2016 Cover Crop Mix in Corn Silage Trial

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2016 COVER CROP MIX IN CORN SILAGE TRIAL

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While growing corn silage, it is important to plan for soil health management during the season. Cover cropping is one way to prevent soil erosion, maintain and/or improve soil nutrients, improve soil aggregation, prevent nutrient loss from runoff, and increase water retention. Such soil improvements can promote conditions that add resiliency to a crop, especially in light of extreme weather patterns that may affect yields. It can be challenging to integrate cover crops into corn silage systems. Late harvest of corn silage can limit the ability to properly establish cover crops in the fall. Interseeding cover crops or earlier corn harvest can help get cover crops seeded earlier and help increase the overall benefits of the cover crop. In this trial, our goals were to evaluate the effect of three cover crop seeding dates and a variety of cover crop mixes for biomass production and percent cover. In order to evaluate how cover crops may fit into a corn silage system, we also evaluated three corn varieties at 85, 96, and 110 relative maturity (RM) for yield differences.

MATERIALS AND METHODS

The cover crop mix in corn silage trial took place at Borderview Research Farm in Alburgh, VT. Three maturities of corn, Mycogen TMF2R720 110 day RM, Mycogen TMF2Q419 96 day RM, and Mycogen TMF2R198 85 day RM were planted on 11-May. The 85 and 96 day corn were each planted into a 7000 ft^2 area and the 110 day corn was planted into a 11,100 ft^2 area. Corn was harvested from the 110 day corn on 4-Oct, the 96 day corn on 15-Sep, and the 85 day corn on 1-Sep. General plot information for the corn silage plantings are shared in Table 1.

Table 1. General plot management of corn plantings, 2016.

Trial Information	Borderview Research Farm Alburgh, VT
Soil Type	Benson rocky silt loam 8-15% slope
Previous crop	Corn
Starter fertilizer	200 lbs ac^{-1} of 10-20-20
Varieties	Mycogen TMF2R720, 110 RM Mycogen TMF2Q419, 96 RM Mycogen TMF2R198, 85 RM
Corn planting dates	11-May
Harvest dates	4-Oct, 15-Sep, 1-Sep
Corn seeding rate	34,000 seeds ac^{-1}
Tillage methods	Disk and spike tooth harrow

After each maturity of corn was harvested, the cover crop experiments were planted. The experimental design for the cover crop mixes was a randomized complete block, with 3 replications, and a plot size of 5'x20'. On 6-Sep, 15-Sep, and 5-Oct, nine cover crop mixes were planted following corn silage harvest using a grain drill and a control plot was established. Mixes 1 and 8 were based off of cover crop mixes in the Cover Crop Specification Guide Sheet 340 (Vermont Natural Resource Conservation Services, United States Department of Agriculture). General plot information is shared in Table 2 and the cover crop mixes are listed in Table 3.

Table 2. General plot management of cover crop plantings, Alburgh, VT, 2016.

Trial Information	Borderview Research Farm Alburgh, VT
Soil Type	Benson rocky silt loam 8-15% slope
Previous crop	Barley
Plot size (ft)	5x20
Cover crop planting dates	6-Sep 15-Sep 5-Oct

Table 3. Cover crop mixes, Alburgh, VT 2016.

Cover crop mixes
Mix 1: Annual ryegrass, crimson clover, arifi radish (pre-mixed) (24 lbs ac^{-1})
Mix 2: Fridge triticale (40 lbs ac^{-1}), t-raptor radish (2 lbs ac^{-1}), mammoth red clover (5 lbs ac^{-1}), lynx winter pea (20 lbs ac^{-1})
Mix 3: Winter rye (40 lbs ac^{-1}), dynamite clover (1 lbs ac^{-1}), and appin turnip (2 lbs ac^{-1})
Mix 4: Hypoctance triticale (60 lbs ac^{-1}), dynamite clover (3 lbs ac^{-1}), and appin turnip (2 lbs ac^{-1})
Mix 5: Everleaf oats (60 lbs ac^{-1}), groundhog radish (3 lbs ac^{-1})
Mix 6: Tri-cal triticale (60 lbs ac^{-1}) and dwarf essex rape (3 lbs ac^{-1})
Mix 7: Everleaf oats (40 lbs ac^{-1}), duration clover (5 lbs ac^{-1}), appin turnip (2 lbs ac^{-1})
Mix 8: Annual ryegrass and arifi radish (pre-mixed) (18 lbs ac^{-1})
Mix 9: Fria ryegrass (annual) (22 lbs ac^{-1}) and eco-till radish (3 lbs ac^{-1})
10: No cover crop CONTROL

