NW CROPS & SOILS PROGRAM

UNIVERSITY OF VERMONT EXTENSION

CULTIVATING HEALTHY COMMUNITIES

2012 Organic Spring Wheat Weed Control Strategies Report

Dr. Heather Darby, UVM Extension Agronomist

Erica Cummings, Hannah Harwood, Rosalie Madden, and Susan Monahan

UVM Extension Crops and Soils Technicians

(802) 524-6501

Visit us on the web at http://www.uvm.edu/extension/cropsoil

The UNIVERSITY of VERMONT EXTENSION

2012 ORGANIC SPRING WHEAT WEED CONTROL STRATEGIES REPORT

Dr. Heather Darby, University of Vermont Extension
Heather.Darby[at]uvm.edu

Many organic cereal grain growers struggle with weed issues, especially in spring wheat. Weed competition is one of the major issues in spring wheat due to many factors. Some of those factors include weed seed flushes from spring tillage and weed germination at the same time as crop germination. With this in mind, the University of Vermont Extension has begun conducting trials to evaluate the effects of different weed control methods in spring wheat. In 2012, the study was continued to develop strategies that will minimize weed competition while maintaining yield and quality parameters to successfully produce high-quality bread wheat. The management practices evaluated include variable row spacing and mechanical cultivation with a tineweeder or inter-row hoe.

MATERIALS AND METHODS

The 2012 study was conducted at Borderview Research Farm in Alburgh, VT (Table 1). The experimental design was a randomized complete block with four replications. The treatments were four weed management practices (Table 2). All 'Standard' plots had a row spacing of seven inches; all plots marked with a '+' symbol were tineweeded twice after emergence; and narrow and wide plots have varied row spacing (4.5 and 9 inches, respectively). The plot size was 5' x 40'. The soil was a rocky Benson silt loam, and the previous crop was sunflowers. In the spring, the seedbed was prepared with a chisel plow, disk and spike-toothed harrow. Each plot was seeded with the spring wheat variety Barlow (North Dakota Foundation Seed). Wheat was planted on 19-Apr with either a Sunflower 9412 no-till planter (for all of the plots with seven-inch row spacing) or, in the case of narrow and wide plots, a Kverneland Accord DL pneumatic seed drill.

Table 1. Trial information and agronomic practices for the 2012 weed control trial, Alburgh, VT.

Location	Borderview Research Farm - Alburgh, VT
Soil type	Benson rocky silt loam
Previous crop	No-till sunflowers
Spring tillage operations	Chisel plow, disk, spike-toothed harrow
Seeding rates (lbs ac^{-1})	135
Wheat variety	Barlow
Replicates	4
Planting date	19-Apr
Harvest date	23-Jul
Harvest area (ft)	5 x 40

Table 2. Treatments in the weed control trial, 2012, Alburgh, VT.

Treatment	Row spacing inches	Tineweeding date	Inter-row cultivation date
Standard	7.0	-	-
Standard +	7.0	21-May and 31-May	-
Narrow	4.5	-	-
Wide	9.0	-	1-Jun

The 'Standard +' plots, were cultivated with a tineweeder at 32 and 42 days after planting (DAP). This type of cultivation is designed to disturb and uproot weed seedlings in their "white thread root" stage, causing desiccation and death. At each tineweeding event, wheat, as well as annual and perennial grasses and broadleaf plants, were tallied in a specific area before and after tineweeding. This allowed for calculations of wheat mortality, as well as reduction in annual grasses and broadleaf plants. At the time of both tineweeding events, few to no perennial weeds were found; the reductions in perennial weeds are therefore not reported.

The plots with nine-inch row spacing were cultivated with a Schmotzer inter-row hoe on 1-Jun. The Schmotzer hoe, imported from Germany, is a manually-guided, rear-mounted implement that can be used to cultivate in between wide rows of wheat (Image 1). This allows weed control to take place later in the growing season, after plants are well established.

Image 1. Inter-row cultivation using the Schmotzer hoe, Alburgh, VT.

Grain plots were harvested with an Almaco SPC50 plot combine on 23-Jul, the harvest area was 5' x 40'. At the time of harvest, plant heights were measured, excluding the awns, in inches. Lodging was recorded by a visual estimate of percent lodged plants and the severity of lodging based on a visual rating with a 1 – 5 scale, where 1 indicates minor plant lodging and wheat could still be combined, and 5 indicates severe lodging and a complete crop loss. In addition, grain moisture, test weight and yield were calculated.

