NORTHWEST CROPS & SOILS PROGRAM

2019 Soybean Cover Crop Trial

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THE UNIVERSITY OF VERMONT EXTENSION

2019 SOYBEAN COVER CROP TRIAL

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In 2019, the University of Vermont Extension Northwest Crops and Soils Program investigated the impact of various cover crop mixtures on the 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, conducted a trial in 2018-2019 to investigate the impacts on soybean yield and quality following annual cover crop mixtures with a soybean crop.

MATERIALS AND METHODS

The trial was done at Borderview Research Farm, Alburgh, VT in the 2018-2019 season. The experimental design was a complete randomized block with four replications (Table 1). The treatments were 10 cover crop monocultures or mixtures planted on 24-Aug 2018. Treatments consisted of cover crops that would over winter and others that would be terminated by winter conditions. Cover crop treatments and seeding rates are listed in Table 2. Fall biomass samples were collected on 22-Oct 2018 from a 0.25m^2 area in each plot. Samples were weighed prior to and after drying to determine dry matter content and calculate yield. Cover crop biomass was measured again in the spring on 6-May 2019 prior to soybean planting. All cover crop treatments were terminated in the spring, just prior to soybean planting using a moldboard plow and disc harrow.

Table 1. Trial management details, 2018-2019.

	Borderview Research Farm-Alburgh, VT
Soil types	Benson rocky silt loam 8-15% slope
Previous crop	Soybeans
Tillage operations	Moldboard plow and disc
Plot size (feet)	5 x 20
Row spacing (inches)	30
Replicates	4
Starter fertilizer (lbs ac^{-1})	5 gal ac^{-1} 9-18-9
Planting dates	Cover crops: 24-Aug 2018 Soybeans: 23-May 2019
Weed control	1 qt. ac^{-1} Roundup PowerMAX® applied 27-May 2019
Harvest date	15-Oct 2019

On 23-May 2019, the soybeans were planted into the terminated cover crop treatments using a 4-row cone planter with John Deere row units fitted with Almaco seed distribution units (Nevada, IA) at 185,000 seeds ac^{-1} with 5 gal ac^{-1} starter fertilizer (9-18-9). The variety SG0975 (maturity group 0.9, Genuity® RoundUp

Ready 2 Yield) soybean was obtained from Seedway, LLC (Hall, NY) for the trial. Soybeans were sprayed with Roundup PowerMAX® herbicide on 27-May to control weeds. On 15-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.

Table 2. Annual cover crop mixture treatments grown in 2018 prior to soybeans in 2019.

Treatment	Species	Variety	Over-winters?	Seeding rate lbs ac-1
AR/CC/DR	Annual ryegrass	Centurion	No	15
	Crimson clover	Dixie		8
	Daikon radish	Eco-till		2
O/CC/DR	Oats	Shelby	No	70
	Crimson clover	Dixie		15
	Daikon radish	Eco-till		3
WR/RC/DR	Winter rye	unknown	Yes	50
	Red clover	Medium		12
	Daikon radish	Eco-till		3
WR/HV	Winter rye	unknown	Yes	50
	Hairy vetch	unknown		20
WR	Winter rye	unknown	Yes	75
AR	Annual ryegrass	Centurion	No	25
DR	Daikon radish	Eco-till	No	6
CC	Crimson clover	Dixie	No	15
RC	Red clover	Medium	No	15
NC	No cover		No	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 treatments were treated as fixed. Treatment 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 treatments 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 treatments 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 treatments.

In this example, treatment C is significantly different from treatment A but not from treatment 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 treatments 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 treatments were significantly different from one another.

Treatment	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 began cooler and wetter than normal but became hot and dry in the middle of the summer. The month of July brought above normal temperatures and little rainfall. The longest period without rainfall in July lasted 12 days. This dry period, which occurred around the time of pod formation, may have negatively impacted soybean plant growth and productivity. However, these warm conditions were welcomed and provided the crop with crucial Growing Degree Days (GDDs) needed to reach maturity. The season had a total of 2400 GDDs accumulated May-Oct, 78 GDDs below normal.

Table 3. Weather data for Alburgh, VT, 2019.

