2022 Soybean Cover Crop Termination Trial

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In 2022, the University of Vermont Extension Northwest Crops and Soils Program investigated the impact of a winter rye cover crop on soybean crop 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. Cereal or winter rye is commonly planted in this region as a cover crop. As soybean production expands throughout Vermont, it is important to understand the potential benefits, consequences, and risks associated with growing cover crops in these systems. 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 2021-2022 to investigate the impacts of winter rye seeding rates and spring termination methods on the yield and quality of the subsequent soybean crop.

MATERIALS AND METHODS

The trial was conducted at Borderview Research Farm in Alburgh, VT in 2021-2022. The experimental design was a complete randomized block design with split plots and four replications (Table 1). The main plots were three spring cover crop termination methods. See Table 2 for a description of termination treatments. Subplots were four winter rye seeding rates, which included a Control (0 lbs. ac^{-1}), 50, 100, and 150 lbs. ac^{-1} of Gardner winter rye (Albert Lea Seedhouse, MN). The winter rye was planted on 29-Sep 2021. In the spring prior to cover crop termination, ground cover was measured by processing photographs using the Canopeo© smartphone application on 6-May 2022 in the tillage and herbicide treatments and on 23-May 2022 in the plant green treatment. Cover crop biomass was also measured at termination on 6-May 2022 in the tillage and herbicide treatments and on 23-May 2022 in the plant green treatment. A $0.25m^2$ area was harvested using hand clippers and a quadrat from each plot except for the control treatments. Samples were weighed prior to and after drying to determine dry matter content and calculate rye biomass. On 24-May 2022, the soybeans were planted using a 4-row John Deere 1750 four-row planter fitted with bean cups at a rate of 180,000 seeds ac^{-1}. The variety SG 0720XT (maturity group 0.7) soybean was obtained from Seedway, LLC (Hall, NY) for the trial.

Table 1. Trial management details, Alburgh, VT, 2021-2022.

Location	**Borderview Research Farm-Alburgh, VT**
Soil type	Covington silty clay loam, 0-3% slopes
Previous crop	Corn silage
Plot size (feet)	10 x 20
Row spacing (inches)	30

Cover crop seeding rates (lbs. ac^{-1})	0, 50, 100, 150
Soybean variety	SG 0720XT (maturity group 0.7, Roundup Ready®2Xtend)
Fertilizer	7-18-36 (200 lbs. ac^{-1})
Soybean planting date	24-May 2022
Soybean seeding rate (seeds ac^{-1})	180,000
Soybean harvest date	5-Oct 2022

Table 2. Cover crop termination treatments, Alburgh, VT, 2022.

Treatment	**Cover crop termination details**
Tillage	Sprayed with Roundup PowerMAX® at 1qt ac^{-1} to terminate then tilled under with a Pottinger Terra Disc one week prior to soybean planting.
Herbicide	Sprayed with Roundup PowerMAX® at 1qt ac^{-1} one week prior to soybean planting.
Plant green	Soybeans were planted into living cover crop and sprayed with Roundup PowerMAX® at 1qt ac^{-1} just following planting.

To determine if the seeding rate or termination of the cover crop had an impact on any soil properties, soil samples were collected from the control and 100 lbs ac^{-1} plots in the tillage and plant green treatments prior to cover crop termination, on 6-May and 23-May 2022 respectively, and were submitted to the Cornell Soil Health Laboratory for the Comprehensive Assessment of Soil Health analysis (Ithaca, NY). Soils were also analyzed for soil Nitrate-N (NO3) content at the UVM Agricultural and Environmental Testing Laboratory in Burlington, VT. Approximately 10 soil cores at a 12ò depth within each plot were taken using a soil probe, then immediately dried and transported to the lab for analysis. To understand the nutrient release rates of the winter rye and how this was impacted by seeding 339.77 Tm6te

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.