Following harvest, seed was cleaned with a small Clipper cleaner (A.T. Ferrell, Bluffton, IN). An approximate one pound subsample was collected to determine quality. Quality measurements included standard testing parameters used by commercial mills. Test weight was measured by the weighing of a known volume of grain. Generally the heavier the wheat is per bushel, the higher baking quality. The acceptable test weight for bread wheat is 56-60 lbs per bushel. Once test weight was determined, the samples were then ground into flour using the Perten LM3100 Laboratory Mill. At this time, flour was evaluated for its protein content and falling number. Grains were analyzed for protein content using the Perten Inframatic 8600 Flour Analyzer. Grain protein affects gluten strength and loaf volume. Most commercial mills target 12-15% protein. Protein was calculated on a 12% moisture and 14% moisture basis. The determination of falling number (AACC Method 56-81B, AACC Intl., 2000) was measured on the Perten FN 1500 Falling Number Machine. The falling number is related to the level of sprout damage that has occurred in the grain. It is measured by the time it takes, in seconds, for a stirrer to fall through a slurry of flour and water to the bottom of the tube. Falling numbers greater than 350 indicate low enzymatic activity and sound quality wheat. A falling number lower than 200 indicates high enzymatic activity and poor quality wheat.

All data was analyzed using a mixed model analysis where replicates were considered random effects. The LSD procedure was used to separate weed management strategy means when the F-test was significant ($P < 0.10$).

LEAST SIGNIFICANT DIFFERENCE (LSD)

Variations in yield and quality can occur because of variations in genetics, soil, weather and other growing conditions. Statistical analysis makes it possible to determine whether a difference among treatments is real or whether it might have occurred due to other variations in the field. All data was analyzed using a mixed model analysis where replicates were considered random effects. At the bottom of each table, a Least Significant Difference (LSD) value is presented for each variable (e.g. yield). LSDs at the 10% level (0.10) of probability are shown. Where the difference between two treatments within a column is equal to or greater than the LSD value at the bottom of the column, you can be sure in 9 out of 10 chances that there is a real difference between the two values. Treatments listed in bold had the top performance in a particular column; treatments that were not significantly lower in performance than the highest value or top performing treatment in a particular column are indicated with an asterisk.

In the example below, treatment C is the top-performer and is significantly different from treatment A but not from treatment B. The difference between B and C is equal to 729, which is less than the LSD value of 889. This means that these treatments did not differ in yield. The difference between A and C is equal to 1454, which is greater than the LSD value of 889. This means that the yields of these two treatments were significantly different from one another.

Variety	**Yield**
A	3161
B	3886*
C	**4615***
LSD	**889**

RESULTS

Seasonal precipitation and temperatures were recorded using a Davis Instruments Vantage Pro2 weather station at Borderview Research Farm in Alburgh, VT, weather data was summarized for the 2012 growing season (Table 3). Though May was wetter than normal (based on 1981-2010 data), April, June, and July all had less precipitation than average. All months during the growing season had higher than average temperatures (based on 1981-2010 data). There were an accumulated 3547 Growing Degree Days (GDDs) at a base temperature of 32°F. This was 195 more than the historical 30-year average for April-July. Favorable spring weather led to earlier than normal planting and harvest of spring wheat.

Table 3. Summarized weather data for 2012 – Alburgh, VT.

Alburgh, VT	April	May	June	July
Average Temperature (F)	44.9	60.5	67.0	71.4
Departure from Normal	0.10	4.10	1.20	0.80
Precipitation (inches) *	2.64	3.90	3.22	3.78
Departure from Normal	-0.18	0.45	-0.47	-0.37
Growing Degree Days (base 32)	396	884	1046	1221
Departure from Normal	12.0	128	32.0	23.0

Based on weather data from Davis Instruments Vantage Pro2 with Weatherlink data logger.
Historical averages for 30 years of NOAA data (1981-2010).
* Precipitation data from June-September 2012 is based on Northeast Regional Climate Center data from an observation station in Burlington, VT.

