. Low-input/organic farmers would prefer to have access to modern varieties that have been selected specifically for organic environments, but such varieties are not available. A few organic farmers grow varieties developed prior to the widespread use of synthetic agrochemicals because they believe older varieties are better adapted to low-input/organic environments than modern varieties that have been developed and selected in environments where synthetic agrochemicals are used.

On the organic field of Jim and Pat Todahl 14 wheat varieties were grown in a randomized complete block design with 5 replicates. The plot size was 5 by 25 feet. The weed control consisted of two harrow operations with a 4-bar spring tooth harrow. Field observations took place during the season. The plots were harvested with a small plot combine and yield, moisture content, protein, and test weight were recorded.

Results and Discussion

Experiment 1: Weed Control with 2 Planting Dates, 2 Varieties, and 3 Harrow Operations
Stand
Stand loss due to harrowing did not have a significant varietal interaction - plant populations of Alsen and Reeder were affected the same by harrow treatments. The May 28 planting date had slightly better stand (8%) than the May 14 planting date.

Harrow treatment effects on stand were as follows:

- Initial plant populations ranged from 1.40 to 1.71 million plants/A.
- Final stands ranged from 1.21 to 1.42 million plants/A.
- Total stand loss ranged from 12% (May 14 planting 3 harrow treatments) to 24% (May 28 planting 6 harrow treatments).
- There was slightly more stand loss due to harrow treatments for the second planting date (18% vs. 14%).
- 3-4 harrow operations – average total stand loss = 14%
- 4-5 harrow operations – average total stand loss = 18%
- 5-6 harrow operations – average total stand loss = 18%

These results indicate that harrow operations before plants were 6-8" tall resulted in 6% to 8% stand loss per operation. Harrow operations after 8" and before boot resulted in 2% to 3% stand loss per operation. Organic growers can increase their planting rates using these results according to the number and planned timings of harrow operations.

Yield

The variety Reeder yielded significantly better than Alsen (5.1 Bu/A). May 14 planting resulted in significantly better yields than May 28 planting (10 Bu/A). The number of harrow operations did not significantly affect yield. None of the interactions were significantly different.

		Bu/A	
Varieties	Alsen	38.4	
	Reeder	43.5	$LSD_{(0.05)}$ 3.0
Planting Date	May 14	46.0	
	May 28	36.0	$LSD_{(0.05)}$ 3.0
Harrow Treatments	3/4X	40.3	
	4/5X	41.7	
	5/6X	40.9	NS

Protein

The variety Reeder had significantly higher protein content than Alsen (0.4%). The May 28 planting had significantly higher protein content than the May 14 planting (0.83%). Protein content was not significantly affected by number of harrow operations. None of the interactions were significantly different.

Varieties	Alsen	14.22	
	Reeder	14.62	$LSD_{(0.05)}$ 0.38
Planting Date	May 14	14.0	
	May 28	14.83	$LSD_{(0.05)}$ 0.38
Harrow Treatments	3/4X	14.61	
	4/5X	14.36	
	5/6X	14.28	NS

Weed Control
Weed control was evaluated visually using a relative number scale of 1 to 5, where 1 = no weeds present and 5 = very weedy. Weed control was not significantly affected by planting date or number of harrow operations. There was, however, a significant varietal effect. Reeder had significantly less weeds than Alsen.

Planting Date	NS	
Harrow Treatments	NS	
Variety	Alsen 2.69	
	Reeder 2.32	LSD (0.05) 0.35


Organic Wheat Weed Control Study

Conclusions and Recommendations from Experiment 1
Stand: Harrow operations before wheat plants were 8 inches tall reduced stand by an average of 8%, while harrow operations after wheat plants were 8 inches tall reduced stand an average of 3%. The effect of harrowing will vary with size of wheat plants, soil type and condition, type and settings of equipment, and other factors. Harrowing is most effective when performed when wheat and weeds are small even though there is more stand loss when wheat is small. Therefore, this research would suggest that a good rule of thumb for organic wheat farmers is to plant an additional 10% pure live seed for every planned harrow operation. Farmers should always check behind the harrow at the beginning of an operation to evaluate whether or not stand loss is excessive due to soil conditions, equipment setting, or other factors.

Yield, Protein, and Weed Control: In organic HRSW production just as in conventional HRSW production varietal selection is very important. Disease resistance and protein potential are particularly important to the organic farmer. In this research study one variety, Reeder, had better yield, protein, and competitiveness against weeds than the other variety, Alsen. Planting date is also very important. Early planting is as important to the organic farmer as it is to the conventional farmer. In this study a 14 day delay in planting resulted in a 10 Bu/A yield loss. It was postulated that delayed planting may be beneficial for weed control by allowing for control of the first flush of weeds by tillage prior to planting. In this study delayed planting was not beneficial for weed control, and had the same amount of weed pressure as early planting.

Results and discussion
Experiment 2 organic wheat variety response to weed pressure

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Cooperator: Jim and Pat Todahl, Fertile, MN
Soil Type: Light sandy loam
Tillage: Chisel plow last fall (2000), cultivated once in the spring
Previous Crop: Soybean
Planting Date: 14 May 2001
Plot size: 6 rows x 8 inches x 25.5 feet
Fertilizer 3 ton turkey manure per acre, fall 2000
Weed control Harrowing (2x)
Harvest Date 20 August 2001
Experimental Design Randomized complete block design with 5 replicates

Purpose of Study: This study evaluated different spring wheat varieties for weed competitiveness when grown under a certified organic production system. Some of the entries came from an organic seed source (Org) compared with a regular seed source.

