NORTHWEST CROPS & SOILS PROGRAM

2014 Early Fall Cover Cropping Trial

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2014 EARLY FALL COVER CROPPING TRIAL

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Farmers are interested in expanding their cover crop options beyond winter rye. Species of interest include annual ryegrass, oats, vetch, winter pea, tillage radish, and canola. These species have not been commonly grown as cover crops in the region because they require an earlier establishment date compared to that of winter rye. Farmers are interested in finding alternative cover crops and cover crop mixtures that may provide additional benefits over the standard practice. As an example, incorporating winter peas or vetch would provide a nitrogen fixing cover crop to the system. Annual ryegrass may provide better soil cover and easier to manage level of biomass in the spring compared to winter rye. Farmers are interested in oats as they would winter kill and hence, reduce the need for spring biomass management. Tillage radish may help break up compacted soil layers and improve soil drainage.

To be successful with these alternative cover crops it is important to know the proper planting date to provide the intended benefits. It is also essential to document if annual ryegrass, winter pea, and vetch will survive the winter conditions of the region. The goal of this project was to evaluate yield and percent cover of WinEarly ryegrass, Kospeed ryegrass, Riley winter canola, Lynx peas, oats, vetch, tillage radish, and mixes of rye/canola, oats/radish, and rye/radish planted in mid-Sep (Figure 1).

