



Integrating Cover Crops and Manure into Corn Silage Cropping Systems



Dr. Heather Darby, UVM Extension Agronomist
Sara Ziegler, John Bruce, Ivy Krezinski, Rory Malone, and Lindsey Ruhl
UVM Extension Crops and Soils Technicians
(802) 524-6501

Visit us on the web at <http://www.uvm.edu/extension/nwcrops>

INTEGRATING COVER CROPS AND MANURE INTO CORN SILAGE CROPPING SYSTEMS

Dr. Heather Darby, University of Vermont Extension

[heather.darby\[at\]uvm.edu](mailto:heather.darby@uvm.edu)

With increasing focus on managing environmental impacts from agriculture, farmers are looking for ways to manage nutrients efficiently on their farms without sacrificing crop productivity. Cover cropping and no-till crop production are strategies that have been promoted as methods that help retain nutrients on farms and minimize losses to the environment. However, integrating these practices into the cropping system requires changes to other aspects of the system. For instance, manure management becomes more difficult when using no-till production methods as the timing or method of application may need to be altered to fit appropriately into the new production system. Farmers are curious what benefits to the soil, nutrient cycling, or crop production, may be realized from the additions of cover crops or transition to no-till methods within a corn silage cropping system. To help answer these questions, University of Vermont Extension's Northwest Crops and Soils Program conducted a field experiment between the fall of 2017 and the fall of 2021 to investigate the impacts of cover crops, tillage, and manure application in corn silage. The results from the 2020-2021 field season are summarized here.

MATERIALS AND METHODS

The field trial was conducted at Borderview Research Farm in Alburgh, VT (Table 1). Treatments included tillage methods (conventional vs. no-till), manure application timing (fall vs spring), and cover crop integration (cover crop vs. no cover crop). Plots were 10' x 40' and replicated four times. Manure was applied to fall manure plots on 21-Sep 2020 at a rate of 6000 gal ac⁻¹. The manure was surface applied and immediately incorporated using an aerway in conventional tillage plots, and surface applied in no-till plots. A manure sample was collected at the time of application and sent to the University of Vermont Agricultural and Environmental Testing Lab (AETL) for nutrient analysis. Winter rye was planted on 22-Sep 2020 into cover crop plots using a Sunflower no-till grain drill. The following spring, soils were sampled by collecting approximately 10 soil cores at a 6" depth within each plot using a soil probe. These samples were immediately dried and transported to the AETL to be analyzed for soil nitrate (NO₃) nitrogen (N) content. An additional sample was collected according to the Cornell Soil Health sampling protocol and sent to the Cornell Soil Health Laboratory to be analyzed (<https://soilhealth.cals.cornell.edu/>). Cover crop ground cover, height, and biomass was measured on 26-Apr 2021. Ground cover was measured by processing photographs using the Canopeo smartphone application (<https://canopeoapp.com/#/login>). Cover crop height was measured at three randomly selected locations within each plot. Due to poor establishment and growth, there was insufficient biomass to collect for dry matter yield or nutrient content analyses. Manure was surface applied to spring manure plots on 26-Apr 2021 at a rate of 6000 gal ac⁻¹. Conventional tillage plots were tilled using a Pottinger TerraDisc to incorporate manure and/or cover crop biomass. All remaining cover crop plots were terminated on 1-May 2021 by an application of Roundup Power Max herbicide at a rate of 1 qt ac⁻¹.

Corn was planted on 8-May 2021 at a rate of 34,000 seeds ac⁻¹ with 250 lbs ac⁻¹ 19-19-19 corn starter fertilizer using a John Deere 7500 no-till corn planter. Soil was again collected from plots at a 6" depth on 10-Jun 2021 and sent to the AETL to determine pre-side dress nitrate (PSNT) concentration.

Table 1. No-Till Cover Crop Trial Management, Alburgh, VT, 2020-2021.