The timing of post-emergence tineweeding was an effective method of weed control (Table 4). The average wheat mortality was lowest when tineweeding occurred on 31-May (0.0%). Tineweeding on 21-May removed more annual grasses and broadleaves than the later tineweeding event. Hence, delaying tineweeding reduced crop loss but also led to less effective weed control.

Table 4. Effect of the timing of tineweed events on wheat mortality and weed reduction, Alburgh, VT.

Tineweed timing	Wheat mortality	Annual grass weed reduction	Annual broadleaf weed reduction
	%	%	%
21-May	1.10	76.0	74.0
31-May	0.00	62.4	66.9

Weed control methods significantly impacted grain yields. The highest yielding treatment was the ‘Narrow’ row spacing with 3787 lbs ac^{-1}. The other top yielding treatment was the ‘Standard +’ with 3654 lbs ac^{-1}. The lowest yielding treatments were the ‘Wide’ row and ‘Standard’ treatment (Table 5, Figure 1). There were no significant differences in the grain moisture, test weight, protein and falling number. All of the treatments were in the optimal 56 to 60lbs bu^{-1} test weight for wheat. The treatments with the highest protein levels were the ‘Standard’ and ‘Standard+’ at 14.4%. Interestingly, the lowest protein was the ‘Narrow’ treatment at 13.8% although not significantly different from the other weed control treatments. All of the treatments had protein levels that met commercial milling standards of 12-15%. The falling numbers for each treatment exceeded industry standards of 250-400 seconds.

Table 5. Impact of weed control strategies on wheat yield and quality.

Treatments				Quality		
	Yield @ 13.5% moisture	Moisture	Test weight	Crude protein @ 12% moisture	Crude protein @ 14% moisture	Falling number
	lbs ac^{-1}	%	bu ac^{-1}	%	%	seconds
Standard	2929	18.7	58.1	**14.4**	**14.1**	418
Standard +	3654*	18.2	58.6	**14.4**	**14.1**	**430**
Narrow	**3787***	**17.4**	**59.8**	13.8	13.5	424
Wide	3006	**17.4**	59.5	14.1	13.8	**430**
LSD (0.1)	683	NS	NS	NS	NS	NS
Trial means	3344	17.9	59.0	14.2	13.8	426

Treatments indicated in **bold** had the top observed performance in a particular column.
* Treatments with an asterisk did not perform significantly lower than the top-performing treatment in a particular column.
NS – No significant difference was determined between treatments.

