2014

Winter Small Grain Forage Trial Species x Harvest Date Dr. Heather Darby, UVM Extension Agronomist Susan Monahan, Erica Cummings, Julian Post and Sara Ziegler UVM Extension Crops and Soils Technicians 802-524-6501 Visit us on the web: http://www.uvm.edu/extension/cropsoil © March

Heather Darby
University of Vermont, heather.darby@uvm.edu

Susan Monahan
University of Vermont

Erica Cummings
University of Vermont

Julian Post
University of Vermont

Sara Ziegler
University of Vermont

NORTHWEST CROPS & SOILS PROGRAM

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UNIVERSITY OF VERMONT EXTENSION
CULTIVATING HEALTHY COMMUNITIES

2014 WINTER SMALL GRAIN FORAGE TRIAL: SPECIES x HARVEST DATE

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

Winter cereals are most commonly used as a cover crop in Vermont. Cereals such as barley, triticale, wheat, spelt and rye also have the potential to provide high yield and quality feed for livestock. These cool season annuals can provide early season grazing, as well as high quality stored feed. Winter grains are generally planted in mid-September and can be harvested at various stages of development. The objective of this project was to evaluate yield and quality of various winter grain species harvested in the vegetative, boot, milk, or soft dough stage. The overall goal of this project is to help livestock producers select winter grain species that best fit their forage needs. The data presented here is from one replicated research trial in Vermont. Crop performance data from additional tests in different locations, and often over several years, should be compared before you make conclusions.

MATERIALS AND METHODS

In the fall of 2013, a small grain forage trial was initiated at Borderview Research Farm in Alburgh, VT (Table 1). The previous crop in this location was corn, and the seedbed was prepared by conventional tillage methods. The field was disked and spike tooth harrowed in April to prepare for planting. Plots were planted with a six-inch Great Plains cone seeder on 27-Sep at a seeding rate of 100 lbs acre^{-1} (except spelt, which was seeded at 150 lbs acre^{-1}). Each treatment was harvested at four development stages: vegetative, boot, milk, and soft dough (Table 2). Subsamples of approximately 2.5 ft^2 were cut 3" from the ground, dried at 40^{o}C, and weighed to determine dry matter yield. Oven dry samples were coarsely ground with a Wiley mill (Thomas Scientific, Swedesboro, NJ), finely ground with a UDY cyclone mill with a 1 mm screen (Seedburo, Des Plaines, IL) and analyzed with an NIRS (Near Infrared Reflectance Spectroscopy) DS2500 Feed and Forage analyzer (Foss, Eden Prairie, MN) at the University of Vermont Cereal Testing Lab (Burlington, VT). Results were analyzed with an analysis of variance method of comparison in SAS (Cary, NC).

Table 1. General plot management.

Trial Information	Borderview Research Farm Alburgh, VT
Soil type	Covington silty clay loam
Previous crop	Corn
Row width (in.)	6
Planting date	27-Sep 2013
Seeding rate	100 lbs acre^{-1} (spelt 150 lbs acre^{-1})
Tillage methods	Mold board plow, disk, and spike tooth harrow

Forage quality analysis included crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF) and various other nutrients. Mixtures of true proteins, composed of amino acids and non-protein nitrogen make up the crude protein (CP) content of forages. The bulky characteristics of forage come from fiber. Forage feeding values are negatively associated with fiber content since the less digestible portions of the plant are contained in the fiber fraction. The detergent fiber analysis system separates forages into two parts: cell contents, which include sugars, starches, proteins, non-protein nitrogen, fats and other highly digestible compounds; and the less digestible components found in the fiber fraction. The total fiber content of forage is contained in the neutral detergent fiber (NDF). Chemically, this fraction includes cellulose, hemicellulose and lignin. Acid detergent fiber (ADF) represents the least digestible portion of fiber: the lignin and cellulose. Recently, forage testing laboratories have begun to evaluate forages for NDF digestibility. Evaluation of forages and other feedstuffs for NDF digestibility is being conducted to aid prediction of feed energy content and animal performance. Research has demonstrated that lactating dairy cows will eat more dry matter and produce more milk when fed forages with optimum NDF digestibility. Forages with increased NDF digestibility (NDFD)

will result in higher energy values, and perhaps more importantly, increased forage intakes. Forage NDF digestibility can range from 20 – 80%.

Table 2. Harvest date at each stage of maturity for the spring grain forages, 2014.

