2019

Cover Crop Termination Trial

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THE UNIVERSITY OF VERMONT EXTENSION

2019 COVER CROP TERMINATION TRIAL

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In 2019, the University of Vermont Extension Northwest Crops and Soils Program investigated the impact of spring cover crop termination methods 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, conducted a trial in 2019 to investigate the impacts of different cover crop termination methods on the yield and quality of the subsequent soybean crop.

MATERIALS AND METHODS

The trial was conducted at Borderview Research Farm, Alburgh, VT in 2018-2019. The experimental design was a complete randomized block design with split plots and four replications (Table 1). The main plot was spring termination method including tillage, herbicide termination before planting, and herbicide termination after planting (Table 2). Subplots were 3 cover crop treatments including winter rye (WR), winter rye & vetch (WRV), and winter rye, red clover & radish (WRRR) (Table 3).

Table 1. Trial management details, 2018-2019.

Location	Borderview Research Farm-Alburgh, VT
Soil type	Benson rocky silt loam 8-15% slope
Previous crop	Soybeans
Plot size (feet)	5 x 20
Row spacing (inches)	30
Replicates	4
Soybean variety	SG0975 (maturity group 0.9, Genuity® RoundUp Ready 2 Yield)
Starter fertilizer	9-18-9 (5 gal ac^{-1})
Weed control	1 qt ac^{-1} Roundup PowerMAX® applied 27-May 2019
Soybean planting date	23-May 2019
Soybean harvest date	15-Oct-19

On 1-May, cover crop biomass and percentage of soil covered were measured prior to termination. A 0.25m^2 area in each plot was harvested and samples were weighed prior to and after drying to determine dry matter content and calculate yield. The beaded string method (Sloneker and Moldenhauer, 1977) was used to calculate percent of soil covered by plant biomass.

Table 2. Cover crop termination treatments, Alburgh, VT, 2019.

Treatment	Cover crop termination details
Tillage (10-May)	Tilled under with moldboard plow and disc harrow prior to soybean planting
Pre-spray (8-May)	Sprayed with Roundup PowerMAX® at 1qt ac^{-1} prior to soybean planting
Post-spray (27-May)	After soybeans were planted, cover crop was sprayed with Roundup PowerMAX® at 1qt ac^{-1}

On 23-May, the soybeans were planted into each of the termination 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) soybean was obtained from Seedway, LLC (Hall, NY) for the trial.

Table 3. Overwintering cover crop mixtures grown prior to soybean crop, Alburgh, VT, 2019.

Treatment	Species	Variety	Seeding rate lbs ac^{-1}
WRRR	Winter rye	VNS	50
	Red clover	Medium	12
	Radish	Eco-till	3
WRV	Winter rye	VNS	50
	Hairy vetch	VNS	20
WR	Winter rye	VNS	75

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.

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 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 treatments B. The difference between B and C 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 4). 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 timely warm conditions did help the crop reach maturity. The season overall had lower than normal Growing Degree Days (GDDs) throughout much of the growing however a warm fall allow for 2400 GDDs accumulated May-Oct, 188 GDDs above normal.

Table 4. 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	-9	-29	76	-13	17	146

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.

Prior to cover crop termination and subsequent soybean planting, the spring soil coverage and cover crop dry matter yield were measured (Table 5). There was significantly higher spring soil coverage and cover crop yields in the plots that would be tilled prior to soybean planting (Tillage) and the plots that would be sprayed prior to soybean planting (Pre-spray). However, there were no statistical differences in soybean yield, indicating that the cover crop termination method did not significantly impact the yield of the subsequent soybean crop (Table 5). Yields at 13% moisture ranged from 4418 lbs ac^{-1} (Tillage) to 4673 lbs ac^{-1} (Pre-spray). There was a significant difference in soybean test weight between the cover crop

termination methods. The pre-spray treatment had the highest test weight, 57.7 lbs bu^{-1}, and this was statistically higher than the tillage and the post-spray treatments (56.3 lbs bu^{-1} and 55.5 lbs bu^{-1} respectively).