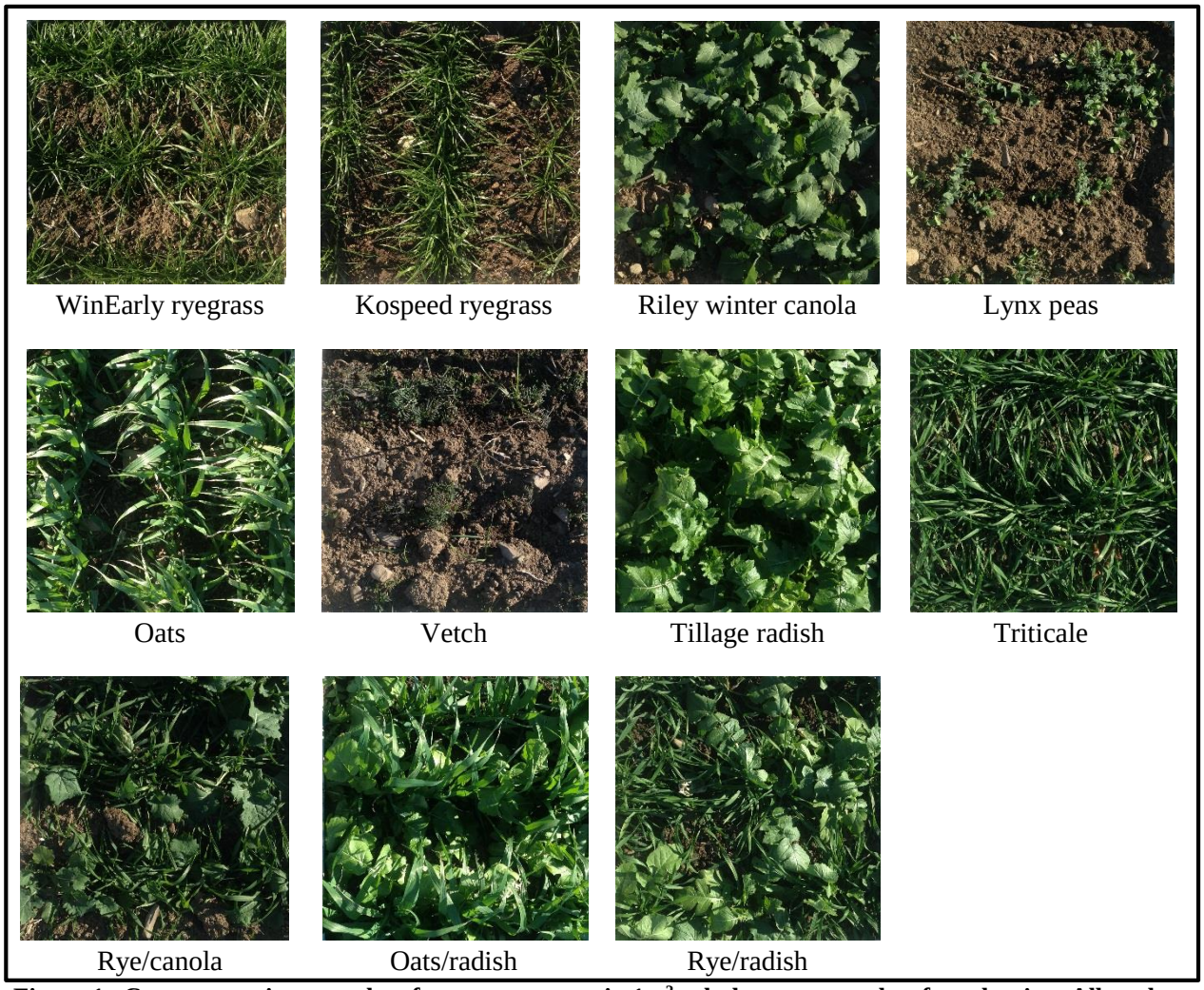

Figure 1. Cover crop pictures taken for percent cover in 1m^2 subplots two months after planting, Alburgh, VT, 2014.

MATERIALS AND METHODS

The early fall cover cropping system was established at Borderview Research Farm in Alburgh, VT (Table 1). The experimental design was a randomized complete block with cover crops and cover crop mixes serving as treatments.

The soil type at the research site was a Benson rocky silt loam with 8-15% slopes (Table 1). Each cover cropping treatment was replicated four times in 5'x20' plots. All cover crops were planted on 15-Sep following recommended seeding rates established by the USDA NRCS VT Cover Cropping Standard (Table 2). Plots were previously planted with a mixture of barley and oats. Pictures for percent cover analysis were taken on 15-Nov following standard procedures for imaging analysis with Rasmussen and Nørremark's IMAGING Crop Response Analyser (Figure 1). To determine yields biomass samples of all cover crops were harvested with hand clippers in a $1m^2$ area on 18-Nov. Soil samples were collected on 18-Nov using a 1-inch diameter Oakfield core to 6 inches in depth at five locations in each plot planted with oat, tillage radish, pea, and WinEarly ryegrass. The samples were combined by plot and analyzed by University of Maine's Soil Testing Laboratory using Modified Morgan extract and ICP.

Table 1. Agronomic information for early fall cover cropping system, Alburgh, VT, 2014.

Location	Borderview Research Farm – Alburgh, VT
Soil type	Benson rocky silt loam, 8-15% slope
Previous crop	Barley/oats
Plot size (ft)	5 x 20
Replications	4
Planting equipment	Great Plains Cone Seeder
Planting date	15-Sep

Table 2. Seeding rate for early fall cover cropping system, Alburgh, VT, 2014.

Cover Crop	Seeding rate: lbs/acre
WinEarly ryegrass	20
Kospeed ryegrass	20
Riley winter canola	6
Lynx peas	65
VNS oats	75
VNS vetch	20
Tillage radish	10
VNS rye/tillage radish	85/3
VNS rye/winter canola	85/4
VNS oats/tillage radish	85/3
VNS triticale	75

Yield data and stand characteristics were analyzed using mixed model analysis using the mixed procedure of SAS (SAS Institute, 1999). Replications within trials were treated as random effects, and cover crops

were treated as fixed. Cover crop mean comparisons were made using the Least Significant Difference (LSD) procedure when the F-test was considered significant ($p<0.10$).