Variety	Vegetative	Boot	Milk	Soft dough
Barley	20-May	5-Jun	24-Jun	3-Jul
Rye	20-May	29-May	27-Jun	8-Jul
Spelt	20-May	18-Jun	8-Jul	31-Jul
Triticale	20-May	9-Jun	30-Jul	11-Jul
Wheat	20-May	9-Jun	30-Jul	11-Jul

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 a weather station in Alburgh, VT are shown in Table 3. The growing season was marked by lower than normal temperatures in September, April, and July, and higher than normal rainfall throughout the growing season (Apr-Jul). In Alburgh, there was an accumulation of 4756 Growing Degree Days (GDDs), which is 284 GDDs below the 30 year average.

Table 3. Seasonal weather data[1] collected in Alburgh, VT, 2013-2014.

Alburgh, VT	Sep-13	Oct-13	Apr-14	May-14	Jun-14	Jul-14
Average temperature (°F)	59.3	51.1	43.0	57.4	66.9	69.7
Departure from normal[2]	-1.30	2.90	-1.80	1.00	1.10	-0.90
Precipitation (inches)	2.20	2.39[◊]	4.34	4.90	6.09	5.15
Departure from normal	-1.44	-1.21	1.52	1.45	2.40	1.00
Growing Degree Days (base 32°F)	825	600	330	789	1041	1171
Departure from normal	-33.4	98.2	-53.9	32.8	27.3	-26.9

[1] Based on weather data from a Davis Instruments Vantage Pro2 with WeatherLink data logger.
[2] Historical averages are for 30 years of NOAA data (1981-2010) from Burlington, VT.
[◊] October 2013 precipitation data based on National Weather Service data from cooperative stations in Burlington, VT (http://www.nrcc.cornell.edu/page_nowdata.html).

Harvest Stage

Forages harvested in the soft dough stage yielded the highest dry matter (DM) averaging 8407 lbs dry matter acre^{-1} (Table 4). Protein levels were highest during the vegetative stage, averaging 18.3%. Additionally, the vegetative stage had the lowest ADF and NDF fiber content. Fiber content generally increases as plants mature, but the formation of starch in the soft dough stage dilutes overall fiber content. Digestible NDF was highest in the milk stage, averaging 57.7% of NDF.

Table 4. Cereal grain yield and quality compared across harvest stages.

Harvest	DM	Yield	CP	Starch	ADF	NDF	NFC	NDFD
	%	lb ac^{-1}	% of DM	% of DM	% of DM	% of DM	% of DM	% of NDF
Vegetative	21.7	925	**18.3***	3.2	**23.4***	**54.4***	28.5	40.8
Boot	18.7	3569	11.9	2.5	33.4	67.5	24.1	37.7
Milk	37.1	7073	6.8	7.7	38.6	59.6	32.3	**57.7***
Soft Dough	**43.1***	**8407***	5.6	**11.1***	36.5	56.9	**34.6***	50.8
Trial mean	30.1	4993	10.7	6.1	33.0	59.6	29.9	46.8
LSD (p<0.10)	1.97	740	0.68	0.81	1.10	1.88	1.22	1.24

Varieties with an asterisk indicate that it was not significantly different than the top performer in column **(in bold)**.

Small Grain Varieties

Averaged across all harvests, Triticale VNS (variety not stated), Triticale 141, and Huron rye yielded the highest, above 6100 lbs acre^{-1}, while barley had the highest protein, starch, NFC, digestible NDF, and lowest ADF and NDF fiber contents (Table 5).

Table 5. Small grain forage yield and quality averaged across four harvest stages (vegetative, boot, milk, and soft dough).

Variety	DM	Yield	CP	Starch	ADF	NDF	NFC	NDFD
	%	lb ac^{-1}	% of DM	% of DM	% of DM	% of DM	% of DM	% of NDF
Barley VNS	29.5	2706	**13.3***	**8.1***	**28.2***	**51.9***	**32.3***	**49.7***
Frederick Wheat	30.3	4897	9.5	6.4	33.0	60.2	31.1*	45.2
Huron Rye	30.7	6175*	8.9	3.4	38.1	67.7	26.2	46.1
Malabar Wheat	32.3	3605	10.0	7.8*	30.6	56.8	32.6*	47.2
Spelt	32.0	4927	10.9	5.0	35.2	62.8	27.1	42.9
Trical 099	28.0	4946	11.2	7.2*	31.2	56.1	31.7*	49.5*
Trical 141	29.1	6299*	11.1	4.8	35.8	62.8	27.0	45.9
Trical VNS	29.3	**6390***	10.5	6.3	31.8	58.7	30.9*	47.5
Trial Mean	30.1	4993	10.7	6.1	33.0	59.6	29.9	46.8
LSD (p<0.10)	NS	1047	0.96	1.15	1.55	2.66	1.73	1.75

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.