Results

Ingot significantly outyielded many of the tested varieties, but did not significantly differ in yield from Gunner, Reeder, Waldron and Kulm. In organic production protein premiums are a major part of the income. Glupro provided the highest protein content followed by Coteau. There are significant differences in weed pressure between wheat varieties at the P = 0.20 level. In the weed control study we showed a significant difference between Alsen (2.69) and Reeder (2.32). In the variety trial Alsen had a score of 3.6 and Reeder a score of 2.4.

There was no significant difference in the weed pressure between the top 5 yielding varieties. The weed pressure by itself was not a good predictor of yield. Variety selection should include the tolerance of a variety to weed pressure but it should not be the only selection criteria.

Data

Variety	Bu Acre(1)	Weed Pressure (3)	Protein %	Test weight lb per bu	Gross Revenue $ (4)	Height Inches	Population Million Per acre
Ingot	44.5a (2)	2.4c	14.0cd	60.0a	271a	38.7bc	1.45a
Gunner	41.2ab	2.6bc	13.8cde	60.0a	241abc	36.0d	1.36ab
Reeder	40.8ab	2.4c	13.7de	59.3ab	232abc	33.4e	1.40ab
Waldron	40.3abc	2.4c	14.3c	56.2ef	253ab	38.8bc	1.40ab
Kulm	38.5abcd	2.2c	13.7de	59.5ab	218bcd	37.2cd	1.40ab
Alsen	36.8bcde	3.6a	14.0cd	59.6a	221bcd	33.4e	1.36ab
Org Parshall	36.0bcdef	2.2c	13.6de	58.6bc	201cd	38.2bc	1.33abc
Grandin	35.5bcdef	3.1ab	14.1cd	57.6cd	216bcd	33.6e	1.28bc
Ernest	34.4cdef	3.1ab	14.0cd	59.2ab	208bcd	39.8b	1.36ab
Org Stoa	33.0def	2.3c	13.8cde	56.7de	194cd	39.8b	1.19cd
Parshall	32.7def	2.7bc	13.4e	59.7a	177d	38.2bc	1.08d
Coteau	32.0ef	2.6bc	15.7b	56.3ef	234abc	39.0bc	1.38ab
Org Coteau	30.9ef	2.7bc	15.5b	56.6e	224abcd	39.4b	1.34ab
Glupro	30.1f	2.6bc	16.4a	55.4f	231abc	42.8a	1.26bc
LSD 0.05	6.3		0.5	1	48	1.8	
LSD 0.20		0.6					0.15

(1) Corrected to 13.5% moisture.

(2) Means in a column followed by the same letter are not significantly different at P = 0.05 (F-protected LSD).

(3) Weed pressure scale 1-5. 1 no weeds. 5 weeds out competed the crop.

(4) 13% protein at $5.00 and for each 0.1% increase in protein $ 0.10 increase in price up to 15% protein ($7.00).
Higher that 15% protein for each 0.1% increase in protein $ 0.05 increase in price. LDP are not included in the calculation.

Below are Data for the Organic Variety Study

ORGANIC WHEAT STUDY 2001 TODAHL FARM

Summary Table

Variety	Bu Acre	Protein %	Test weight lb per bu	Height Inches	Lodging 0 - 5	Stand count	Weed Pressure	Moisture % Harvest
Ingot	44.5a	14.0cd	60.0a	38.7bc	2.1ab	133a	2.4c	15.5abc
Gunner	41.2ab	13.8cde	60.0a	36.0d	1.9ab	125ab	2.6bc	15.0cde
Reeder	40.8ab	13.7de	59.3ab	33.4e	1.2c	128ab	2.4c	14.8cde
Waldron	40.3abc	14.3c	56.2ef	38.8bc	2.2ab	128ab	2.4c	12.7h
Kulm	38.5abcd	13.7de	59.5ab	37.2cd	2.1ab	128ab	2.2c	15.2bcd
Alsen	36.8bcde	14.0cd	59.6a	33.4e	1.8b	125ab	3.6a	16.2a
Org Parshall	36.0bcdef	13.6de	58.6bc	38.2bc	1.9ab	122abc	2.2c	14.7de
Grandin	35.5bcdef	14.1cd	57.6cd	33.6e	1.9ab	117bc	3.1ab	14.6de
Ernest	34.4cdef	14.0cd	59.2ab	39.8b	2.3a	125ab	3.1ab	15.0cde
Org Stoa	33.0def	13.8cde	56.7de	39.8b	1.9ab	109cd	2.3c	14.4ef
Parshall	32.7def	13.4e	59.7a	38.2bc	1.9ab	99d	2.7bc	16.0ab
Coteau	32.0ef	15.7b	56.3ef	39.0bc	1.9ab	126ab	2.6bc	13.2gh
Org Coteau	30.9ef	15.5b	56.6e	39.4b	1.8ab	124ab	2.7bc	13.6g
Glupro	30.1f	16.4a	55.4f	42.8a	2.2ab	116bc	2.6bc	13.7fg
LSD 0.05	6.3	0.5	1	1.8	0.5			0.8
LSD 0.20						13.8	0.6	