Location	Borderview Research Farm – Alburgh, VT
Soil type	Benson rocky silt loam
Previous crop	Corn silage
Tillage treatments	Conventional tillage: immediate incorporation with aerway in fall, Pottinger TerraDisc in spring No-Till: manure not incorporated
Manure treatments	Fall application (21-Sep 2020) Spring application (26-Apr 2021)
Cover crop treatments	Winter rye No cover crop
Seeding rates (rye/corn)	100 lbs ac ⁻¹ /34,000 seeds ac ⁻¹
Corn variety	Syngenta NK8618, 86 RM
Replications	4
Plot size (ft)	10' x 40'
Manure application dates (rate, gal ac⁻¹)	Fall: 21-Sep 2020 (6,000) Spring: 26-Apr 2021 (6000)
Planting dates	Rye: 22-Sep 2020 Corn: 8-May 2021
Cover crop termination	Roundup PowerMax 1 qt ac ⁻¹ applied 1-May 2021 incorporated with disc harrow in conventional tillage plots
Harvest date	10-Sep 2021

No additional N was applied to the plots. Just prior to corn harvest, 8" basal corn stalk segments from 6" above ground level were collected from three randomly selected corn plants in each plot. The stalk samples were dried, ground to 1mm particle size, and analyzed for end of season nitrate content at the Dairy One Forage Laboratory (Ithaca, NY). Corn was harvested on 10-Sep 2021 using a John Deere 2-row chopper and a wagon fitted with scales. The yield of each plot was recorded and an approximate 1 lb subsample was collected and dried to determine dry matter content and calculate yield. The samples were then ground and analyzed for forage quality at the E. E. Cummings Crops Testing Lab at the University of Vermont via near-infrared reflectance spectroscopy (NIR) procedures using a FOSS DS2500 NIRS.

Data were analyzed using the general linear model procedure in SAS (SAS Institute, 1999). Replications were treated as a random effect and manure, cover crop, and tillage treatments were treated as fixed. Treatments were considered different at the 0.10 level of significance. Orthogonal contrasts were conducted to determine mean differences cover crop versus no cover crop, tillage versus no-tillage, and spring versus fall manure applications. Variations in yield and quality can occur because of variations in genetics, soil, 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.

Hybrids that were not significantly lower in performance than the highest hybrid in a particular column are indicated with an asterisk. 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. The asterisk indicates that hybrid B was not significantly lower than the top yielding hybrid C, indicated in bold.

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

RESULTS

Weather data were recorded with a Davis Instrument Vantage Pro2 weather station, equipped with a WeatherLink data logger at Borderview Research Farm in Alburgh, VT (Table 2). From September 2020 through May 2021 there were 3385 Growing Degree Days (GDDs) accumulated for the winter rye, 230 more than the 30-year normal. Precipitation during this time was extremely low with the monthly accumulation being below normal in all months except for April. Overall precipitation was 10.5 inches below normal across this time span. For the corn, there were 2613 GDDs accumulated from May through September, 64 more than normal. Precipitation during this time remained below normal for all months except Sep with a total of 6.27 inches below normal being accumulated. The region was classified as experiencing “abnormally dry” and “moderate drought” conditions throughout the entire season (Drought.gov).

Table 2. 2020-2021 weather data for Alburgh, VT.

	2020				2021								
	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Average temperature (°F)	59.2	48.3	42.0	29.4	21.5	19.8	33.2	48.1	58.4	70.3	68.1	74.0	62.8
Departure from normal	-3.53	-2.01	2.69	1.20	0.64	-3.07	0.93	2.52	-0.03	2.81	-4.31	3.25	0.14
Precipitation (inches)	2.75	3.56	1.41	1.40	0.39	0.47	0.97	3.52	0.66	3.06	2.92	2.29	4.09
Departure from normal	-0.92	-0.27	-1.29	-1.10	-1.74	-1.30	-1.27	0.45	-3.10	-1.20	-1.14	-1.25	0.42
Growing Degree Days (base 32°F)	816	521	352	100	8	32	241	497	818				
Departure from normal	-107	-48	117	52	8	21	103	85	-1				
Growing Degree Days (base 50°F)									334	597	561	727	394
Departure from normal									33	73	-134	85	7

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.