Alburgh, VT	May	June	July	August	September	October
Average temperature (°F)	53.3	64.3	73.5	68.3	60.0	50.4
Departure from normal	-3.11	-1.46	2.87	-0.51	-0.62	2.22
Precipitation (inches)	4.90	3.06	2.34	3.50	3.87	6.32
Departure from normal	1.45	-0.63	-1.81	-0.41	0.23	2.72
Growing Degree Days (base 50°F)	189	446	716	568	335	146
Departure from normal	-103	-36	86	-14	-25	14

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.

Cover crop treatments WR/RC/DR, O/CC/DR, and DR produced statistically similar quantities of fall biomass (Table 4). As many of the treatments consisted of species that do not overwinter, only three mixtures had a measurable spring biomass. Cover crop treatments of WR/RC/DR, WR/HV, and WR collectively produced just under 2 tons ac^{-1}. None of the top treatments in the fall were top yielding in the following spring. The WR treatment had the highest spring dry matter yield with 1595 lbs ac^{-1} and the WR/HV treatment was statistically similar with 1536 lbs ac^{-1}. The WR/RC/DR had a dry matter yield about two times lower than the top yielding variety in the spring. Soybean yield and test weight did not differ significantly by the preceding cover crop treatments. Yields averaged 4580 lbs ac^{-1} or 76.3 bu ac^{-1} and test weight averaged 56.4 lbs bu^{-1}. The test weights were consistent with the averages observed in our other soybean trials in 2019, while the average soybean yield in this trial was higher than in other soybean trials from this season.

Table 4. Cover crop and soybean harvest characteristics, 2018-2019.

Cover crop treatment	Overwinters	Fall 2018	Spring 2019	Soybean harvest 2019			
		Dry matter yield		Yield at 13% moisture			Test weight
		lbs ac^{-1}		lbs ac^{-1}	bu ac^{-1}		lbs bu^{-1}
AR/CC/DR	No	1318 ^{bcd}	0 ^{c}	5350	89.2		56.1
O/CC/DR	No	2039 ^{ab}	0 ^{c}	4192	69.9		55.7
WR/RC/DR	Yes	**2430 ^{a}**	771 ^{b}	4650	77.5		55.9
WR/HV	Yes	1390 ^{bc}	1536 ^{a}	4182	69.7		57.0
WR	Yes	1315 ^{bcd}	**1595 ^{a}**	4422	73.7		56.0
AR	No	626 ^{cd}	0 ^{c}	4307	71.8		56.7
DR	No	2296 ^{a}	0 ^{c}	4506	75.1		56.6
CC	No	655 ^{cd}	0 ^{c}	4451	74.2		56.7
RC	Yes	545 ^{d}	0 ^{c}	4098	68.3		56.5
NC	No	617 ^{cd}	0 ^{c}	5640	94.0		56.9
LSD (p = 0.10) ‡	N/A	826	243	NS¥	NS¥		NS¥
Trial mean	N/A	1323	390	4580	76.3		56.4

†Within a column treatments marked with the same letter were statistically similar (p=0.10). Top performers are in **bold.**

‡LSD – Least significant difference at p=0.10.

¥NS – No significant difference between treatments.

N/A – No statistical analysis run on this parameter.

In 2017, we saw a significant decrease in soybean yields when following an overwintering cover crop. In 2018, while there was a decrease in soybean yields following an overwintering cover crop, it was not significantly different than the yield of soybeans planted following a winter-killed cover crop. This year, the trend was similar to that of the previous year (Table 5). Soils were analyzed for nitrate (NO_3) content four times between the planting and harvesting of soybeans in 2019 (Table 6, Figure 1). Cover crops were terminated in late May, and soybeans were planted on 23-May. At this time, there were no significant differences in soil nitrate levels between overwinter and winterkilled plots. By early June, soil nitrate levels in the overwinter plots start to exceed that of the winterkill plots. This trend holds through the middle of July. This suggests that the nitrogen in the living cover crop material that was incorporated into the soil prior to planting soybeans was mineralized in mid-July. The extra nitrogen released from the overwintered cover crops did not appear to impact soybean yield. It is important to recognize that starter fertilizer was applied at planting to all soybean plots. A greater impact may have been seen, had starter not been used. We plan to continue to investigate nitrogen cycling in these cover crop treatments and its potential impacts on subsequent soybean productivity.

