2017

Soybean Cover Crop Trial

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

Sara Ziegler
University of Vermont

Erica Cummings
University of Vermont

Abha Gupta
University of Vermont

Lindsey Ruhl
University of Vermont

NORTHWEST CROPS & SOILS PROGRAM

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Dr. Heather Darby, UVM Extension Agronomist
Sara Ziegler, Erica Cummings, Abha Gupta, and Lindsey Ruhl
UVM Extension Crops and Soils Technicians
(802) 524-6501

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2017 SOYBEAN COVER CROP TRIAL

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

In 2017, the University of Vermont Extension Northwest Crops and Soils Program investigated the impact of various cover crop mixtures on a subsequent soybean crop's yield and quality at Borderview Research Farm in Alburgh, VT. Soybeans are grown for human consumption, animal feed, and biodiesel and can be a useful rotational crop in corn silage and grass production systems. As cover cropping expands throughout Vermont, it is important to understand the potential benefits, consequences, and risks associated with growing cover crops in various cropping systems. In an effort to support the local soybean market and to gain a better understanding of cover cropping in soybean production systems, the University of Vermont Extension Northwest Crop and Soils (NWCS) Program, as part of a grant from the Eastern Soybean Board, established a trial in 2017 to investigate the impacts on soybean yield and quality of following annual cover crop mixtures with a soybean crop.

MATERIALS AND METHODS

The trial was established at Borderview Research Farm, Alburgh, VT in the fall of 2016. The experimental design was a complete randomized block design with four replications. The treatments were 10 cover crop mixtures planted on 6-Sep 2016. Treatments consisted of mixtures that would both be over-wintered and some that would be winter-killed. Cover crop treatments and seeding rates are listed in Table 2. Cover crop living biomass was determined in the fall prior to winter dormancy. Cover crop was measured again in the spring just prior to soybean planting (4-May 2017). Ground cover was assessed via the beaded string method (Sloneker and Moldenhauer, 1977) and biomass was collected from a $0.25m^2$ area in each plot. The biomass was weighed and dried to determine dry matter content and dry matter yield. Soil was sampled within each plot at a depth of 6" and a width of 2" on 12-May. These samples were submitted to the Cornell Soil Health Testing Laboratory (Geneva, NY) for wet aggregate stability analysis. All cover crop treatments were terminated just prior to soybean planting using a moldboard plow and disc harrow (Table 1).

Table 1. Trial management details, 2016-2017.

	Borderview Research Farm-Alburgh, VT
Soil types	Benson rocky silt loam 8-15% slope
Previous crop	Annual cover crop mixtures
Tillage operations	Moldboard plow and disc
Plot size (feet)	5 x 20
Row spacing (inches)	30
Replicates	4
Starter fertilizer (lbs ac^{-1})	200 lbs ac^{-1} 10-20-20
Planting dates	Cover crops: 6-Sep 2016 Soybeans: 29-May 2017
Weed control	1 qt ac^{-1} RoundUp Power Max 5-Jul 2017
Harvest date	13-Oct 2017

On 29-May 2017, the soybeans were planted into the terminated cover crop treatments using a Monosem NG-Plus 2-row precision air planter (Edwardsville, KS) at 185,000 seeds ac^{-1} with 200 lbs ac^{-1} starter fertilizer (10-20-20). The variety SW1055 (maturity group 1.0, Genuity® RoundUp Ready 2 Yield) soybean was obtained from Seedway, LLC. (Hall, NY) for the trial. Soybeans were sprayed with RoundUp Power Max herbicide on 5-Jul to control weeds. On 13-Oct, the soybeans were harvested using an Almaco SPC50 small plot combine. Seed was cleaned with a small Clipper M2B cleaner (A.T. Ferrell, Bluffton, IN). They were then weighed for plot yield and tested for harvest moisture and test weight using a DICKEY-John Mini-GAC Plus moisture/test weight meter using a Berckes Test Weight Scale.

Table 2. Annual cover crop mixture treatments grown in 2016 prior to soybean in 2017.