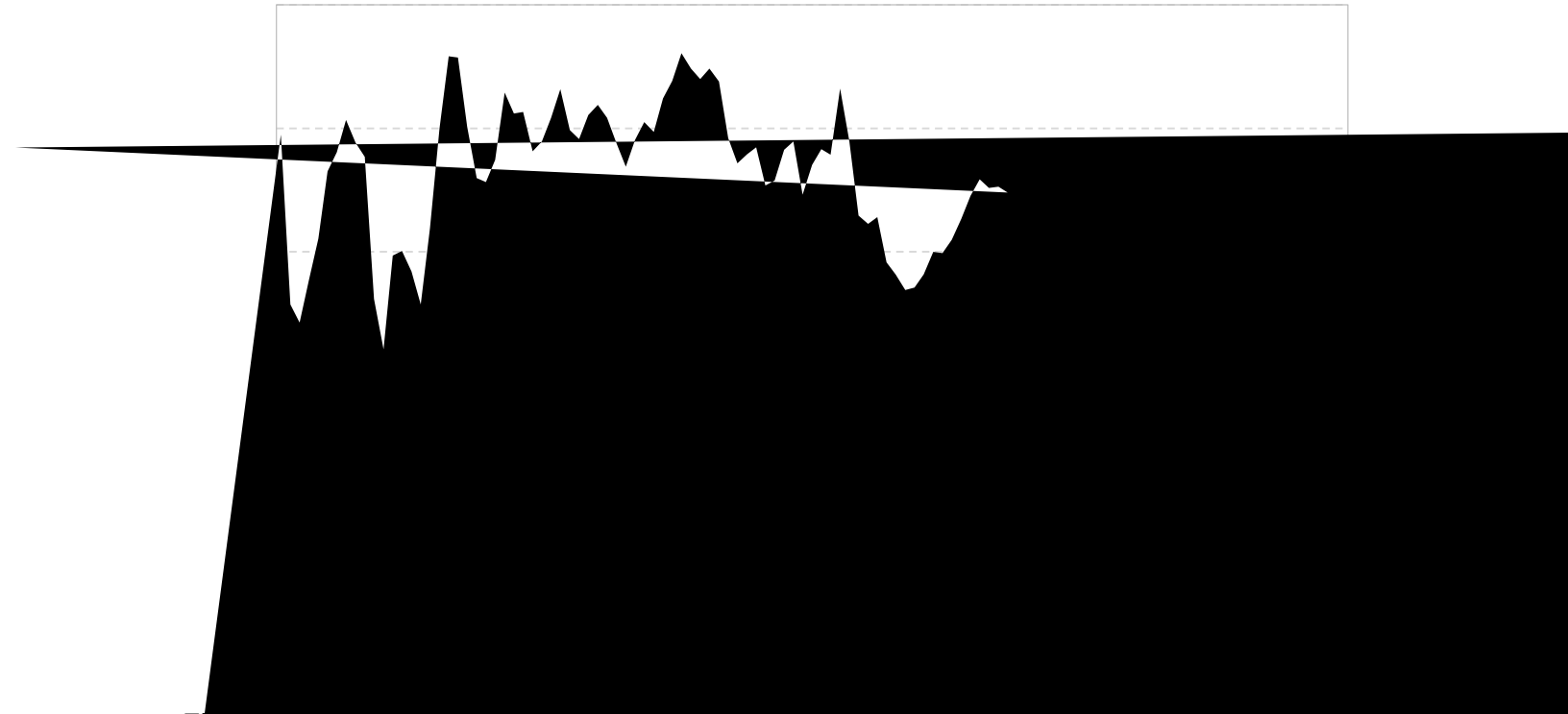
RESULTS

Weather data were recorded throughout the season with a Davis Instrument Vantage Pro2 weather station, equipped with a WeatherLink data logger at Borderview Research Farm in Alburgh, VT (Table 3). Precipitation was much higher this season than normal. From May-Sep 2022 there was a total of 23.9 inches of rain, 4.6 inches above the 30-year average for that same time frame. Warm temperatures in May were followed by unseasonably cool temperatures in June through September. While May was 2 degrees warmer than normal, June and September were both about 2 degrees cooler than the 30-year average. With the cooler temperatures, there was a total of 2501 accumulated Growing Degree Days (GDDs), which is 47 below the average the 30-year average.

Table 3. Weather data for Alburgh, VT, 2022.