Harvest Stage x Variety Interaction

There was a harvest stage by variety interaction for each parameter studied (except crude protein), which indicates that varieties performed differently at each harvest. For example, Figure 1 shows that DM yields of winter small grains increased with each stage of maturity, except for spelt and Tritical 141. Spelt's milk stage yields were less than the boot stage. Additionally, Tritical 141 had higher yields in the milk stage than in the soft dough stage. It is possible the crop lost leaf biomass from the milk to the soft dough stage. It is also possible this interaction may be due to stand variability at sample time. Increasing plot size would decrease these errors.

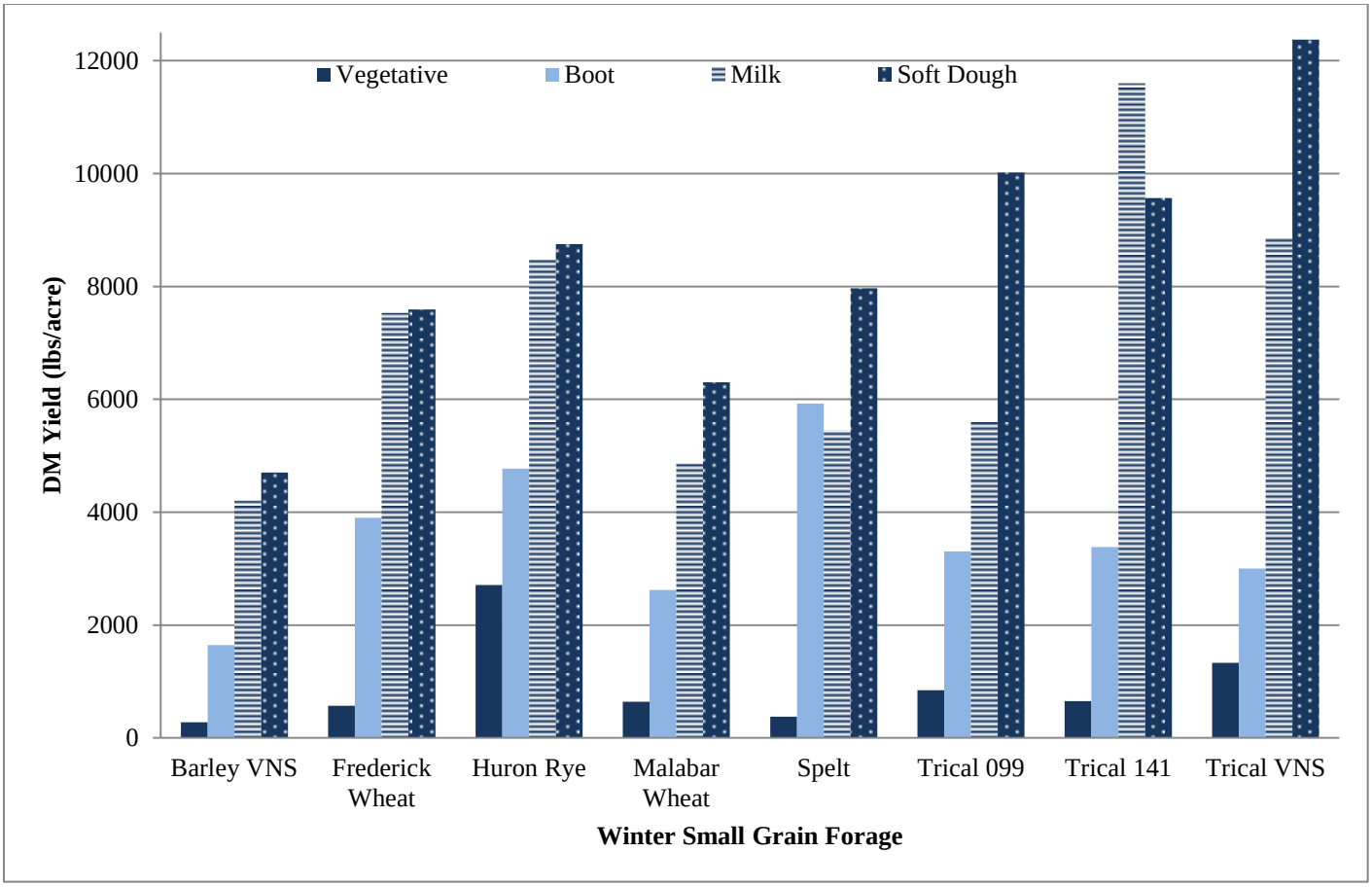

Figure 1. Dry matter yields of eight small grain forages at four stages of maturity (vegetative, boot, milk, and soft dough).