Effects of Conservation Management Systems

Conservation management systems differed statistically in spring ground cover and soil health metrics (Table 3). Spring winter rye ground cover was highest (50.0%) in the conventional tillage treatment receiving fall manure. This was statistically similar to only the conventional tillage treatment with winter cover receiving spring manure. While we would expect significantly lower ground cover from treatments without a winter cover crop, both no-till treatments with cover crops receiving either spring or fall manure

were significantly lower than the conventionally tilled treatments with cover crops. As little to no weeds were growing at this time, increased ground cover can be attributed to increased cover crop establishment. Soil health metrics also differed by conservation management system. All significant soil health metrics were statistically higher in the conventionally tilled treatment receiving spring manure with a winter cover crop. For each soil health metric except for overall soil health score, not only did this treatment have the highest level, but it was also statistically higher than all other treatments. For the overall soil health score, the conventional tillage treatment receiving spring manure with a winter cover crop performed statistically similarly to three other treatments that were all no-till treatments. Treatments did not differ in aggregate stability, organic matter content, or respiration.

Table 3. Ground cover and soil health metrics by conservation management systems.

System treatment	Ground cover	Soil carbon	Soil nitrogen	Active carbon	Predicted water holding capacity	Soil protein	Overall score
		%			g H ₂ O g soil ⁻¹	mg protein g soil ⁻¹	
CT-FM-NoCC [†]	1.65c [‡]	2.82bc	0.262b	835b	0.255bc	8.96b	82.1bcd
CT-FM-WRCC	50.0a	2.68bc	0.240b	799b	0.249c	8.34b	79.7d
CT-SM-NoCC	0.0850c	2.55c	0.240b	793b	0.258b	8.52b	81.2cd
CT-SM-WRCC	37.0ab	3.25a	0.300a	947a	0.268a	11.0a	86.6a
NT-FM-NoCC	1.75c	2.77bc	0.252b	795b	0.250bc	8.41b	82.3bcd
NT-FM-WRCC	27.3b	2.78bc	0.259b	844b	0.254bc	8.89b	85.0ab
NT-SM-NoCC	0.400c	2.88b	0.263b	852b	0.253bc	9.21b	84.1abc
NT-SM-WRCC	12.6bc	2.80bc	0.250b	818b	0.254bc	9.09b	85.3ab
LSD ($p = 0.10$) [¥]	13.5	0.290	0.029	64.0	0.00830	1.03	3.64
Trial mean	16.4	2.82	0.258	835	0.255	9.05	83.3

[†]CT- conventional tillage; NT- no-till; FM- fall manure; SM- spring manure; WRCC- winter rye cover crop; NoCC- no cover crop

[‡]Treatments that share letters performed statistically similarly to one another. The top performer is indicated in **bold**.

[¥]Least significant difference (LSD) at the 0.10 level.

At the beginning of the season, management systems did not differ statistically in soil nitrate content (Table 4). However, by the time the corn was in the V6 growth stage, treatments ranged widely in soil nitrate content (summer). The highest nitrate content was observed in the no-till treatment with spring manure and winter cover crop, which was statistically similar to four other treatments which all also received spring manure. The treatment with the lowest soil nitrate at topdress was the conventionally tilled treatment that received fall manure with no winter cover crop. However, the level of nitrate available even in that treatment would only warrant 17.2 lbs N ac⁻¹ to be supplemented (based on a 20 ton ac⁻¹ yield goal, Nutrient Recommendations for Field Crops in Vermont). All other treatment would not require additional nitrogen. At the end of the season, nitrate levels were assessed in the basal segments of corn stalks in each plot in order to determine nitrate uptake and therefore availability to the plant. The treatment with the highest corn stalk nitrate content was the no-till treatment that received spring manure with a winter cover crop. This was higher than all other treatments which were statistically similar to one another. However, despite not requiring much if any supplemental nitrogen at the time of topdress, all plots had corn stalk nitrate levels below 250ppm indicating insufficient nitrogen available for adequate yield. This was likely due to the

extreme drought conditions that persisted through the duration of the trial which would have limited uptake of nitrogen into the plant despite it being present in the soil.

Table 4. Soil and corn stalk nitrate content by conservation management system.