Alburgh, VT	May	Jun	Jul	Aug	Sep
Average temperature (°F)	60.5	65.3	71.9	70.5	

Table 4. Spring soil health



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							N mg/soil g	CO2 mg/soil g	pH	Overall score
					36.3	0.244[b]	9.06[b]	0.851	6.92	85.3[b]
		980[a]	5.19	0.461	34.8	**0.266[a]**	**12.5[a]**	0.862	6.90	**91.1[a]**
LSD (p=0.10)[ÿ]	NS§	100	NS	NS	NS	0.014	1.66	NS	NS	2.89
Trial Mean	7.27	821	4.80	0.427	35.6	0.255	10.8	0.857	6.91	88.2

†Within a column, treatments marked with the same letter were statistically similar (p=0.10).
ÿLSD; Least significant difference at the p=0.10.
§NS; No significant difference between treatments.

Spring soil coverage and cover crop dry matter yield were significantly impacted by termination method (Table 9). The tillage and herbicide treatments were terminated approximately two and a half weeks before the plant green treatment, and that time allowed for an increase in ground cover and rye biomass. The plant green termination treatment had a spring soil cover (62.3%) and rye dry matter yield (2.61 tons ac^{-1}) that was statistically greater than both other termination methods, but there was no statistical difference between the tillage and herbicide treatments for either metric. Soil cover increased by almost 20% from 6-May to 23-May. Winter rye biomass was 2.4X greater than the herbicide treatment and 3.6X greater than the tillage treatment. Soybean test weight was significantly greater in the plant green treatment, and there was no statistical difference between the other two termination methods.

Table 9. Cover crop and soybean harvest characteristics by termination method, Alburgh, VT, 2022.

	Prior to cover crop termination	Soybean harvest
Termination method		

There were some significant differences in soil moisture between the termination methods (Table 11). On 6-May when rye in the tillage and herbicide treatments was terminated, the soil moisture was statistically greater in the herbicide block. On 23-May, just before soybean planting, soil moisture was statistically greater in the herbicide and tillage treatments than the plant green treatment, with soil moistures of 24.7, 24.4, and 20.2% respectively. The cover crop in the plant green treatment block had not been terminated yet, and these data suggest that the living winter rye had reduced the available water in the soil. There were no statistical differences in soil moisture on 21-Jun, 3-Aug or 15-Aug. On 7-Jul, soil moisture was significantly greater in the plant green treatment than the tillage treatment but not the herbicide treatment. On 29-Aug and 13-Sep, the herbicide treatment had the greatest soil moisture.

Soil temperature by termination method can be seen in Figure 2. This figure provides a visualization of temperature but does not, however, state that these differences are statistically significant. Soil temperature was similar in all three termination methods over the season. Earlier in the season soil temperature was higher in the tillage treatment, followed by the herbicide treatment, and coolest in the plant green treatment. This trend was likely because there was still cover crop residue, especially in the plant green treatment, and soybean canopy closure had not occurred. By July, soil temperature was similar in the tillage and herbicide treatments and coolest in the plant green treatment. This makes sense because the later termination of the winter rye in the plant green treatment, there was more cover crop residue. By the end of July, there was little difference in soil temperature between the treatments.

Table 11. Soil moisture by termination method, Alburgh, VT, 2022.

Termination method	Soil moisture							
	6-May[ú]	23-May	21-Jun	7-Jul	3-Aug	15-Aug	29-Aug	13-Sep
	%							
Tillage	16.8[b]†	24.4[a]	23.1	16.5[b]	12.8	15.8	21.3[ab]	20.7[b]
Herbicide	**19.7[a]**	**24.7[a]**	23.5	18.9[a]	13.4	16.0	**22[a]**	**22.4[a]**
Plant green	--	20.2[b]	25.5	**19.2[a]**	13.0	17.3	20.4[b]	21.7[ab]
LSD (p=0.10)[ÿ]	1.22	2.54						

Figure 2. Soil temperature by cover crop termination method, Alburgh, VT, 2022.

DISCUSSION

The 2022 growing season was much wetter than 2021. From May to September 2022 there was an accumulated 23.8 inches of rain,

a greater impact on the spring biomass production than the seeding rate or termination method. Soybean yields were