NW CROPS & SOILS PROGRAM

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CULTIVATING HEALTHY COMMUNITIES

2012 Vermont
On-Farm Spring Wheat Breeding Trials

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2012 VERMONT SPRING WHEAT BREEDING TRIALS

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INTRODUCTION

On-farm wheat breeding began in Vermont, in cooperation with UVM Extension, in 2007 with a USDA SARE grant to build farmer knowledge in plant breeding. The goal of on-farm breeding is to develop spring wheat varieties that are suited for organic management in Vermont soils and climactic conditions. Most commercially available varieties are developed in regions with climates, soils and management techniques that are very different from our own. In addition, those varieties are genetically homogenous and inbred for uniformity. This has often led to rapid breakdown of genetic resistance to local diseases. To address this situation, farmers in Vermont have been gaining the technical skills needed to develop their own varieties by making wheat crosses and selections under organic management.

To acquire hands-on breeding skills, Vermont farmers along with UVM Extension agronomist Heather Darby, attended an intensive short course on wheat breeding at Washington State University. Nineteen modern and heirloom varieties of spring wheat were originally planted in 2007, including three varieties from famed Vermont botanist and wheat breeder, Cyrus Pringle. Of these varieties, a number of crosses were made that have been grown out on farms in Vermont with varying soils and climates for the last 4 years. Farmers continue to grow the crosses and select the best-looking plants, while capturing the genetic diversity from the populations. In 2012, five of the top performing crosses were selected to be grown at each farm. Parents of the crosses are listed in Table 1.

Table 1. Cultivars used as parents in spring wheat breeding project.

Abbreviation	Cultivar	Year	Place of Origin	Pedigree
ACB	AC Barrie	1997	Saskatchewan	Neepawa / Columbus // BW90
Ch	Champlain	1870	Vermont	Black Sea/Gold Drop
D	Defiance	1878	Vermont	Golden Drop/White Hamburg
H	Hope	1927	South Dakota	Yaroslav emmer/Marquis
RB	Red Bobs	1926	Saskatchewan	selection from field of Bobs
RF	Red Fife	1918	Ontario, Canada	information not found
S	Surprise	1909	Vermont	Chile Club/Michigan Club

METHODS

In 2012, the spring wheat crosses were planted at two locations: Gleason Grains in Bridport, VT and Butterworks Farm in Westfield, VT. Both farms are certified organic by Vermont Organic Farmers, LLC. The seedbeds were prepared by conventional tillage methods. See Table 2 for general plot management. Plots were planted with a six-inch Carter cone-seeder on 12-Apr in Bridport and with a Kincaid cone-seeder on 18-Apr in Westfield. Wheat was harvested with an Almaco SPC50 small plot combine on 6-Aug in Westfield. The plots in Bridport were too weedy and unable to be harvested. Grain moisture, test weight and yield were determined. The grain was cleaned with a Clipper M2B cleaner and dried at 40^{o}C until grain moisture was below 13%. Samples were ground into flour using a Perten LM3100 Laboratory Mill. 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 14% moisture basis. Falling number 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. Deoxynivalenol (DON) was analyzed using Veratox DON 5/5 Quantitative test from the NEOGEN Corp. This test has a detection range of 0.5 to 5 ppm. Samples with DON values greater than 1 ppm are considered unsuitable for human consumption. All data was analyzed with an analysis of variance with SAS (Cary, NC). The LSD procedure was used to separate cultivar means when the F-test was significant ($p< 0.10$).

Table 2. General plot management.