System treatment	Spring	Summer	End of Season	Supplemental N recommendation
	ppm			lbs ac ⁻¹
CT-FM-NoCC [†]	4.14	28.2d [‡]	36.8b	17.2
CT-FM-WRCC	2.69	57.7cd	14.5b	0
CT-SM-NoCC	4.36	93.1ab	29.0b	0
CT-SM-WRCC	3.35	116a	48.5b	0
NT-FM-NoCC	4.01	87.5abc	16.0b	0
NT-FM-WRCC	4.00	62.5bcd	17.0b	0
NT-SM-NoCC	4.04	99.6a	29.5b	0
NT-SM-WRCC	3.53	120a	157a	0
LSD ($p = 0.10$) [¥]	NS [€]	35.2	76.6	
Trial mean	3.77	83.1	43.5	

[†]CT- conventional tillage; NT- no-till; FM- fall manure; SM- spring manure; WRCC- winter rye cover crop;

NoCC- no cover crop

[‡]Treatments that share a letter performed statistically similarly to one another.

[¥]Least significant difference (LSD) at the 0.10 level.

[€]NS; Not statistically significant

Treatments did not differ in corn silage yield but did vary in some quality parameters (Table 5). Yields ranged from 13.4 to 19.7 tons ac⁻¹ but did not differ statistically.

Table 5. Corn silage yield and quality by conservation management system.

System treatment	Yield at 35% DM	CP	aNDFom	Lignin	Starch	TDN	NeI	240-hr uNDF	30-hr NDFD	Milk yield	
	tons ac ⁻¹			% of DM			Mcal lb ⁻¹	% of NDF		lbs ton ⁻¹	lbs ac ⁻¹
CT-FM-NoCC	16.4	7.50	51.2	3.47bc [†]	19.7	60.3	0.582	17.2bc	52.3bc	2979	17159
CT-FM-WRCC	16.7	7.07	49.5	3.23abc	24.7	62.0	0.606	14.8ab	56.3a	3142	18526
CT-SM-NoCC	18.9	8.10	50.6	3.90c	17.8	59.0	0.567	17.4bc	53.0abc	2891	19510
CT-SM-WRCC	18.4	7.80	50.3	3.90c	20.0	60.7	0.580	18.3c	49.6c	3037	19701
NT-FM-NoCC	13.4	6.77	44.1	2.43a	33.5	64.7	0.656	12.6a	56.5a	3293	15340
NT-FM-WRCC	15.2	7.30	49.4	3.03ab	23.7	62.3	0.614	15.2ab	52.9abc	3176	17129
NT-SM-NoCC	19.7	7.73	52.3	3.77bc	18.2	60.3	0.571	17.8bc	51.0c	2979	20880
NT-SM-WRCC	14.9	8.37	48.4	3.27bc	22.3	62.3	0.615	14.9ab	55.7ab	3178	16613
LSD ($p = 0.10$) [‡]	NS [¥]	NS	NS	0.811	NS	NS	NS	3.04	3.68	NS	NS
Trial mean	16.7	7.58	49.5	3.38	22.5	61.5	0.599	16.0	53.4	3084	18107

[†]CT- conventional tillage; NT- no-till; FM- fall manure; SM- spring manure; WRCC- winter rye cover crop; NoCC- no cover

[‡]Treatments that share a letter performed statistically similarly to one another.

[¥]Least significant difference (LSD) at the 0.10 level.

[€]NS; Not statistically significant

Treatments differed in lignin, 240-hr uNDF, and NDF digestibility. The no-till treatment receiving fall manure with no cover crop was the top performer in each of these categories but performed statistically similarly to at least two other management treatments within each category. Individual quality parameter differences did not impact the ultimate predicted milk yield.

Effects of Individual Conservation Practices

Contrasts between the manure timing, tillage, and cover crop treatments were analyzed to determine the impact of each of these individual components within these system treatments (Table 6).

Table 6. Cover, manure, and tillage treatment contrast effects (*p*-values) on soil and crop parameters.