Mixture #	Species	Variety	Cover crop over-winters	Seeding rate lbs ac^{-1}
1	Annual ryegrass Tillage radish	Fria Eco-till	yes, ryegrass only	22 3
2	Forage rape Triticale	Dwarf Essex Trical 815	yes, triticale only	3 60
3	Forage turnip Red clover Triticale	Appin Dynamite Hyoctane	yes, clover and triticale only	2 3 60
4	Forage turnip Red clover Winter rye	Appin Dynamite VNS	yes clover and winter rye only	2 1 40
5	Annual ryegrass Tillage radish	unknown Arifi	no	18 total (premixed)
6	Annual ryegrass Crimson clover Tillage radish	unknown unknown Arifi	no	24 total (premixed)
7	Forage oats Forage turnip Red clover	Everleaf Appin Duration	no	40 2 5
8	Forage oats Tillage radish	Everleaf Groundhog	no	60 31
9	Red clover Forage brassica Winter pea Winter triticale	Mammoth T-Raptor Lynx Fridge	yes, clover and triticale only	5 2 20 40
10	No cover crop		N/A	N/A

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 hybrids were treated as fixed. Hybrid 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 hybrids 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 two hybrids 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 two hybrids. In this example, hybrid C is significantly different from hybrid A but not from hybrid 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 hybrids 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 hybrids were significantly different from one another.

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

RESULTS

Weather data was recorded with a Davis Instrument Vantage Pro2 weather station, equipped with a WeatherLink data logger at Borderview Research Farm in Alburgh, VT (Table 3). Overall, the season was cooler and wetter than normal. More than 1.5 inches of rain fell within 10 days following planting. Unseasonably cool temperatures and above average rainfall persisted through August followed by above average temperatures and below average rainfall in September and October. The dry warm weather in the fall provided good weather for the soybeans to mature and to be harvested at optimal moisture content. Overall, a total of 2335 growing degree days (GDDs) were accumulated June-October, 209 above the 30-year normal. Despite these unusual growing conditions, the soybeans appeared relatively unharmed and produced very well.

Table 3. Weather data for Alburgh, VT, 2017.

Alburgh, VT	June	July	August	September	October
Average temperature (°F)	65.4	68.7	67.7	64.4	57.4
Departure from normal	-0.39	-1.90	-1.07	3.76	9.2
Precipitation (inches)	5.64	4.88	5.54	1.84	3.3
Departure from normal	1.95	0.73	1.63	-1.80	-0.31
Growing Degree Days (base 50°F)	468	580	553	447	287
Departure from normal	-7	-60	-28	129	175

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.

Table 4 summarizes the cover crop production and soil health characteristics in the spring for each treatment. The treatment that produced the most biomass in the fall was treatment 1 (annual ryegrass/tillage radish) which produced 2104 lbs ac^{-1}. This was statistically similar to six other treatments. Treatments 3 and 4, which both included turnip, red clover, and a winter grain (triticale and winter rye respectively), both produced the lowest biomass but were statistically similar to one another. Of the five treatments that survived the winter, treatment 9, which contained red clover, forage brassica, winter pea, and triticale, produced the most biomass with 1494 lbs ac^{-1}. In reality only the triticale and clover survived the winter and produced that spring biomass. It is interesting that this treatment, despite having a lower seeding rate of triticale compared to treatment 2 (triticale/rape) produced significantly more biomass in the spring. Furthermore, winter rye is traditionally regarded as the species that produces the most biomass in this region, however, treatment 4, the only treatment containing winter rye, was one of the lowest producing treatments in the fall and produced half the biomass of treatment 9 in the spring.

Treatments did not differ in the percent ground cover that they provided. This suggests that, even cover crops that winterkill in our region can provide substantial ground cover in the spring to help protect the soil surface from the impacts of rainfall. Treatments also varied significantly in terms of soil aggregate stability. The highest aggregate stability was obtained by treatment 5 (annual ryegrass/tillage radish) with 33.4% aggregate stability. This was statistically higher than any other cover crop treatment. The next highest treatment was the oat/turnip/clover treatment with 26.5% aggregate stability.

Table 4. Cover crop and soil health characteristics, 2017.