Table 5. Cover crop and soybean harvest characteristics by termination method, Alburgh, VT, 2019.

Termination method	Prior to cover crop termination		Soybean harvest		
	Spring soil coverage	Cover crop dry matter yield	Yield at 13% moisture		Test weight
	%	lbs ac^{-1}	lbs ac^{-1}	lbs ac^{-1}	lbs bu^{-1}
Tillage	**84.2** [a]	1571 [a]	4418	73.6	56.3 [b]
Pre-spray	82.1 [a]	**1779** [a]	4673	77.9	**57.7** [a]
Post-spray	61.0 [b]	1071 [b]	4634	77.2	55.5 [b]
LSD (p = 0.10)	7.49	245	NS	NS	1.26
Trial mean	75.8	1473	4575	76.3	56.5

*Within a column, treatments marked with the same letter were statistically similar (p=0.10). Top performers are in **bold**.
LSD-Least significant difference.
NS-No significant difference between treatments.

Prior to cover crop termination, there was significantly higher spring soil coverage and cover crop yield in WR; WRV was statistically similar (Table 6). Soybean yields were impacted by cover crop treatment. The soybean yield was highest in WRRR with 4816 lbs ac^{-1} and WRV was statistically similar (4556 lbs ac^{-1}). Test weight was not significantly different between cover crop treatments. It is interesting to note that the soybean yields were highest in the plots that had lower spring soil coverage (WRRR) and cover crop yields. Lower spring biomass in the WRRR treatment was likely a result of lower seeding rates of the winter rye and the winter termination of the radish.

Table 6. Cover crop and soybean harvest characteristics by cover crop mixture, Alburgh, VT, 2019.

Treatment	Species	Prior to cover crop termination		Soybean harvest 2019		
		Spring soil coverage	Cover crop dry matter yield	Yield at 13% moisture		Test weight
		%	lbs ac^{-1}	lbs ac^{-1}	bu ac^{-1}	lbs bu^{-1}
WRRR	Winter rye/red clover/radish	71.5 [b]	1183 [b]	**4816** [a]	**80.3** [a]	56.5
WRV	Winter rye/ hairy vetch	76.9 [ab]	1584 [a]	4556 [ab]	75.9 [ab]	56.5
WR	Winter rye	**79.0** [a]	**1653** [a]	4353 [b]	72.6 [b]	56.5
LSD (p = 0.10)		7.49	245.1	451.2	7.52	NS
Trial mean		75.8	1473	4575	76.3	56.5

*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.

Soils were analyzed for soil nitrate-N (NO_3) concentration every other week starting from 23-May (time of planting) through mid-July (Table 7, Figure 1). There were significant differences in soil nitrate-N concentrations between the cover crop termination methods. The tillage treatment had statistically higher concentrations of soil nitrate-N throughout the time of soil sampling. By the last week of soil sampling, the pre-spray treatment had a soil nitrate-N concentration that was statistically similar to the tillage treatment. The post-spray treatment consistently had the lowest concentration of soil nitrate-N.

Table 7. Soil nitrate-N (NO_3) by cover crop termination method, Alburgh, VT, 2019.

Termination method	Soil nitrate-N (NO_3, ppm)			
	Late May	Early June	Mid-Late June	Early-Mid July
Tillage	**13.0** [a]	**33.6** [a]	**44.2** [a]	**46.4** [a]
Pre-spray	9.57 [b]	17.9 [b]	29.3 [b]	39.7 [a]
Post-spray	3.54 [c]	6.75 [c]	12.0 [c]	16.1 [b]
LSD (p = 0.10)	3.18	9.05	10.9	10.9
Trial mean	8.71	19.4	28.5	34.1

*Within a column, treatments marked with the same letter were statistically similar (p=0.10). Top performers are in **bold**.
LSD-Least significant difference.
NS-No significant difference between treatments.