Vegetative Stage Harvest

Forages were harvested at the vegetative stage to document the value of small grains as a potential early season grazing crop. At the vegetative harvest, the highest yielding treatment was Huron rye, averaging 2708 lbs dry matter acre^{-1} (Table 6). Barley had the highest protein levels, over 21% CP (Figure 2). Barley also had the lowest ADF and NDF fiber contents and the highest NFC levels.

Table 6. Small grain forage yield and quality when harvested in the vegetative stage, 20-May 2014.

Vegetative	DM %	Yield lb ac^{-1}	CP % of DM	Starch % of DM	ADF % of DM	NDF % of DM	NFC % of DM	NDFD % of NDF
Barley VNS	23.2*	275	**21.8***	4.0*	**20.5***	**48.0***	**30.2***	41.8
Frederick Wheat	21.3	570	16.7	3.1	23.9	55.5	28.8	40.6
Huron Rye	17.6	**2708***	16.6	1.5	27.4	61.8	24.3	40.7
Malabar Wheat	23.2*	641	17.6	3.5	22.3	53.6	29.5*	43.3
Spelt	**25.1***	378	19.0	**4.1***	22.5	52.5	29.2*	39.0
Trical 099	21.1	847	17.6	3.6*	23.4	54.1	29.7*	40.0
Trical 141	20.5	651	19.3	2.9	23.7	54.0	28.4	40.4
Trical VNS	21.6	1330	18.1	2.6	23.5	56.0	28.0	40.7
Veg Mean	21.7	925	18.3	3.2	23.4	54.4	28.5	40.8
LSD (p<0.10)	2.77	312.0	1.90	0.59	1.50	2.59	1.39	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.