	Cover treatment	Manure timing treatment	Tillage treatment
	Level of significance		
Ground cover	NS [†]	** [‡]	***
Spring soil nitrate	NS	NS	**
Aggregate stability	NS	**	NS
Organic matter	NS	NS	NS
Respiration	NS	NS	NS
Soil total carbon	**	NS	NS
Active carbon	NS	NS	*
Soil total nitrogen	*	NS	NS
Soil protein	*	NS	*
Water holding capacity	NS	*	NS
Overall score	NS	NS	NS
Soil nitrate at topdress	NS	*	NS
Corn stalk nitrate	*	NS	NS
Corn yield	NS	NS	NS
Crude protein (CP)	NS	**	NS
Acid detergent fiber (ADF)	NS	NS	NS
Neutral detergent fiber (aNDFom)	NS	NS	NS
NDF digestibility (30-hr NDFD)	NS	*	NS
Undigestible NDF (240-hr uNDF)	NS	**	*
Lignin	NS	**	**
Starch	NS	**	NS
Total digestible nutrients (TDN)	NS	NS	NS
Net energy for lactation (Nel)	NS	NS	NS
Milk yield per ton	NS	NS	NS
Milk yield per acre	NS	NS	NS

[†]NS; Not statistically significant at the *p*=0.10 probability level

[‡]**Significant at the *p*=0.10 probability level; **Significant at the *p*=0.05 probability level; ***Significant at the *p*=0.0001 probability level.

Impact of Cover Crop

Treatments that contained cover crops exhibited higher total soil carbon, nitrogen, and protein than plots with no cover crop (Table 7). However, these did not correspond to higher active carbon, respiration,

aggregate stability, or overall scores for cover crop plots. It is important to note that this trend is different than was observed across the 2018-2020 seasons and may be due to overall poor establishment of the cover crop impacted by drought conditions through the season and around planting.

Table 7. Cover crop and soil health metrics by cover crop treatment.

Cover crop treatment	Ground cover	Soil carbon	Soil nitrogen	Active carbon	Predicted water holding capacity	Soil protein	Overall score
		%		mg C kg soil ⁻¹	g H ₂ O g soil ⁻¹	mg protein g soil ⁻¹	
No cover crop	0.970	2.75	0.254	819	0.254	8.77	82.4
Cover crop	31.7	2.88	0.262	852	0.256	9.32	84.1
Level of significance	NS‡	**†	*	NS	NS	*	NS
Trial mean	16.4	2.82	0.258	835	0.255	9.05	83.3

†*Significant at the p=0.10 probability level; **Significant at the p=0.05 probability level.

‡NS; Not statistically significant.

Farmers can be hesitant to adopt cover cropping because they believe that the cover crop will immobilize nitrogen, thereby, requiring more additional nitrogen or negatively impacting the corn silage yield. However, plots with cover crops contained similar soil nitrate-N both in the spring and at time of topdress to plots without cover crops (Figure 1). Furthermore, based on the soil nitrate-N contents at the time of topdress, no additional nitrogen was recommended for either treatment. By the end of the season, the nitrate content of the corn stalks did differ statistically (Figure 2), however, levels were higher in plots with cover crops indicating corn in those plots took up more nitrate from the soil than in plots without cover crops. However, this did not translate into higher yields and corn stalk nitrate levels in both treatments indicate insufficient nitrate to support high yields. This was likely due to drought conditions limiting uptake into the plant despite the presence of nitrate in the soil. Most importantly, the presence of a cover crop did not hinder nitrate availability nor corn yield.