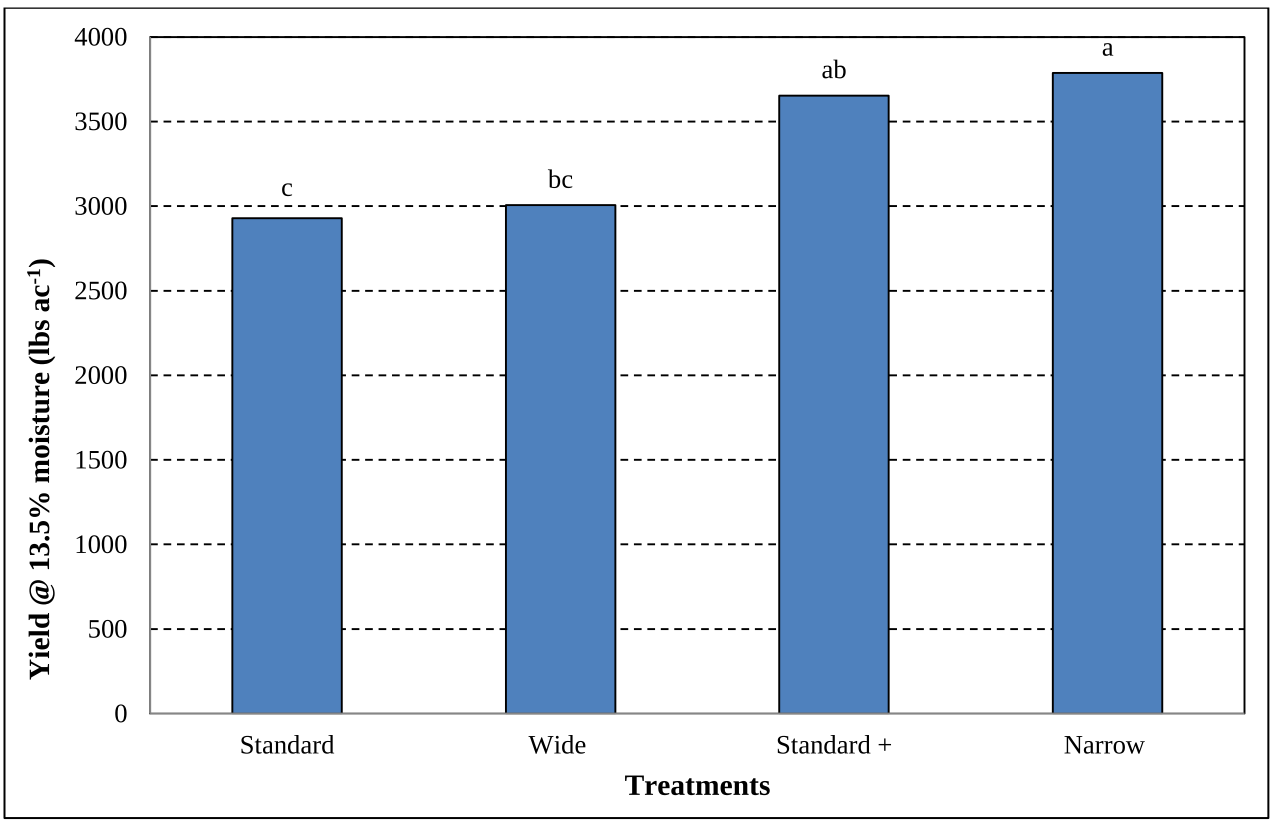

Figure 1. The impact of weed control strategies on yield, Alburgh, VT. Treatments with the same letter did not differ significantly in yield.

DISCUSSION

The ‘Narrow’ row treatment resulted in the highest yield; this could be attributed to the 4.5” row spacing enabling more wheat to be planted in each plot. Conversely, the ‘Wide’ row treatment with 9” row spacing had one of the lowest yields, possibly due to less wheat being planted per plot and potentially plants killed through cultivation. The ‘Standard+’, which was tineweeded twice post wheat emergence, yielded 725 lbs ac^{-1} higher than the ‘Standard’ treatment without tineweeding. Tineweeding did appear to reduce annual grass and broadleaf weeds. As shown by other studies, the timing of tineweeding events can have a significant impact on the effectiveness of weed control. In 2012, the tineweeding events occurred later than they had in previous trial years (32 and 42 DAP). The first tineweeding event (21-May) caused greater reduction in annual grasses than the second event (31-May). This may be attributed to the grasses having deeper root systems and more difficult to remove by tineweeding. The 31-May tineweeding resulted in no losses in wheat, which could be attributed to the wheat being more established at the time of tineweeding. Overall, increasing the density and tineweeding improved overall yields and presumably weed control. Ultimately, it appears that several strategies will lead to improved weed control over standard practices.

Grain quality was not impacted by the different treatments. The lowest protein levels were in the ‘Narrow’ row treatments (13.8%), which could be attributed to more competition for plant available nitrogen by the wheat. The dry conditions during wheat dry down resulted in very little sprout damage and very high falling numbers. The falling numbers of all the treatments were above 400 seconds, which means there is too little enzymatic activity, and therefore, would need to be amended with barley malt to increase enzymatic activity. The test weights, protein levels and falling numbers met or exceeded commercial milling standards for bread baking.

While this study represents only one season of research, it implies that weed pressure is reduced by tineweeding and inter-row cultivation, that a variety of agronomic practices may comparably reduce weed pressure, and that yield and quality does not need to be compromised in order to control weeds in organic spring wheat production.

ACKNOWLEDGEMENTS

The UVM Extension Crops and Soils Team would like to thank Roger Rainville and his staff at the Borderview Research Farm for their generous help with the trials, as well as acknowledge the USDA OREI grants program for their financial support. We would also like to thank Katie Blair, Chantel Cline, and Savanna Kittell-Mitchell for their help with data collection and entry. This information is presented with the understanding that no product discrimination is intended and no endorsement of any product mentioned, nor criticism of unnamed products, is implied.

UVM Extension helps individuals and communities put research-based knowledge to work.

The UNIVERSITY of VERMONT EXTENSION