UNIVERSITY OF VERMONT EXTENSION

CULTIVATING HEALTHY COMMUNITIES

2009
Cover Crop Termination Study

Figure 1 Rolling & crimping of winter rye cover crop.

Dr. Heather Darby
Erica Cummings, Rosalie Madden & Amanda Gervais
802-524-6501

2009 Cover Crop Termination Study

Heather Darby, University of Vermont Extension
hdarby@uvm.edu

When corn silage is harvested in the fall, the entire plant is removed leaving the soil exposed through the winter. Many farmers have started to plant cover crops following corn harvest. The cover crop protects the soil from erosion and also scavenges excess soil nitrogen. This keeps the nitrogen fro potentially being lost through leaching. Farmers have asked, what is the best strategy for terminating the cover crops in the spring? Farmers would like to reap the most benefit from the cover crop while protecting corn silage yield and quality. As a part of this study a unique termination strategy called "rolling and crimping" was demonstrated in a corn silage system. In order to properly utilize this technique the rye crop must be in the flowering stage before it is terminated. Once in the flowering stage the cover crop is rolled down and the stems crimped by the machine (Figure 1). The rolled cover crop will act as a mat of mulch to suppress weeds. The corn is planted into the mat of mulch using a no-till planter (Figure 2). This system has many advantages as it reduces both weed control and tillage costs. However, this practice has not been evaluated in a corn silage system in New England. Therefore we are unsure how it might best fit into our climate and cropping system. In 2009, the University of Vermont Extension conducted an experiment to evaluate the impact of cover crop termination strategies on soil health, soil nitrogen dynamics, and corn silage yield and quality. The goal is to document the positive and negative aspects of each strategy so farmers can decide the best way to terminate cover crops on their farm. It is important to remember that the data presented are from a single test at only one location. Cover crop data from additional tests in different locations and often over several years should be compared before you make conclusions.

Figure 2. The knife points at the crimped winter rye stem.

CULTURAL PRACTICES

The experiment was conducted on a silt loam soil with the previous crop being sunflowers. On October 10, 2008 the winter rye was seeded at a rate of 100 lbs/acre. Plots without cover crops served as controls. The plot design was a randomized complete block with three replications and the plot size measured 10'x 50'. In mid-April the soil was sampled to determine soil quality. Soil was sampled from multiple locations to a 6" depth using a trowel. The subsample of soil was taken from each plot and sent to the Cornell Soil Health Lab for analysis. Soil quality was monitored to determine if a single season of cover cropping would improve soil health. Soil nitrates were measured weekly from the end of April until mid July. Soil nitrate sampling was used to monitor the break-down of the cover crop and subsequent nitrogen release. Nitrate sampling was terminated once the corn was at the V6 stage (time of nitrogen topdress). Multiple soil samples to a depth of 12 inches were taken from each plot, composited, and subsample analyzed for soil nitrate-N. Prior to cover crop termination, a one-meter^2 sample of cover was taken to determine crop biomass and nitrogen content. In the spring of 2009, the cover crops were terminated with a burn-down herbicide (glyphosate at 2 qts/acre), plowing the cover crop into the soil, or by rolling and crimping the crop (Figure 1). After the cover crop was terminated, corn (var. Pioneer 36Y26) was planted with a John Deere 4-row corn planter at 32,000 seeds to the acre. Starter fertilizer was applied at a rate of 200 lbs 10-20-20 to the acre. In early July, the corn plots were topdressed with urea-nitrogen at the V6 growth stage. Fertilizer rates were determined with soil nitrate-N tests. The plots were harvested when the corn reached 35% whole plant dry matter or following a killing frost. The plots were harvested on September 24, 2009 with a John Deere 2 row chopper, and the forage wagon was weighed on a platform scale. A subsample was collected for moisture determination and quality analysis. Pertinent trial information is summarized in Table 1.

Table 1. Cover crop termination trial information.

Cover crop termination method	Cover crop termination date	Tillage type	Corn planting Date	N topdress* lbs/acre	Corn harvest date
No cover crop (control)		Plow & disk	13-May	70	6-Oct
Plow under	6-May	Plow & disk	13-May	66	6-Oct
Herbicide burn-down	6-May	No-till	13-May	70	6-Oct
Rolled & Crimped	1-Jun	No-till	1-Jun	140	21-Oct

*Nitrogen topdress rates were determined by soil nitrate-N testing just prior to corn growth stage V6.