Cover crop mixture	Fall biomass	Spring biomass	Ground cover	Aggregate stability
	-----DM lbs ac^{-1}-----		%	
1	**2104**	127	43.0	22.7
2	1851*	987	**52.0**	26.1
3	1627*	140	49.5	24.7
4	1350	767	37.5	23.2
5	1837*	0	41.5	**33.4**
6	1935*	0	42.0	21.9
7	1883*	0	45.5	26.5
8	1183	0	28.5	25.5
9	2050*	**1494**	46.5	24.8
10	0	0	46	22.8
LSD (p = 0.10)	599	497	NS	5.01
Trial Mean	1582	352	43.2	25.2

*Varieties that did not perform significantly lower than the top performing variety in **bold** are indicated with an asterisk.
NS – No significant difference.

Soybeans were harvested on 13-Oct 2017. Table 5 summarizes the yield and harvest characteristics of soybeans from each cover crop treatment. Despite relatively wet and cool weather conditions through most of the growing season, the soybeans produced high yields with all producing at least 58 bu ac^{-1}. The highest yielding treatment was treatment 6 (annual ryegrass/crimson clover/tillage radish) which produced 4541 lbs ac^{-1} or 75.7 bu ac^{-1}, an incredible yield, especially for a region with such a short growing season. This was statistically similar to the control and treatment 5 (annual ryegrass/tillage radish). The lowest yielding treatment was treatment 3 (triticale/turnip/red clover) which only produced 3481 lbs ac^{-1} or 58.0 bu ac^{-1}. Cover crop treatments did not significantly impact harvest moisture or test weight. Of the 10 cover crop treatments examined, five (mixtures 5, 6, 7, 8, and 10) did not produce living vegetation in the spring while the other five treatments did. Overwintering treatments produced on average 4073 lbs ac^{-1} or 67.9 bu ac^{-1} while the treatments that had living spring biomass produced on average 3625 lbs ac^{-1} or 60.4 bu ac^{-1} (Table 6). These data suggest that soybean yields may be negatively impacted by preceding overwintering cover crops (Figure 1). However, to fully understand this interaction, more data needs to be collected, such as nutrient content of the cover crop biomass and availability, as differences between mixture composition would likely impact soybean yields differently.

Table 5. Soybean harvest characteristics by cover crop treatment, 2017.

Cover crop mixture	Harvest moisture	Test weight	Seed yield @ 13% moisture	
	%	lbs bu^{-1}	lbs ac^{-1}	bu ac^{-1}
1	15.4	54.4	3727	62.1
2	15.3	54.8	3492	58.2
3	15.1	55.7	3481	58
4	15.1	55.4	3769	62.8
5	15.1	55.9	4051*	67.5*
6	14.8	56.7	**4541***	**75.7***
7	14.8	56.3	3839	64
8	15.4	54.2	3847	64.1
9	15.4	54	3657	60.9
10	**14.6**	**56.8**	4088*	68.1*
LSD (p = 0.10)	NS	NS	614	10.2
Trial Mean	15.1	55.4	3849	64.2

*Varieties with an asterisk performed similarly to the top performer in **bold**.
NS – No significant difference.

Table 6. Soybean yields by cover crop overwintering status.

Overwinter	Soybean yield	
	lbs ac^{-1}	bu ac^{-1}
Yes	3625	60.4
No	**4073**	**67.9**
LSD (p = 0.10)	265	4.42
Trial mean	3849	64.2

The top performing treatment is indicated in **bold**.

DISCUSSION

Overall, soybeans produced high yields in 2017. Preceding a soybean cash crop with a cover crop can help retain excess nutrients that would otherwise be lost from the soil. However, using a mixture that includes a winter grain, such as winter rye or triticale, can present management considerations in the spring as they will overwinter and can produce a lot of biomass early in the spring. These data suggest that overwintering cover crop mixtures can reduce the yields of a following soybean crop. This may be due to the immobilization of nitrogen or other nutrient dynamics in the soil when the soybean crop is establishing. However, these dynamics were not investigated in this study. Further analysis will be conducted in order to determine potential differences between the mixtures, both that winterkill and overwinter, to identify best cover cropping practices that support high yielding soybeans in this region.