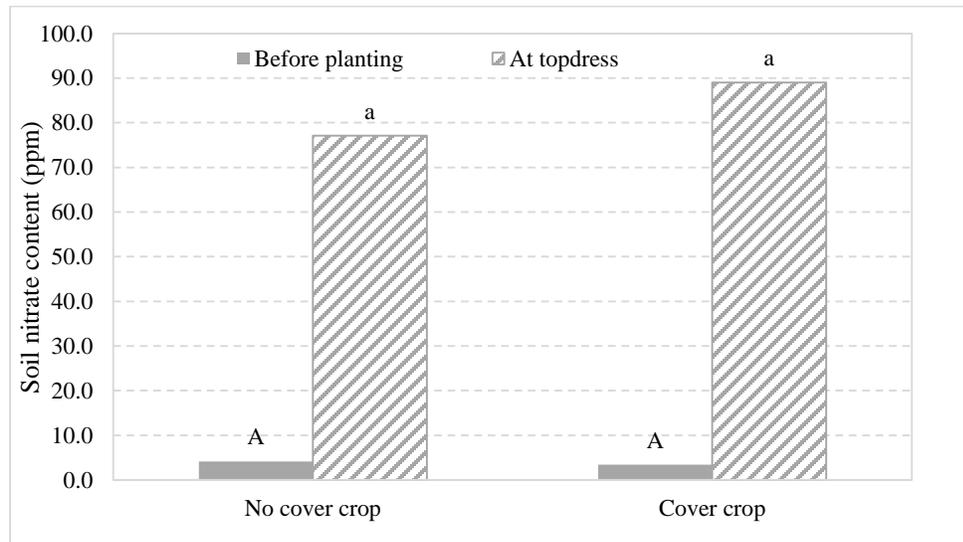


Figure 1. Soil nitrate content before planting and at the time of topdress.

Treatments with the same letter performed statistically similarly to one another.

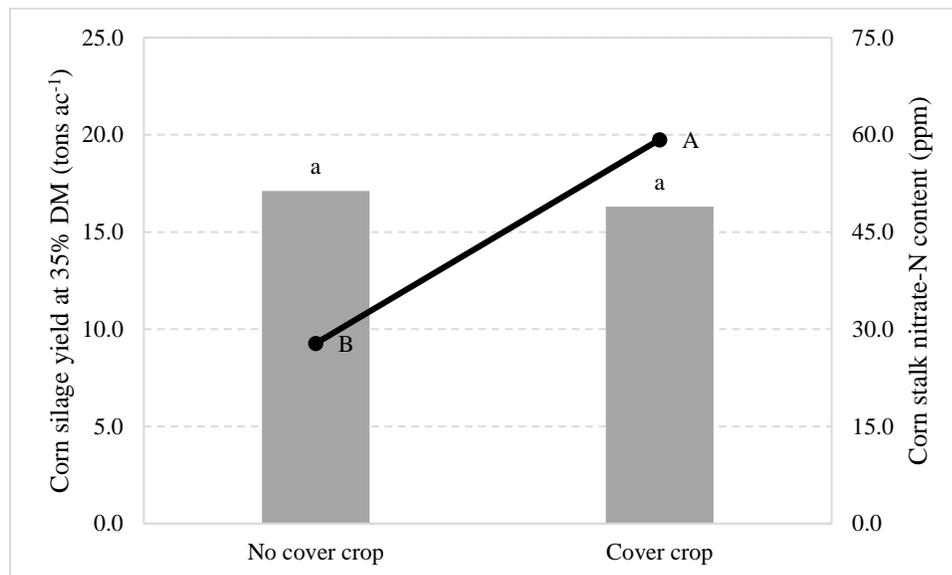


Figure 2. Corn silage yield and corn stalk nitrate content by cover crop treatment.

Treatments with the same letter performed statistically similarly to one another.

Despite this higher N uptake in cover crop plots, corn silage quality was similar across cover crop treatments (Table 8).

Table 8. Corn silage quality characteristics by cover crop treatment.

	CP	aNDFom	Lignin	Starch	TDN	NEL	24-hr uNDF	30-hr NDFD	Milk yield	
	% of DM					Mcal lb ⁻¹	% of NDF		lbs ton ⁻¹	lbs ac ⁻¹
No cover crop	7.53	49.6	3.39	22.3	61.1	0.594	16.3	53.2	3035	18222
Cover crop	7.63	49.4	3.36	22.7	61.8	0.604	15.8	53.6	3133	17992
Level of significance	NS [†]	NS	NS	NS	NS	NS	NS	NS	NS	NS
Trial mean	7.58	49.5	3.38	22.5	61.5	0.599	16.0	53.4	3084	18107

[†]NS; Not statistically significant.

Impact of Manure Application Timing

Cover crops established better when manure was applied in the fall at the time of planting (Table 9). This is evidenced by higher spring ground cover in plots receiving fall manure where the cover crop growth was denser and thus provided more ground coverage. However, aggregate stability and water holding capacity were higher in plots receiving spring manure while all other soil health metrics remained statistically similar between manure timing treatments. This was similar to what was observed in the 2018-2020 seasons.