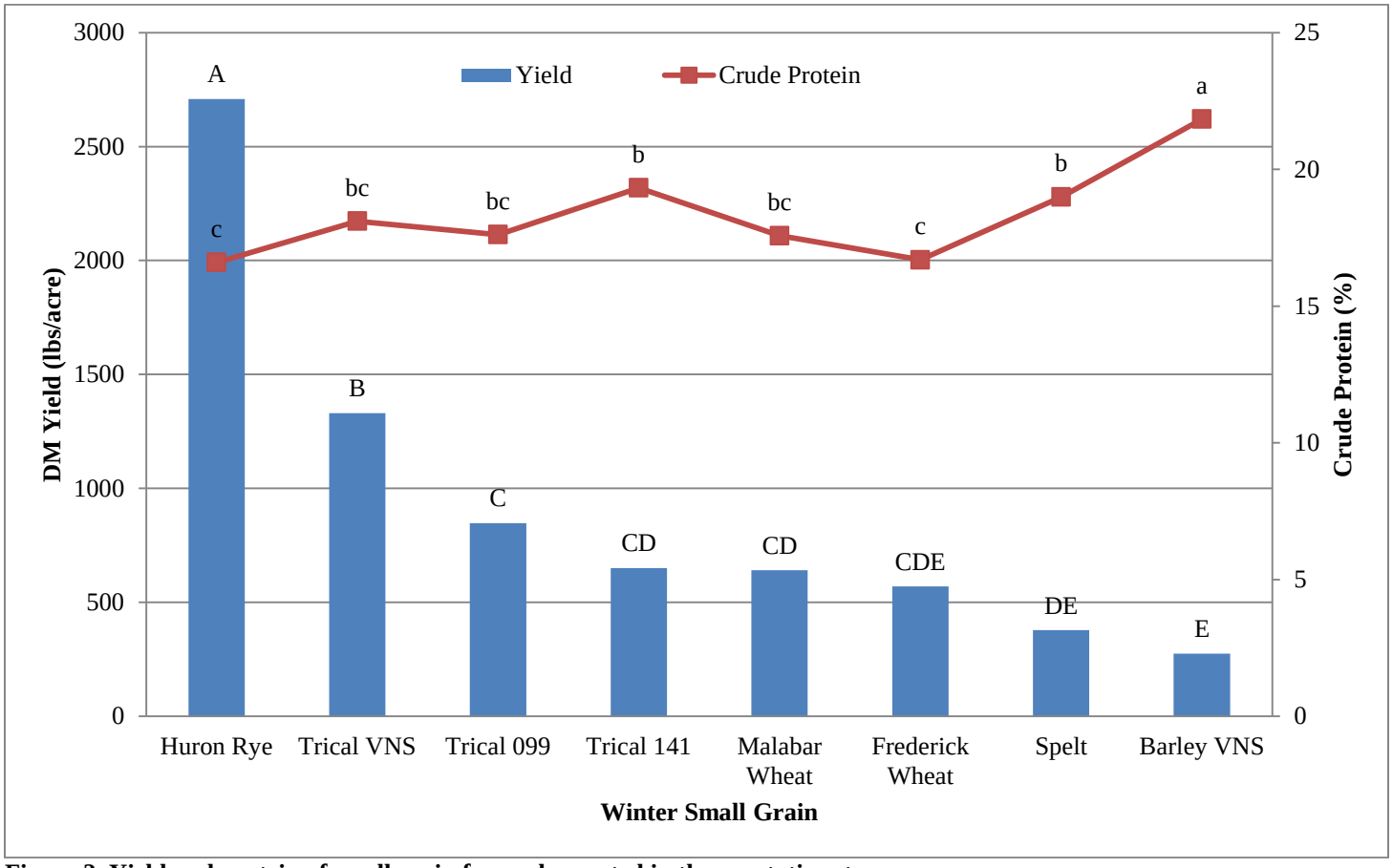

Figure 2. Yield and protein of small grain forage harvested in the vegetative stage.
Treatments with the same letter did not differ significantly from one another.

Boot Stage Harvest

In small grain development, the boot stage occurs when the grain head is just barely visible and about to emerge. This is the most common stage at which small grains are harvested for forage. Spelt had the greatest dry matter yields of the boot stage, yielding 5927 lbs dry matter acre^{-1} (Table 7 and Figure 3). There was no difference in protein levels in the boot stage, which averaged 11.9%. Overall, barley had the highest starch, NFC, NDFD and the lowest ADF and NDF fiber levels.

Table 7. Small grain forage yield and quality harvested in the boot stage, late May-early June 2014.

Boot	DM %	Yield lb ac^{-1}	CP % of DM	Starch % of DM	ADF % of DM	NDF % of DM	NFC % of DM	NDFD % of NDF
Barley VNS	20.3*	1645	14.7	**3.7***	**28.8***	**60.4***	**27.1***	**41.0***
Frederick Wheat	**21.5***	3900	9.3	2.5	35.0	71.0	25.2*	33.8
Huron Rye	16.8	4772	10.3	1.2	37.9	73.1	18.9	35.6
Malabar Wheat	19.3	2619	11.4	3.4*	31.9	65.3	26.3*	40.4*
Spelt	20.2*	**5927***	12.1	1.3	36.6	72.0	21.3	33.0
Trical 099	17.1	3305	12.3	3.3*	31.6	64.2	26.2	40.7*
Trical 141	16.2	3382	13.1	1.9	34.1	67.6	22.8	38.7*
Trical VNS	18.0	2999	11.8	2.9	31.6	66.3	24.8	38.6*
Boot Mean	18.7	3569	11.9	2.5	33.4	67.5	24.1	37.7
LSD (p<0.10)	1.50	1114	NS	0.69	2.66	4.40	2.19	3.09

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.