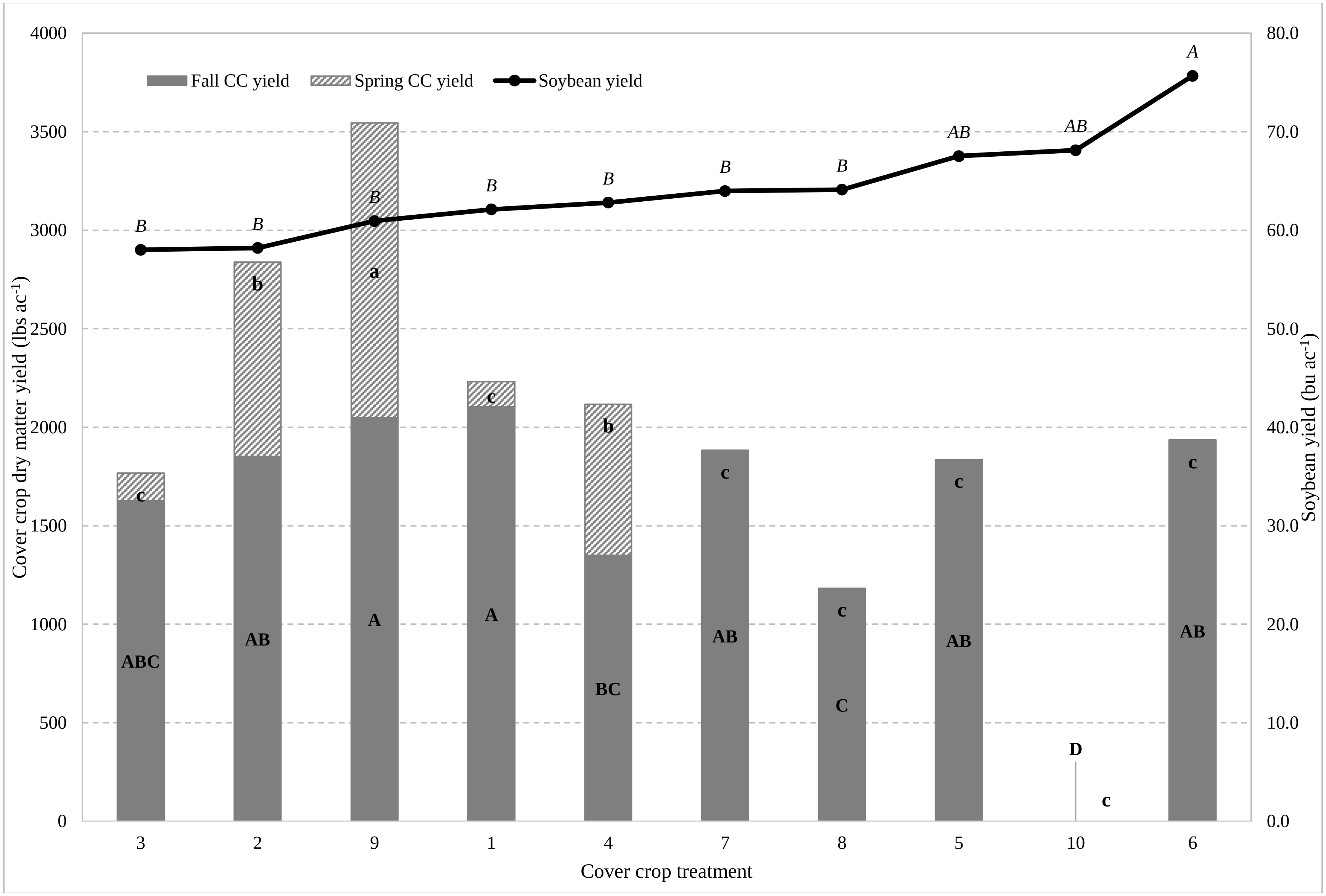

Figure 1. Soybean and cover crop yield by cover crop mixture treatment, 2017.
Treatments that share a letter performed statistically similarly to one another. Letters presented for cover crop yield indicated differences in total biomass.

REFERENCES

Sloneker, L. L. and W. C. Moldenhauer, 1977. Measuring the amounts of crop residue remaining after tillage. J. Soil Water Conserv. 32:23 l-236.

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