Table 5. Soybean yield by cover crop type.

Overwinter	Soybean yield (bu ac^{-1})		
	2017	2018	2019
Yes	60.4	61.1	72.3
No	**67.9**	63.9	79.0
p value	0.007	NS ¥	NS
Trial mean	64.2	62.6	76.3

The top performers are in **bold.**
¥ NS – No significant difference between treatments.

Table 6. Soil nitrate-N (NO_3) concentration (ppm) by soil sampling date, Alburgh, VT, 2019.

Cover crop type	Soil NO_3 (ppm)			
	Late May	Early June	Mid-Late June	Early-Mid July
Winterkill	14.14 [a]	18.13 [b]	30.80 [b]	31.36 [b]
Overwinter	13.05 [a]	**30.43** [a]	**45.77** [a]	**43.38** [a]
p value	0.57	<0.01	0.01	<0.01
Trial mean	13.70	23.05	36.79	36.17

†Within a column treatments marked with the same letter were statistically similar.
The top performers are in **bold.**

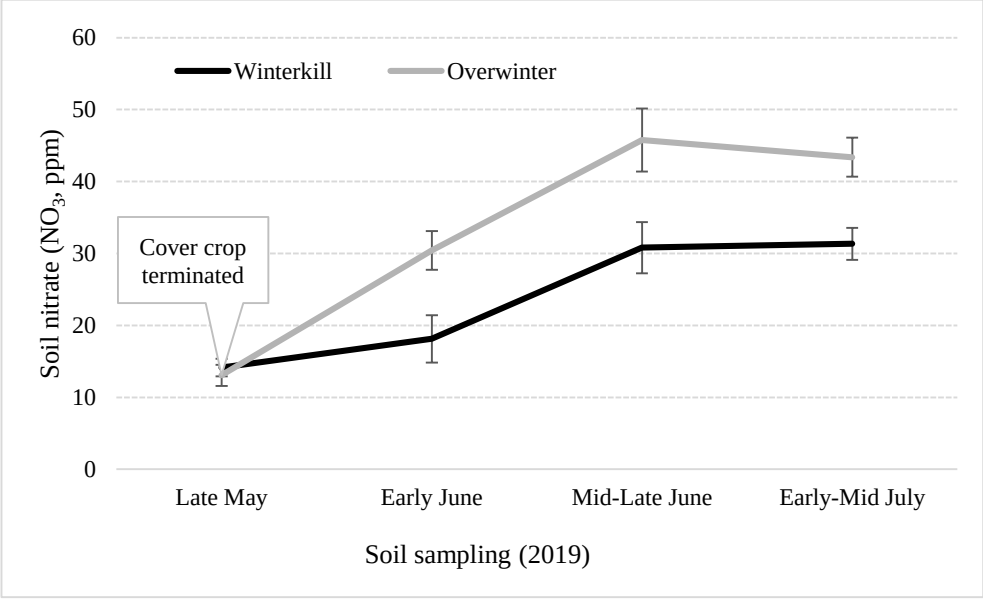

Figure 1. Soil NO_3 content by cover crop treatment type, 2019.

DISCUSSION

In 2019, soybean establishment and ultimate yields were not significantly impacted by previous cover crop treatments (Figure 2). Soybean yields were similar in overwinter plots to plots that had winterkilled cover crops. These data suggest that soybeans can successfully follow high yielding cover crop mixtures without experiencing yield depressions. A similar result was seen in 2018, but in 2017, there was a significant decrease in soybean yields following an overwintering cover crop. As a result, we will continue to investigate cover cropping practices in soybeans in this region to gain a better understanding of successful cover cropping practices and their impacts on soybean performance.

ACKNOWLEDGEMENTS

UVM Extension Northwest Crops and Soils Program would like to thank Eastern Soybean Region Board for the funding for this trial. We would also 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 John Bruce, Catherine Davidson, Hillary Emick, Haley Jean, Shannon Meyler, and Lindsey Ruhl for their assistance with data collection and entry. We would also like to thank the seed companies for their seed and cooperation in this study. The information is presented with the understanding that no product discrimination is intended and no endorsement of any product mentioned or criticism of unnamed products is implied.