WEATHER DATA

Seasonal precipitation and temperature recorded at weather stations in close proximity to the trial site is shown in Table 2. This season brought cooler than normal temperatures and higher than normal rainfall patterns across the region. In general corn silage yields were average to below average for most farms including our trial locations. Below average Growing Degree Days (GDD) resulted in corn maturing at a slower rate and hence a later than normal harvest date. The total accumulated GDD for corn growth was 1836 when planted in mid-May and 1777 GDU when corn was planted on June 1st of 2009.

Table 2. Temperature, precipitation, and growing degree days summary – Alburgh, VT

	April	May	June	July	August	September	October
Average Temperature	44.9	53.9	62.8	65.9	67.7	57.7	44.1
Departure from Normal	+1.4	-2.7	-3.0	-5.2	-1.3	-2.7	-4.7
Precipitation	2.89	6.32	5.19	8.07	3.59	4.01	5.18
Departure from Normal	+0.38	+3.39	+1.98	+4.66	-0.26	+0.55	+0.79
Growing Degree Days (50˚)	111.5	209.0	398.0	494.5	557	286	40.5
Departure from Normal	+71.0	-51.4	-76.0	-158.1	-32.0	-26.0	-61.8

*Based on National Weather Service data from cooperative observer stations in South Hero. Historical averages are for 30 years of data (1971-2000).

PRESENTATION OF DATA

The amount of cover crop biomass terminated is reported in Table 3. The impact of cover cropping on soil quality is reported in table 4. The soil nitrate-N measured is reported in Figure 3. Finally the impact of cover crop termination strategy on corn yield and quality is shown in Table 5 and Figure 4. Dry matter corn yields were calculated and then adjusted to 35% dry matter for the report. The numbers presented in the tables are of three replications. All data was analyzed using a mixed model analysis where replicates were considered random effects. The LSD procedure was used to separate cover crop termination means when the F-test was significant ($P< 0.10$).

LEAST SIGNIFICANT DIFFERENCE (LSD)

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 (LSD's) at the 10% level of probability 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 in 9 out of 10 chances that there is a real difference between the two hybrids. Treatments that were not significantly lower in performance than the highest treatment in a particular column are indicated with an asterisk. In the example below treatment A is significantly different from treatment C but not from treatment B. The difference between A 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 A and C 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. The asterisk indicates that treatment B was not significantly lower than the top yielding treatment.

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

RESULTS

Table 3. Cover crop biomass and nitrogen content

Cover crop termination method	Cover crop dry matter	Cover crop tissue nitrogen	
	tons/acre	%	lbs/acre
No cover crop (Control)	0	0	0
Rolled & crimped	**3.10***	1.57	97
Herbicide burn-down	1.84	2.93*	**107***
Plow under	1.73	**3.02***	104*
LSD (0.10)**	0.26	0.242	3.21

* Treatments that did not perform significantly lower than the top performing treatment in a particular column is indicated with an asterisk.
** See text for further explanation.

Table 4. Impact of a single season of cover cropping on soil quality.

Treatment	Organic matter	Active carbon	Stable aggregates	Potential N-mineralization
	%	mg kg^{-1}	%	ug N g^{-1} d soil
Cover crop	4.42	702	63.2	12.3
No cover crop	4.46	676	61.4	11.1
P-value (0.10)	NS	*	*	NS

*Coefficients significanct at the 0.10 probablity levels.
NS - None of the varieties were significantly different from one another.

Table 5. Impact of cover crop termination method on soil nitrate-N levels.

Cover crop termination method	Soil nitrate-N
	Ppm
No cover crop (Control)	10.5
Plow under	**11.7**
Herbicide burn-down	8.94
Rolled & crimped	4.29
LSD (0.10)**	1.18

* Treatments that did not perform significantly lower than the top performing treatment in a particular column is indicated with an asterisk.
** See text for further explanation.

Table 6. Impact of cover crop termination method on soil nitrate-N levels.

Cover Crop termination method	Soil nitrate-N sample date								
	6-May	13-May	20-May	27-May	3-Jun	10-Jun	17-Jun	24-Jun	1-Jul
	ppm								
No cover crop (Control)	5.65	5.07*	7.82*	7.55*	8.71	8.78*	12.6*	**17.1***	14.7*
Plow under	5.62	**6.34***	**8.86**	**8.82***	**11.0***	**9.70***	**16.1***	16.5*	**16.3***
Herbicide burn-down	5.42	4.83*	5.70	6.25	7.92	8.48*	10.8	15.9*	14.2*
Rolled & crimped	4.63	1.94	2.20	1.94	3.10	2.63	2.84	3.29	3.56
LSD (0.10)**	NS	2.29	2.41	1.58	1.88	4.09	4.54	5.09	5.31

* Treatments that did not perform significantly lower than the top performing treatment in a particular column is indicated with an asterisk.
** See text for further explanation.
NS - None of the varieties were significantly different from one another.