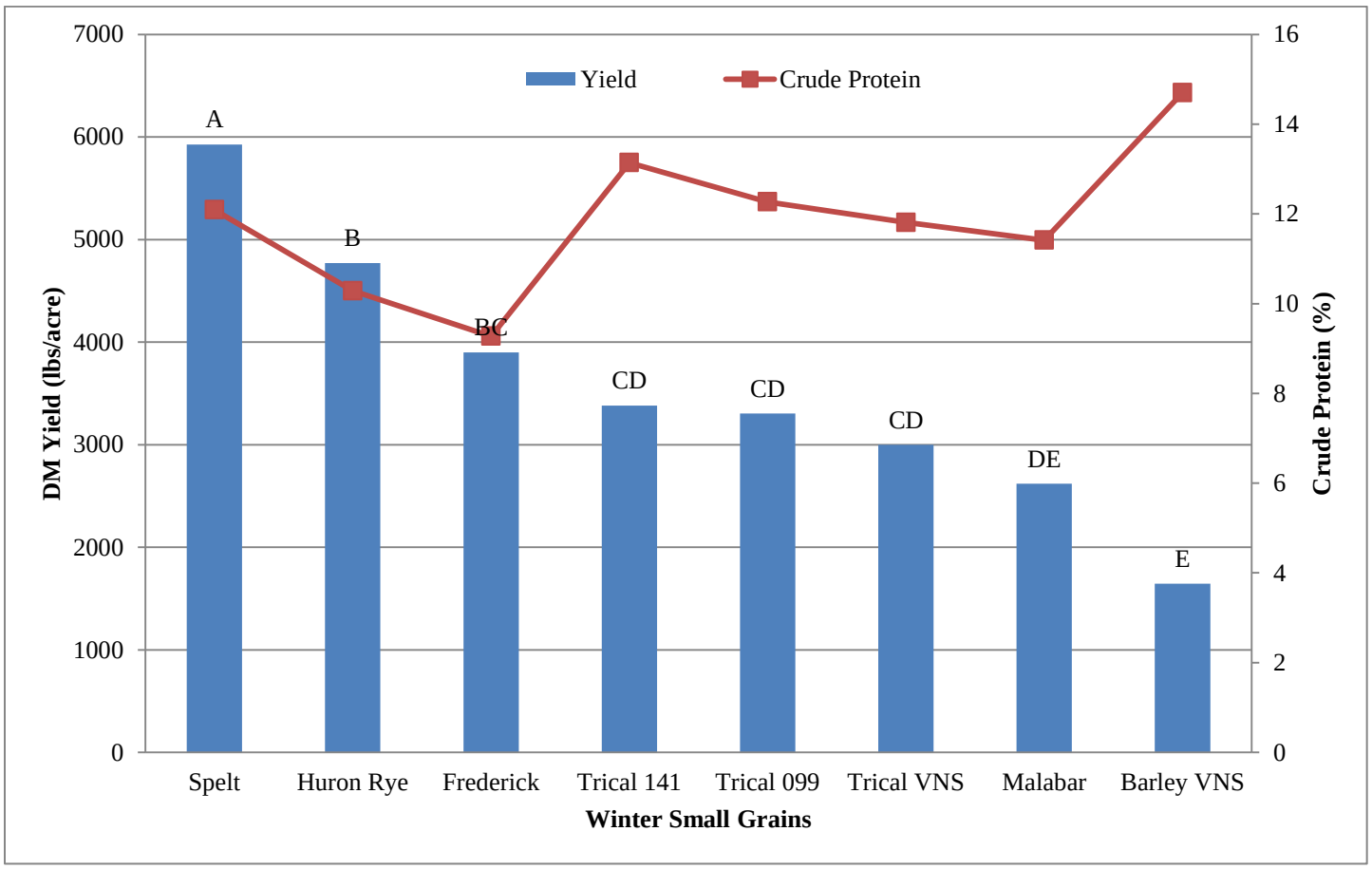

Figure 3. Yield and protein of small grain forage in the boot stage.
Treatments with the same letter did not differ significantly from one another.

Milk Stage Harvest

Tritical 141 was the highest yielding forage when harvested during the milk stage, yielding over 11,000 lbs dry matter acre^{-1} (Table 8 and Figure 4). Barley had the highest protein levels of the milk stage at 8.7%. Barley was also a top performer for the other quality characteristics with the lowest ADF and NDF fiber content, and highest starch level.

Table 8. Small grain forage yield and quality harvested at the milk stage, late June-early July 2014.

Milk	DM %	Yield lb ac^{-1}	CP % of DM	Starch % of DM	ADF % of DM	NDF % of DM	NFC % of DM	NDFD % of NDF
Barley VNS	29.9	4205	**8.7***	**11.6***	**32.5***	**49.6***	35.3	61.1*
Frederick Wheat	34.5	7528	6.6	6.7	39.4	61.4	31.3	56.7
Huron Rye	48.1	8470	5.5	4.3	43.6	67.5	30.4	59.2*
Malabar Wheat	38.9	4859	6.0	10.5*	35.1	55.2	**37.0***	56.1
Spelt	37.1	5443	7.1*	6.1	41.0	63.7	29.9	54.8
Trical 099	34.0	5616	7.9*	8.7	36.6	56.0	32.8	60.0
Trical 141	38.9	**11598***	6.1	4.8	44.4	69.0	27.3	51.3
Trical VNS	35.0	8861*	6.8	8.9	36.1	54.6	34.5*	**62.2***
Milk Mean	37.1	7073	6.8	7.7	38.6	59.6	32.3	57.7
LSD (p<0.10)	NS	3058	1.62	2.21	2.36	3.66	3.48	4.70

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.