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 cover crops 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 (LSDs) at the 0.10 level of significance are shown. Where the difference between cover crops within a column is equal to or greater than the LSD value at the bottom of the column, you can be sure that for 9 out of 10 times, there is a real difference between the cover crops. Cover crops that were not significantly lower in performance than the highest cover crop in a particular column are indicated with an asterisk. In the example below, cover crop C is significantly different from cover crop A but not from cover crop B. The difference between C and B is equal to 1.5, which is less than the LSD value of 2.0. This means that these cover crops did not differ in yield. The difference between C and A is equal to 3.0 which is greater than the LSD value of 2.0. This means that the yields of these cover crops were significantly different from one another. The asterisk indicates that cover crop B was not significantly lower than the top yielding cover crop C, indicated in bold.

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

RESULTS

Weather Data

Weather data was collected with an onsite Davis Instruments Vantage Pro2 weather station equipped with a WeatherLink data logger. Temperature, precipitation, and accumulation of Growing Degree Days (GDDs) are consolidated for the 2014 growing season (Table 3). Historical weather data are from 1981-2010 at cooperative observation stations in Burlington, VT, approximately 45 miles from Alburgh, VT.

The fall of 2014 was warmer by 2.4°F and dryer with 1.56 inches less rain than the average year. The warmer weather may have increased growing potential while the lack of precipitation may have stunted growth. Overall there were 127 more GDDs for canola and wheat/grains than the 30-year average (Table 3).

Table 3. Consolidated weather data and GDDs for corn, Alburgh, VT, 2014.

Alburgh, VT	September	October	November
Average temperature (°F)	60.6	51.9	36.9
Departure from normal	0.0	3.7	-1.3
Precipitation (inches)	1.33	4.27	1.56
Departure from normal	-2.31	0.67	-1.56
Canola GDDs (base 32°F)	860	622	190
Departure from normal	2	119	6
Wheat/grains GDDs (base 32°F)	860	622	190
Departure from normal	2	119	6

Based on weather data from a Davis Instruments Vantage Pro2 with WeatherLink data logger.
Historical averages are for 30 years of NOAA data (1981-2010) from Burlington, VT.

Soil Data

On 18-Nov, soil samples were collected on oats, peas, tillage radish, and WinEarly ryegrass treatments (Table 4). The winter pea cover crop treatment had the most nitrogen (17.2 ppm), as NO_3-N, but was not statistically different from WinEarly ryegrass (13.5 ppm). The radish and oat treatments had the lowest soil nitrate levels potentially indicating more growth than the other cover crops. Soils with WinEarly ryegrass had the highest levels of Mg (97.5 ppm), Na (11.5 ppm), and S (8.0 ppm), but was not statistically different from two other cropping systems for each nutrient. For example, the tillage radish plots were statistically lower in Mg (71.8 ppm) than other treatments and oats were statistically lower in S (6.3 ppm) and Na (6.5 ppm) than other treatments. There was no statistically significant difference in other measured soil fertility parameters among treatments.

Table 4. Soil nutrient analysis for select cover cropping systems, Alburgh, VT, 2014.

Cover crop	pH	Organic matter %	Al ppm	NO_3-N ppm	Available P ppm	K ppm	Mg ppm	S ppm	Na ppm	Effective CEC meq
VNS Oats	7.4	4.6	9.0	8.50	2.8	49.8	80.0*	6.3	6.50	26.6
Lynx Peas	7.1	4.2	13.5	**17.2***	2.7	49.3	93.8*	7.8*	10.5*	27.9
Tillage Radish	7.3	4.1	10.3	9.50	3.2	52.5	71.8	6.5*	8.80*	20.5
WinEarly Ryegrass	7.3	4.4	12.3	13.5*	3.4	53.3	**97.5***	**8.0***	**11.5***	33.1
LSD (0.10)	NS	NS	NS	4.9	NS	NS	17.8	1.6	4.8	NS
Trial Mean	7.3	4.3	11.3	12.2	3.0	51.2	85.8	7.1	9.3	27.0

Treatments shown in **bold** are top-performing 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.