Trial Information	Gleason Grains, Bridport	Butterworks Farm, Westfield
Soil type	Farmington loam	Dixfield sandy loam
Previous crop	Winter Rye	Spring Wheat
Seeder	Carter seeder	Kincaid cone-seeder
Planting date	12-Apr	18-Apr
Harvest Date	-	6-Aug
Seeding rate	100 lbs/acre	100 lbs/acre
Plot size (ft)	6' x 25'	7' x 20'
Tillage methods	fall plow, disk and spike-toothed harrow	fall plow, tandem disk and field cultivate

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 varieties is real, or whether it might have occurred due to other variations in the field. At the bottom of each table a LSD value is presented for each variable (i.e. yield). Least Significant differences (LSD's) at the 10% level 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 varieties. Treatments that were not significantly lower in performance than the highest value in a particular column are indicated with an asterisk. In the example below, A is significantly different from C but not from B. The difference between A and B is equal to 1.5 which is less than the LSD value of 2.0. This means that these varieties did not differ in yield. The difference between A and C is equal to 3.0 which is greater than the LSD value of 2.0. This means that the yields of these varieties were significantly different from one another. The asterisk indicates that B was not significantly lower than the top yielding variety.

Variety	Yield
A	6.0
B	7.5*
C	9.0*
LSD	**2.0**

RESULTS AND DISCUSSION

Seasonal precipitation and temperature recorded at weather stations in close in proximity to Bridport and Westfield are reported in Table 3. The growing season in Bridport was hotter and drier than normal. There were a total of 4611 GDD, 233 GDD more than average. May and August were warmer than average in Westfield, with less rain than average in July and August. There were 4264 GDDs from April through August, 102 GDD more than the average.

Table 3. Seasonal weather data collected near Bridport and Westfield, VT.

Bridport, Vermont*	April	May	June	July	August
Average Temperature (F)	45.1	60.2	64.4	71.5	70.2
Departure from Normal	0.2	3.8	-0.6	1.7	2.6
Precipitation (inches)	2.55	8.43	3.22	2.49	4.41
Departure from Normal	-0.28	4.93	-0.57	-1.10	0.55
Growing Degree Days (base 32)	392	876	972	1225	1146
Departure from Normal	3.5	120	-19.5	53.2	76.5

Westfield, Vermont	April	May	June	July	August
Average Temperature (F)	41.8	56.7	63.0	67.9	68.1
Departure from Normal	-0.9	1.9	-0.8	-0.1	2.0
Precipitation (inches)	3.2	3.6	4.0	3.6	2.8
Departure from Normal	0.4	0.0	0.0	-0.7	-1.8
Growing Degree Days (base 32)	336	769	928	1112	1119
Departure from Normal	4	64	-25	-4	63

*Data compiled from Northeast Regional Climate Center data from Cornwall, VT. Historical averages for 30 years of NOAA data (1981-2010).

Unfortunately, we were not able to harvest the crosses in Bridport. The wheat was planted on time in mid-April, however the hot, dry growing season likely set back the spring wheat just enough so weeds were able to overtake the plots. In 2013, we plan to continue evaluating spring wheat crosses in Bridport from saved seed from this location from 2011.

The spring wheat crosses at both locations were planted at 100 lbs acre^{-1}, which is less than the recommended seeding rate for commercial varieties of wheat. This seeding rate allows for plenty of space for development of each plant and seed head, but also yields less than if a more commonly used seeding rate was used. Yields of the crosses harvested in Westfield averaged 582 lbs acre^{-1} (Table 4). Extreme weather in 2011 prevented harvesting in Westfield, however in Bridport in 2011, yields were similar, averaging around 600 lbs acre^{-1} (data not shown). Champlain x AC Barrie had the highest protein at 14.4% (Figure 1).

Table 4. Harvest data from F5 spring wheat crosses grown in Westfield, VT, 2012.

Cross	Population plants m^2	Height cm	Yield lbs $acre^{-1}$	Harvest Moisture %	Crude Protein 14% moist	Falling Number seconds	DON ppm
ACB/RF	268	103	745	19.5	12.0	**418***	0.5
Ch/ACB	310	94	522	18.9	**14.4**	405*	0.4
D/ACB	406*	101	709	19.0	13.2	371	0.5
H/Ch	369*	97	390	19.2	12.6	357	0.5
S/RB	**473***	100	543	18.6	11.6	362	0.4
Trial Mean	365	99	582	19.1	12.8	383	0.5
LSD (p<0.1)	114.65	NS	NS	NS	0.5812	29.992	NS

*Varieties with an asterisk indicate that it was not significantly different than the top performer in column (in **bold**).
NS - None of the varieties were significantly different from one another.