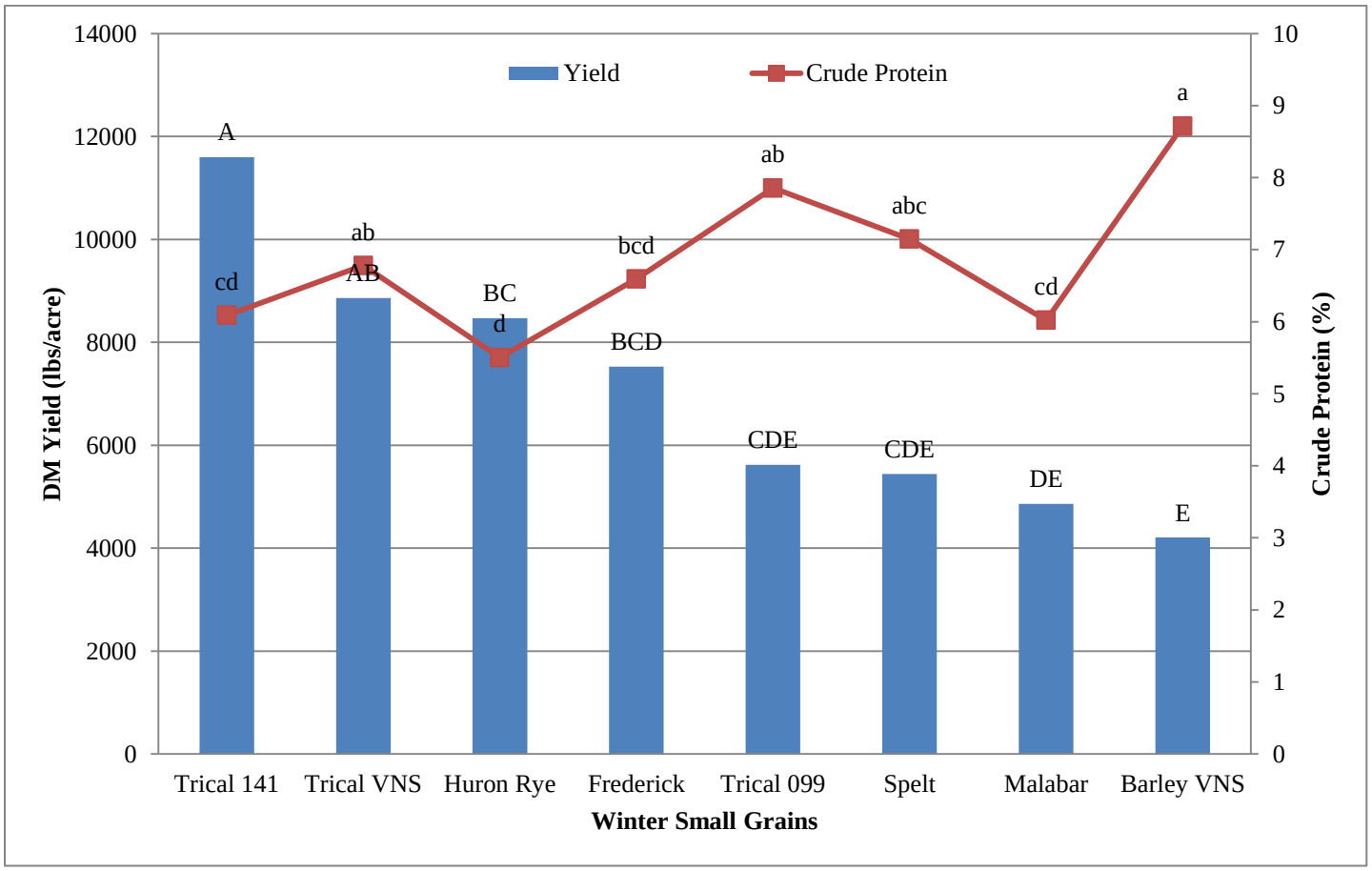

Figure 4. Yield and crude protein (CP) of small grain forages harvested in the milk stage.
Treatments with the same letter did not differ significantly from one another.

Soft Dough Harvest

Two of the triticale varieties yielded the highest of all the forage species in the soft dough stage, over 10,000 lbs acre^{-1} (Table 9, Figure 5). Barley had the highest CP levels at 7.8%. Again, barley was a top performer for other quality characteristics with the lowest ADF and NDF fiber content, and high NDFD and starch levels.

Table 9. Small grain forage yield and quality at the soft dough stage, mid-July 2014.

Soft Dough	DM %	Yield lb ac^{-1}	CP % of DM	Starch % of DM	ADF % of DM	NDF % of DM	NFC % of DM	NDFD % of NDF
Barley VNS	44.7	4700	**7.8***	13.0*	**31.1***	**49.6***	36.7*	54.9*
Frederick Wheat	43.8	7590	5.3	13.2*	33.5*	52.9*	**39.0***	49.7
Huron Rye	40.3	8750	3.4	6.7	43.6	68.5	31.2	48.6
Malabar Wheat	**47.8***	6301	4.9	**13.9***	33.1*	53.0*	37.4*	49.0
Spelt	45.5*	7962	5.5	8.5	40.8	63.0	28.2	44.6
Trical 099	39.8	10016*	7.2*	13.3*	33.1*	50.3*	38.2*	**57.4***
Trical 141	40.7	9565	5.8	9.5	41.1	60.6	29.6	53.4
Trical VNS	42.5	**12370***	5.5	10.7*	36.0*	57.8*	36.4*	48.6
SD Mean	43.1	8407	5.6	11.1	36.5	56.9	34.6	50.8
LSD (p<0.10)	2.63	2626.8	1.22	4.09	5.09	9.14	5.66	3.58

Varieties with an asterisk indicate that it was not significantly different than the top performer in column (in **bold**).