Corn silage yield was not impacted by manure timing (Figure 3). While soil nitrate levels at the time of topdress were significantly higher in plots receiving spring manure, both manure timing treatments provided sufficient nitrate that additional nitrogen supplementation would not be recommended. Furthermore, by harvest both treatments had statistically similar levels of N uptake into the plant as evidence by the corn stalk nitrate analysis.

Table 9. Cover crop and soil health metrics by manure application timing.

Manure application timing	Ground cover	Aggregate stability	Soil carbon	Active carbon	Predicted water holding capacity	Soil protein	Overall score
		%			mg C kg soil ⁻¹		
Fall manure	20.2	25.2	2.76	818	0.252	8.65	82.3
Spring manure	12.5	25.3	2.87	853	0.258	9.44	84.3
Level of significance	**†	**	NS‡	NS	*	NS	NS
Trial mean	16.4	25.3	2.82	835	0.255	9.05	83.3

†*Significant at the p=0.10 probability level; **Significant at the p=0.05 probability level.

‡NS; Not statistically significant.

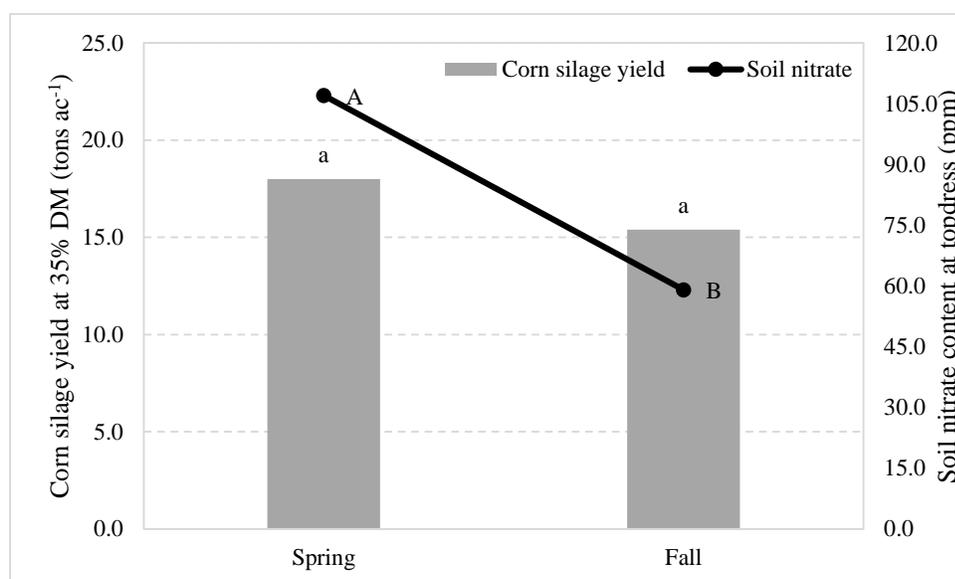


Figure 3. Corn yield and soil nitrate content at time of topdress by manure application timing treatment.

Treatments that share the same letters performed statistically similarly to one another.

Crude protein levels were higher in corn silage plots that received spring manure (Table 10). Conversely, fall manure application led to lower lignin, 240-hr uNDF, and higher 30-hr NDF digestibility. However, when multiple quality parameters were considered, predicted milk yields did not differ between treatments.

Table 10. Corn silage yield and quality characteristics by manure application timing.

Manure application timing	CP	aNDFom	% of DM			TDN	NEL	240-hr uNDF	30-hr NDFD	Milk yield	
			Lignin	Starch	Mcal lb ⁻¹			% of NDF	lbs ton ⁻¹	lbs ac ⁻¹	
Fall manure	7.16	48.6	3.04	25.4	62.3	0.614	15.0	54.5	3147	17038	
Spring manure	8.00	50.4	3.71	19.6	60.6	0.583	17.1	52.3	3021	19176	
Level of significance†	**	NS‡	**	**	NS	NS	**	*	NS	NS	
Trial mean	7.58	49.5	3.38	22.5	61.5	0.599	16.0	53.4	3084	18107	

†*Significant at the p=0.10 probability level; **Significant at the p=0.05 probability level.