On 27-Oct, heights were measured for each cover crop mix by randomly taking the height of 3 plants per plot. Biomass yield was also measured by clipping the contents in one 0.5 m^2 quadrat per plot. Harvest moisture was calculated by drying the biomass samples at 105° F until they reached a stable weight. Photos of the cover crop were taken in order to assess the percent cover from the cover crop, as opposed to the bare ground. Percent cover was measured by using the web based IMAGING crop response analyzer. Digital images were taken with a compact digital camera, Canon PowerShot G12 (Melville, NY) (10.4 Megapixels). Digital images were analyzed with the automated imaging software, which was programmed in MATLAB (MathWorks, Inc., Natick, MA) and later converted into a free web-based software (www.imaging-crops.dk).

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 following example, 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**

The p-value is another statistical marker that is given. This value represents the probability that the difference between treatments happened randomly by chance. For example, a trial comparing the nutritive quality of forage A and forage B has a p-value of 0.01. That means that there is a 1% chance that the difference in quality between the two forages was a random occurrence and there is a 99% chance that the difference in quality was due to the difference in the forages themselves.

RESULTS AND DISCUSSION

Seasonal precipitation and temperature were recorded with a Davis Instrument Vantage Pro2 weather station, equipped with a WeatherLink data logger at Borderview Research Farm in Alburgh, VT. Most of the growing season was dry, with May-September experiencing 0.88-2.37 less inches of precipitation per month than normal (Table 4). October experienced more precipitation, with 1.39 more inches than normal. Temperatures in June-July were comparable to historical averages, while May and August-October was at least 1.8 degrees warmer than normal, per month. Overall, there were an accumulated 2708 Growing Degree Days (GDDs) this season, approximately 302 more than the historical average.

Table 4. Seasonal weather data[1] collected in Alburgh, VT, 2016.

Alburgh, VT	May	June	July	August	September	October
Average temperature (°F)	58.1	65.8	70.7	71.6	63.4	50.0
Departure from normal	1.80	0.00	0.10	2.90	2.90	1.90
Precipitation (inches)	1.50	2.80	1.80	3.00	2.50	5.00
Departure from normal	-1.92	-0.88	-2.37	-0.93	-1.17	1.39
Growing Degree Days (base 50°F)	340	481	640	663	438	146
Departure from normal	74	7	1	82	104	34

[1]Based on weather data from a Davis Instruments Vantage Pro2 with WeatherLink data logger. Alburgh precipitation data from August-October was provided by the NOAA data for Highgate, VT.
Historical averages are for 30 years of NOAA data (1981-2010) from Burlington, VT.

Trial plantings of 85, 96, and 110 day corn yielded 19.0-25.0 tons ac^{-1} (Table 5). The 110 day corn yielded at most 6 tons higher than the earlier maturing corn varieties. Early planting and optimum growing conditions allowed the full season variety to reach yield potential. Interestingly in 2015, the mid and short season varieties yielded 5 tons higher than the full season variety. In 2015, the month of June and July were well below average in temperature. This indicates that a full season hybrid does not always guarantee higher yields. We have begun to evaluate the practice of interseeding into growing corn to see if cover crops can be established earlier especially in late planted or full season corn. The short season corn was harvested one month earlier essentially allowing for a variety of cover crop mixtures to be seeded and successfully establish prior to winter.

Table 5. Yields from corn silage of varying relative maturity, Alburgh, VT, 2016.

Corn varieties, planted 11-May		Moisture content at harvest	Yield at 35% DM	Corn harvest
Relative maturity	**Variety**	**%**	**tons ac^{-1}**	**Date**
110 day	Mycogen TMF2R720	64.3	25.0	4-Oct
96 day	Mycogen TMF2Q419	62.3	19.0	15-Sep
85 day	Mycogen TMF2R198	66.3	19.8	1-Sep

Not surprisingly, the 6-Sep planting date outperformed the 15-Sep planting date by yielding 3270 lbs ac^{-1}, providing 95.8% ground cover, and growing to an average height of 38.1 cm (Table 6). The 6-Sep planting had a 9 day advantage over the 15-Sep planting, which amounted to a yield difference of 800 lbs ac^{-1}. Interestingly both planting dates provided over 90% soil cover. There were no significant interactions between cover crop mixes and planting date. This indicates that cover crop mixtures performed by planting date. In 2015, the mid-Sep planting date only produced an average of 20% soil cover far different than the 90% observed in 2016. A very dry Sep and Oct likely led to slow growth of the cover crops. This indicates that an early-Sep planting date would lead to more reliable yields and ground cover for these types of cover crop mixtures.