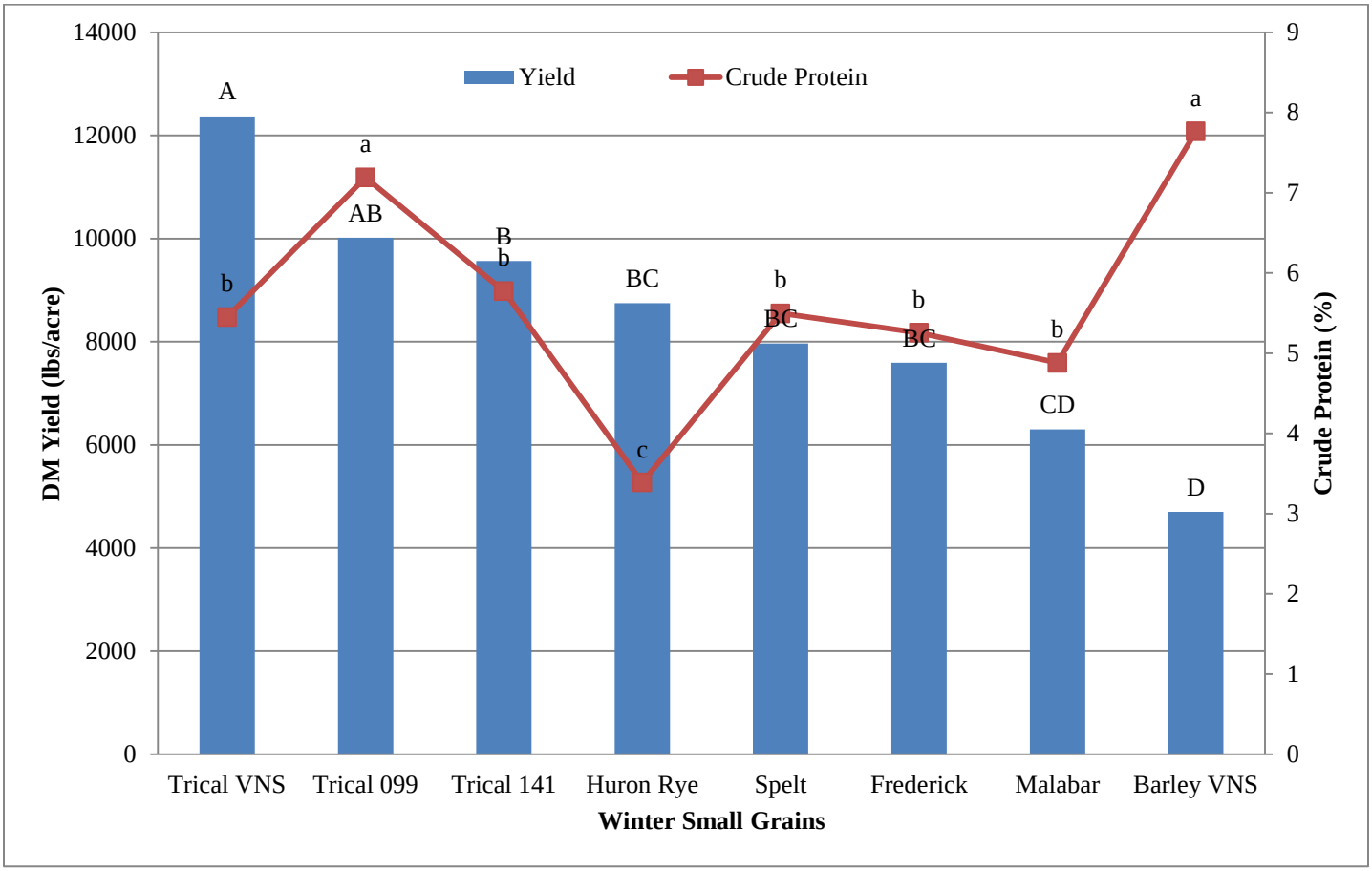

Figure 5. Yield and crude protein of small grain forage harvested in the soft dough stage.
Treatments with the same letter did not differ significantly from one another.

ACKNOWLEDGEMENTS

The UVM Extension Northwest Crops and Soils Team would like to thank Roger Rainville and the staff at Borderview Research Farm for their generous help with this research trial. We would like to acknowledge Conner Burke, Lily Calderwood, Julija Cubins, Hannah Harwood, Ben Leduc, Laura Madden, and Dana Vesty for their assistance with data collection and entry. This information is presented with the understanding that no product discrimination is intended and neither endorsement of any product mentioned, nor criticism of unnamed products, is implied.

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