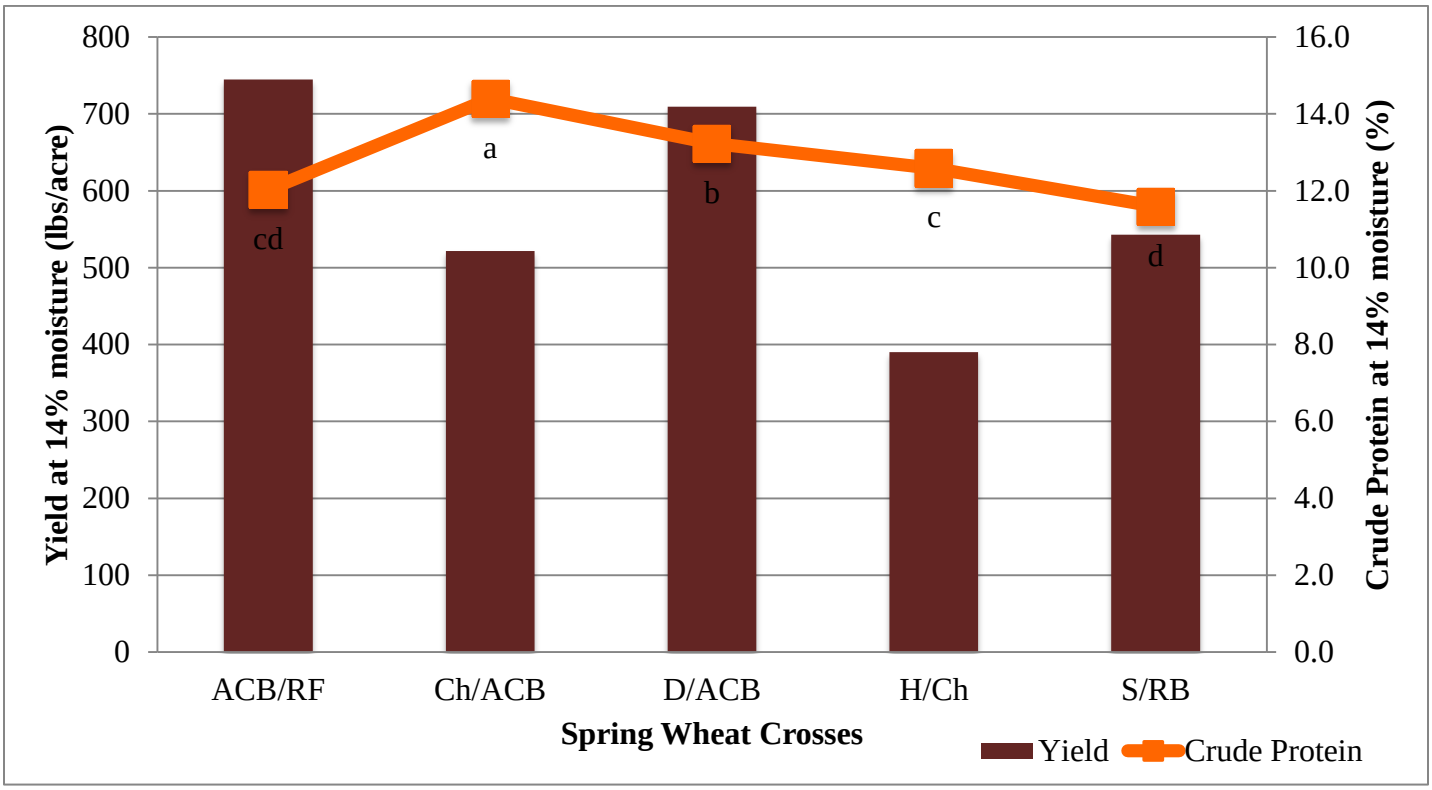

Figure 1. Yield and protein of spring wheat crosses grown in Westfield, VT, 2012.

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UVM Extension would like to thank Gleason Grains and Butterworks Farm for hosting these trials.

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

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