Yield Data

Pictures for percent cover analysis were taken on 15-Nov. On 18-Nov, a $1m^2$ subsample was collected from each plot to determine yield, measured in dry pounds $acre^{-1}$ (Table 5). Oats had the highest percent cover of any grain (51.9%) and the percent cover was boosted over 10% when combined with tillage radish (62.9%). Oats (51.9%), tillage radish (51.7%), and rye/tillage radish (51.7%) were more similar than any other treatments. Percent cover of winter canola (49.6%) decreased by 10% when mixed with VNS rye (38.5%). Plots with tillage radish produced the highest yield (558 lbs $acre^{-1}$), but did not statistically outperform oats or the two cover crop mixes with tillage radish (Figure 2). Plot dry matter yield of tillage radish decreased by 162 lbs $acre^{-1}$ when mixed with rye. Of the two brassicas, tillage radish plots statistically yielded more dry matter than winter canola. Only oats did not perform significantly lower than plots with tillage radish.

Table 5. Percent cover and yield of cover cropping treatments, Alburgh, VT, 2014.

Cover cropping system	Percent cover %	Yield lbs ac^{-1}
Tillage radish	51.7*	**559***
VNS Oats/Tillage radish	**62.9***	396*
VNS Rye/Tillage radish	51.7*	384*
VNS Oats	51.9*	382*
Winter Canola	49.6*	273
Lynx Peas	6.44	265
Kospeed ryegrass	8.09	262
VNS Vetch	0.99	210
WinEarly ryegrass	24.9	142
VNS Rye/Winter canola	38.5*	129
VNS Triticale	30.2	ND
LSD (0.10)	14.7	272
Trial mean	34.3	300

Treatments shown in **bold** are top-performing in a particular column.
* Treatments with an asterisk did not perform significantly lower than the top-performing treatment in a particular column.
ND – Not determined.