The concentration of soil nitrate-N starts off low for all treatments at the time of soybean planting in late May and continues to increase through the summer. Concentrations were highest for all treatments by mid-July (Figure 1). The release of nitrogen occurred very gradually in the post-spray treatment, and even by mid-July when soil nitrate-N concentrations peaked for the other two treatments, the concentration was still more than 2.5 times lower in the post-spray treatment. The slower mineralization of cover crop organic matter in herbicide terminated treatments did not impact soybean yields.

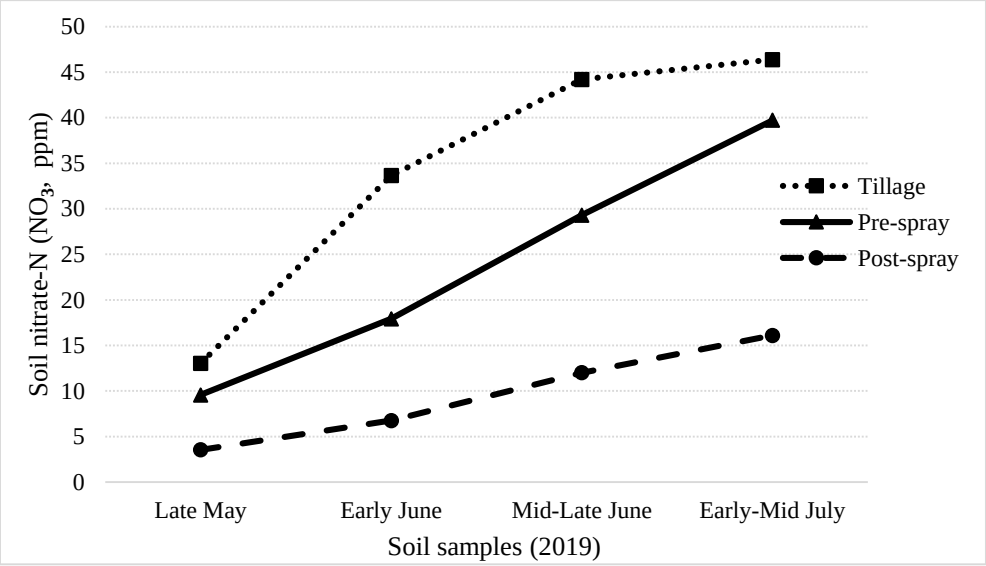

Figure 1. Soil nitrate-N (NO_3) concentration by cover crop termination method, 2019.

DISCUSSION

In 2019, soybean yields were not significantly impacted by the different cover crop termination methods, but there were statistical differences in soybean yield between cover crop treatments. All cover crop treatments were overwintering mixes, but the WRRR resulted the in highest soybean yields. Interestingly, soil nitrate-N concentrations were not significantly different between the three cover crop treatments, but were significantly impacted by the cover crop termination method. The release of nitrogen from cover crops into the soil was likely due to the timing and method of cover crop termination in the spring. The cover crops that were tilled two weeks prior to soybean planting allowed for a faster release of nitrogen, making it available to the soybeans by mid-July during pod formation. Slower degradation and release of N from herbicide killed cover crops is likely due to the fact that the cover crops are not mixed into the soil and take more time to degrade. The later spray treatment meant that there was even more time for the degradation and release of N. Starter fertilizer was applied at planting to all soybean plots. A greater impact may have been seen had starter fertilizer not been used.

Overall, soybean yields in this trial were comparable to the yield of soybeans in other trials conducted at Borderview Research Farm in 2019. These data suggest that soybeans can successfully be grown following an overwintering cover crop and not be negatively impacted by cover crop termination method. It is important to remember that these data represent only one year of research at one location. 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 performances. UVM Extension Northwest Crops and Soils Program plans to repeat this trial in 2020.

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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