Table 6. Yield and plot characteristics for cover crops at each planting date, Alburgh, VT, 2016.

Cover crop planting date	Yield	Ground cover	Height
	lbs ac^{-1}	**%**	**inches**
6-Sep	**3270**	**95.8**	**38.1**
15-Sep	2470	91.0	20.3
LSD (0.10)	539	2.00	1.63
Trial mean	2870	93.4	29.2

Treatments in **bold** were top performers for the given variable (p=0.10).

The cover crop mixes planted on 5-Oct did not establish well enough to have biomass yield and height collected from it (Image 1). The 5-Oct planting date had an average percent ground cover of only 5.85%. Many of the cover crop species in the mixtures are winter terminated and early planting will be required to make sure adequate fall biomass is obtained prior to killing temperatures.

Image 1. Ground cover photos of contents in a 0.5m^2 quadrat from the 5-Oct (left), 15-Sep (middle), and 6-Sep (right) planting. Alburgh, VT, 2016.

The cover crop mixes all yielded comparably, with the average across all mixes being 2870 lbs ac^{-1} (Table 7). Mix 5 (Everleaf oats, groundhog radish) had performed the best for ground cover, providing 97.2% cover (Figure 1) and having the greatest height at 33.6 cm (Table 7). Mixes 1-4 performed comparably well for ground cover and mix 7 was also a top performer for height, at 32.8 cm.

Table 7. Yield and plot characteristics of cover crop mixes, Alburgh, VT, 2016.

Cover crop mix	Yield	Ground cover	Height	Moisture
	lbs ac^{-1}	%	cm	%
Mix 1 Annual ryegrass, crimson clover, arifi radish	3690	94.2*	25.4	82.2
Mix 2 Fridge triticale, t-raptor radish, mammoth red clover, lynx winter pea	3630	93.9*	28.7	82.3
Mix 3 Winter rye, dynamite clover, appin turnip	3250	96.5*	32.2*	84.2
Mix 4 Hypoctance triticale, dynamite clover, appin turnip	2900	95.1*	30.1	84.6
Mix 5 Everleaf oats, groundhog radish	2770	**97.2***	**33.6***	**88.9***
Mix 6 Tri-cal triticale, dwarf essex rape	2580	88.7	27.2	80.6
Mix 7 Everleaf oats, duration clover, appin turnip	2490	92.8	32.8*	86.9*
Mix 8 Annual ryegrass, arifi radish	2280	90.5	27.7	83.1
Mix 9 Fria ryegrass (annual), eco-till radish	2250	91.6	25.6	84.2
LSD (0.10)	NS	4.24	3.46	4.07
Trial mean	2870	93.4	29.2	84.1

*Treatments marked with an asterisk were not statistically different top performing treatment (p=0.10).
Treatments in **bold** were top performers for the given variable.
NS – There was no statistical difference between treatments in a particular column (p=0.10).