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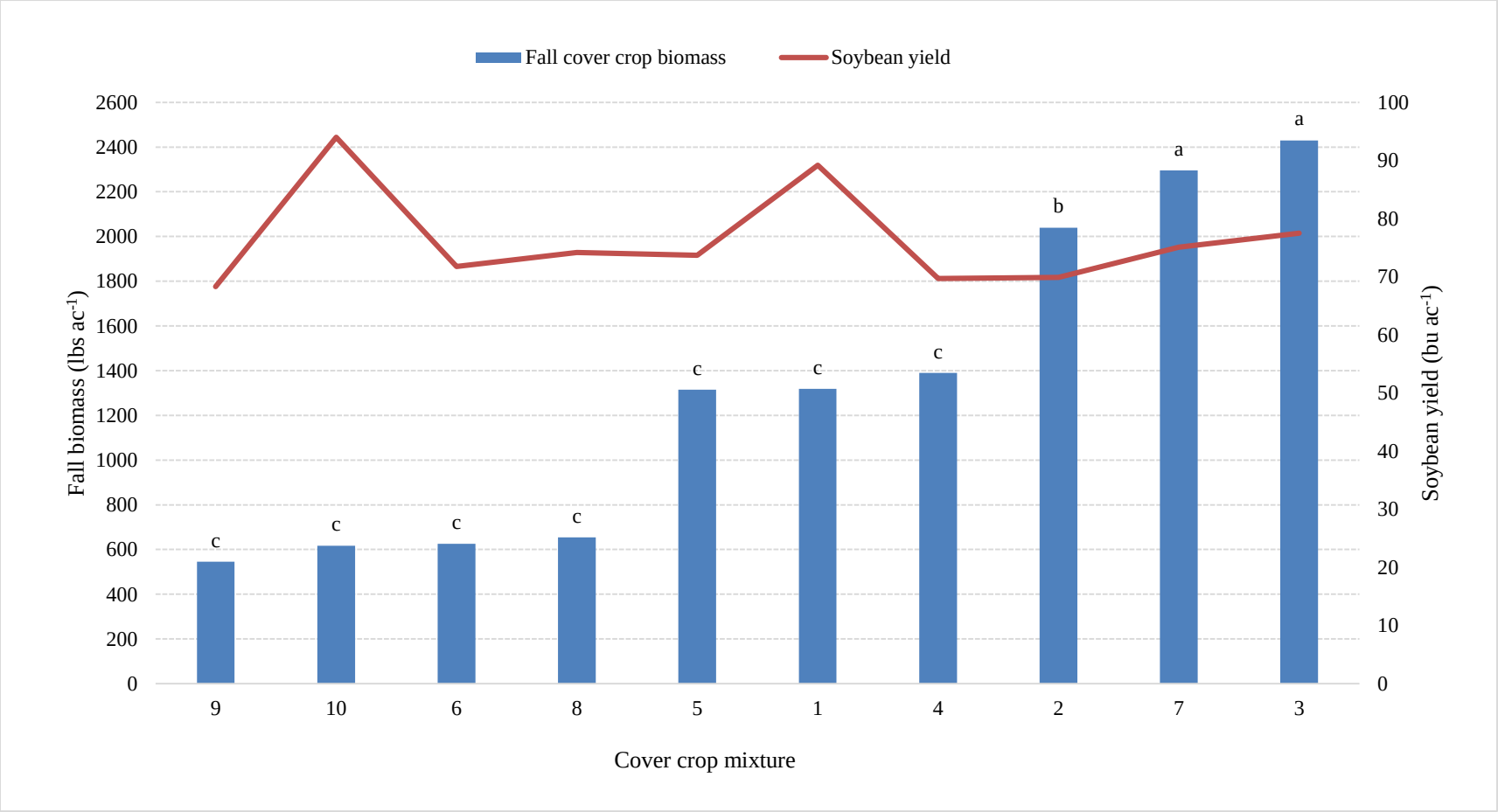

Figure 2. Fall biomass and soybean yield by cover crop mixture treatment, 2019.
Treatments that share a letter performed statistically similarly to one another. Soybean yields did not differ statistically across treatments.