‡NS; Not statistically significant.

Impact of Tillage Method

Ground cover differed statistically between tillage treatments (Table 11) as cover crops established more consistently in conventionally tilled plots (Images 1 and 2). Active carbon and soil protein were 17 mg kg⁻¹ and 0.290 mg g⁻¹ higher respectively in conventionally tilled plots. This is likely related to the better establishment of cover crops in these plots as cover crops were shown to increase active carbon and protein in the soil. Despite some differences in soil health metrics, overall soil health scores did not differ significantly by tillage treatment.

Table 11. Cover crop and soil health metrics by tillage treatment.

Tillage treatment	Ground cover	Aggregate stability	Soil carbon	Active carbon	Predicted water holding capacity	Soil protein	Overall score
		%		mg C kg soil ⁻¹	g H ₂ O g soil ⁻¹	mg protein g soil ⁻¹	
Conventional	22.2	22.8	2.82	844	0.258	9.19	82.4
No-till	10.5	27.8	2.81	827	0.253	8.90	84.2
Level of significance	***†	NS‡	NS	*	NS	*	NS
Trial Mean	16.4	25.3	2.82	835	0.255	9.05	83.3

†*Significant at the P=0.1 probability level; ***Significant at the P<.0001 probability level.

‡NS; not statistically significant.



Image 1 - 2. Cover in conventionally tilled (left) and no-till (right) plots.

Corn silage yields did not differ between tillage treatments (Table 12). In terms of quality, tillage treatments only differed in lignin and 240-uNDF content. In both cases the no-till plots produced corn silage with lower lignin and 240-uNDF content. Overall, however, predicted milk yields were similar between tillage treatments.

Table 12. Corn silage yield and quality by tillage treatment.

Tillage treatment	Yield at 35% DM tons ac ⁻¹	CP	aNDFom % of DM	Lignin % of DM	Starch	TDN	NEL Mcal lb ⁻¹	240-hr uNDF % of NDF	30-hr NDFD % of NDF	Milk yield	
										lbs ton ⁻¹	lbs ac ⁻¹
Conventional	17.6	7.62	50.4	3.63	20.5	60.5	0.584	16.9	52.8	3012	18724
No-till	15.8	7.54	48.6	3.13	24.4	62.4	0.614	15.1	54.0	3156	17491
Level of significance	NS‡	NS	NS	***†	NS	NS	NS	*	NS	NS	NS
Trial mean	16.7	7.58	49.5	3.38	22.5	61.5	0.599	16.0	53.4	3084	18107

†*Significant at the P=0.1 probability level; ***Significant at the P<.0001 probability level.

‡NS; not statistically significant.

DISCUSSION

Integrating no-tillage into corn silage systems can pose challenges with other aspects of the cropping system, especially regarding the method and timing of manure application, and cover crops. Managing cover crop biomass in the spring to adequately prepare the soil for planting can be a challenge. In a conventional tillage system, incorporating the biomass into the soil can tie up nitrogen that otherwise would be utilized by the crop. Pairing cover crop incorporation with manure application can help provide more available nitrogen to the subsequent crop. However, in a no-till system, manure is left unincorporated and much of the ammonium-N may be lost through volatilization. Cover crops can help build soil health and aide with the transition to no-till. However, the additional cover crop biomass may further exacerbate the lack of N in these systems, especially in fields transitioning to no-till systems (such as the one in this study). Additional fertility may be needed in a no-till system to support the corn crop yield goals.

ACKNOWLEDGEMENTS

This project is supported by a USDA NIFA CARE grant (2017-68008-26306). UVM Extension would like to thank Roger Rainville and his staff at Borderview Research Farm. We would like to acknowledge Henry Blair, Catherine Davidson, and Hillary Emick for their assistance with data collection and entry. This information is presented with no product discrimination, endorsement, or criticism.

UVM Extension helps individuals and communities put research-based knowledge to work.



Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the United States Department of Agriculture. University of Vermont Extension, Burlington, Vermont. University of Vermont Extension, and U.S. Department of Agriculture, cooperating, offer education and employment to everyone without regard to race, color, national origin, gender, religion, age, disability, political beliefs, sexual orientation, and marital or familial status.