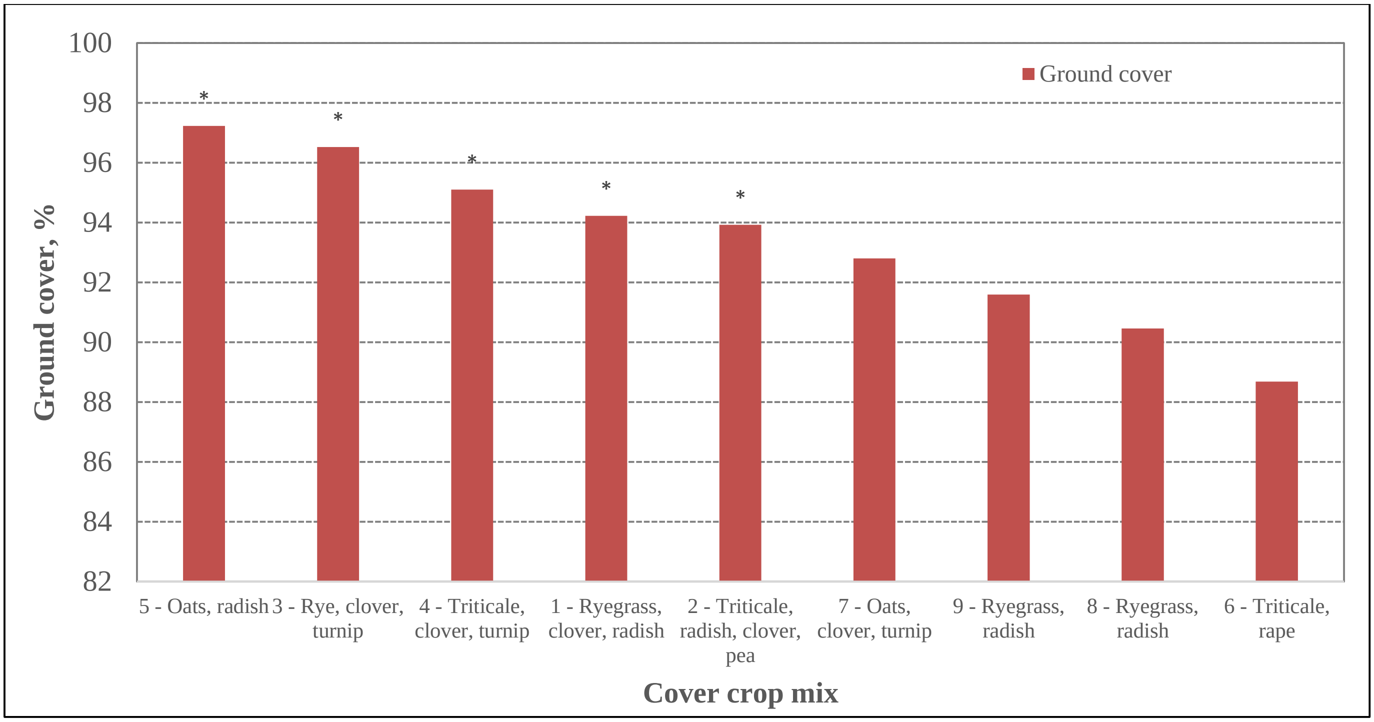

Figure 1. Ground cover for each of the cover crop mixes, LSD (0.10) = 4.24. Treatments indicated with an asterisk did not perform significantly lower than the top performer. Alburgh, Vermont, 2016.

Results from this trial showed that the cover crop mixes performed similarly in biomass production and ground cover. Early-Sep planting of the cover crop mixtures will likely produce more favorable results especially when evaluated across multiple years and environments. Farmers will need to decide what varieties to include in their mix based off of their soil health needs. Rye and small grains are generally good for building organic matter, brassicas with a taproot can help to scavenge for nutrients deep in the soil profile, and clovers/peas/vetch will add nitrogen to soils. Many of the cover crop mixtures were selected for their aggressive fall growth but poor winter survival. This allows the farmer to easily begin spring field work without having to manage for cover crop termination.

Seed costs will be another consideration. Of the cover crop mixes trialed in this experiment, mix 8 and 9 were the cheapest and mix 2 was the most expensive (Table 8). It is clear that a return on investment will need to be realized so farmers continue to cover crop without subsidy programs.

Table 8. Cost of each cover crop mix, Alburgh, VT, 2016.

Cover crop mix	Varieties	lbs bag^{-1}	Cost $ bag^{-1}	Cost acre^{-1}
1	Indy mix (Tillage root max annual ryegrass, crimson clover, tillage radish)	50	83.00	29.88
2	Fridge triticale	50	27.00	72.20
	T-raptor brassica	25	80.00	
	Mammoth red clover	50	120.00	
	Lynx winter pea	50	80.50	
3	Winter rye	50	20.00	48.41
	Milvus clover	22	122.00	
	T-raptor brassica	25	80.00	
4	Hypoctance triticale	50	17.00	28.80
	Dynamite clover	50	135.00	
	Appin turnip	25	87.50	
5	Everleaf oats	50	31.50	45.00
	Groundhog radish	50	120.00	
6	Tri-cal triticale	50	25.25	34.86
	Dwarf essex rape	25	38.00	

7	Everleaf oats	50	31.50	44.20
	Duration clover	50	120.00	
	Appin turnip	25	87.50	
8	Annual ryegrass and arifi radish (pre-mixed)	50	47.50	23.75
9	Fria ryegrass (annual) and eco-till radish, pre-mixed	50	47.50	23.75

Farmers who choose to interseed cover crops will face the challenge of trying to establish their cover crops, while also maintaining corn silage yields. It may be worthwhile to use a shorter day corn in order to harvest earlier and provide more time for cover crop establishment. The Northwest Crops and Soils Program's 2016 short season (80-97 days RM) corn silage variety trial of 39 varieties had an average yield of 24.0 tons ac^{-1} while the long season (98 days RM and greater) corn silage variety trial of 43 varieties yielded similarly, at an average of 22.8 tons ac^{-1}. These results indicate that short season corn has potential to yield comparably to a long season variety. For more information on the corn silage variety trials, please refer to our website.

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