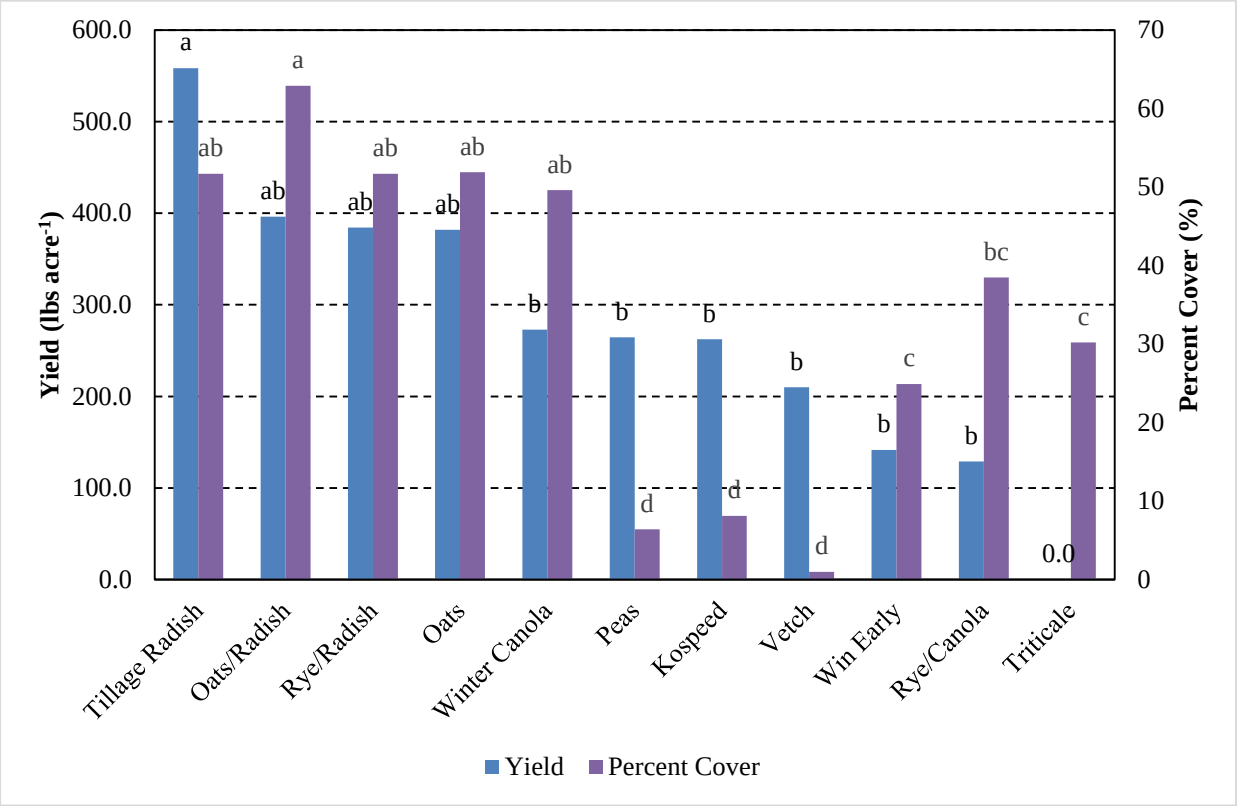

Figure 2. Yield and percent cover of cover crops, Alburgh, VT, 2014. Treatments, by variable (yield or percent cover) that share a letter were not significantly different from one another (p=0.10).

DISCUSSION

It is important to note that the results of this trial represent only one year of data and only in one location. The goal of this project is to assess the impact of early fall cover crops on soil fertility and the biomass they can produce late in the growing season. This trial showed that plots planted with peas had significantly more NO_3-N. Peas are hosts to bacteria that fix atmospheric nitrogen and do not need as much soil nitrogen as other non-leguminous plants. Plots planted with peas leave more residual soil nitrogen that is susceptible to leaching. WinEarly ryegrass plots did not significantly differ from peas in soil nitrogen concentrations and overall had the highest soil fertility measurements. WinEarly ryegrass established poorly and nutrient uptake was limited compared to more vigorous cover crops, oats and radish.

In general, crops mixed with brassicas had higher percent cover than those that did not. This may be because they are quick to germinate and produce broad, horizontal leaves. In contrast, the Kospeed annual ryegrass, peas, and vetch had the lowest percent cover of any of the treatments. This may be because they are slower to establish under cooler conditions and did not have adequate time to grow prior to fall dormancy. Earlier planting dates would improve the productivity of these cover crop species. In terms of yield, plots with tillage radish produced the highest yield. This study suggests that brassicas are a good

addition to cover crops mixes if planting cover crops to limit erosion or produce high amounts of dry matter.

This study did not analyze all cover crop treatments for soil fertility and results may be different with different plant varieties. Variety selection may be important as demonstrated by the differing strengths of the annual ryegrass varieties compared in this study. Kospeed ryegrass had 1/3 the percent cover and 120 lbs acre^{-1} more dry matter than WinEarly ryegrass. All cover crops do not produce the same outcome. When choosing which cover crops to plant, goals should be considered.

This early fall cover crop trial demonstrates that tillage radish, tillage radish mixes, and oats are the highest performers in terms of overall production and nutrient uptake. The growth of the cover crops was aided by a warmer than usual autumn. Even with these favorable conditions, the full benefits of the cover crops were not realized. In a complimentary late summer study, oats planted in late August had a similar amount of ground cover, but produced over twice as much biomass (Table 6). Both Kospeed ryegrass and Lynx peas had more than five times the ground cover when planted in late summer than in the early fall. It is recommended to plant cover crops earlier than the middle of September to gain maximum return.

Table 6. Percent cover and yield of late summer and early fall cover crops, Alburgh, VT, 2014.

	Percent cover %		Yield lbs ac^{-1}	
Cover cropping system	Late summer	Early fall	Late summer	Early fall
VNS Oats	54.8	51.9	730	382
Lynx Peas	34.7	6.44	176	265
Kospeed ryegrass	71.5	8.09	451	262

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