RESULTS

Figure 3. Soil nitrate-N of cover crop termination strategies from late April to mid-July.

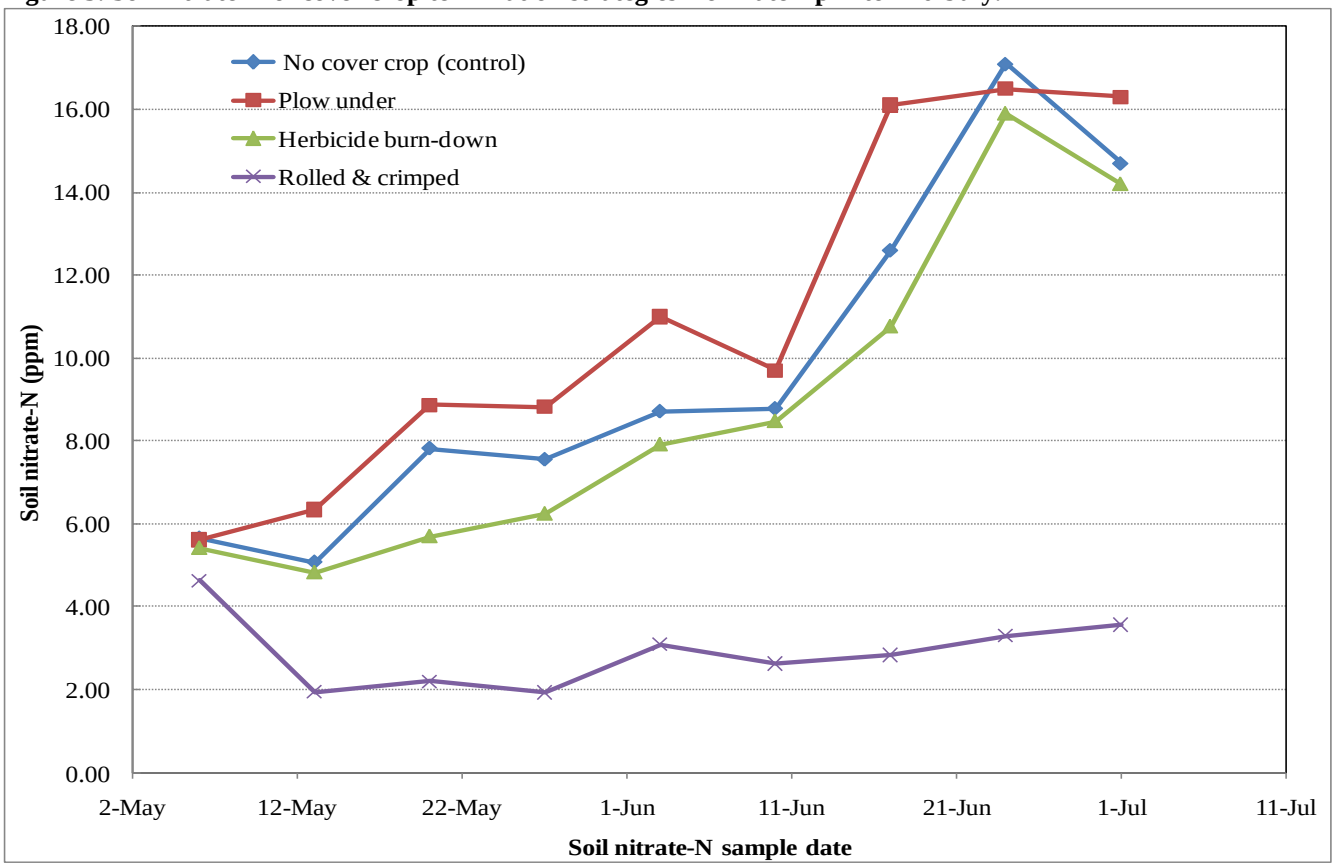


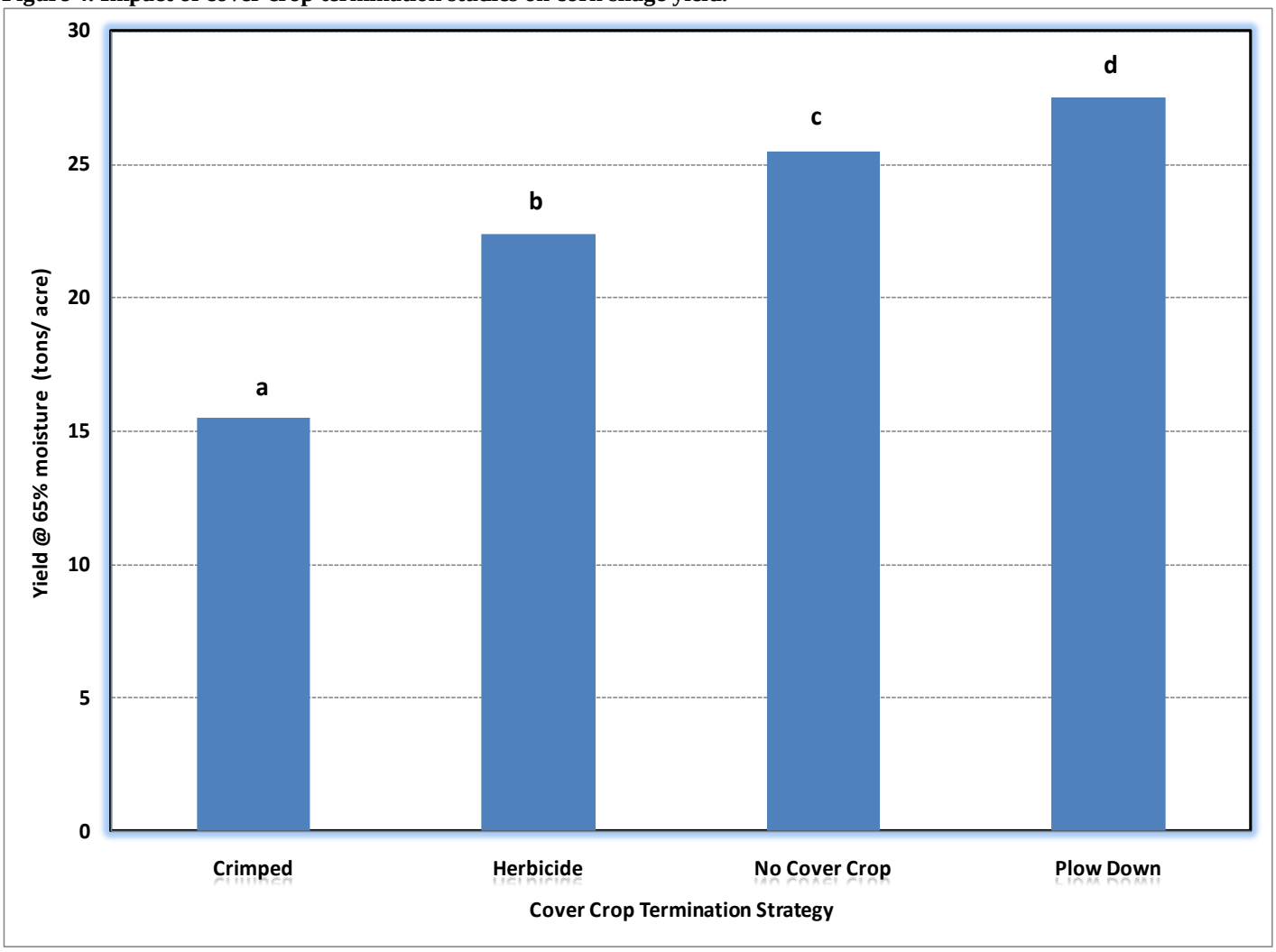
Table 7. Impact of cover crop termination strategy on corn silage yield and quality.

Cover crop termination method	Yield 35 % DM T/A	Forage Quality Characteristics CP %	ADF %	NDF %	Nel %	Milk per ton	Milk per acre
Rolled & crimped	15.5	7.83	25.8	43.0	0.75	2977	16095
Herbicide burn-down	22.4	7.07	25.9	42.1	0.75	2749	21556
No cover crop	25.5	**8.90***	23.0	39.2	0.76	2893	25814*
Plow down	**27.5***	8.07	24.4	40.4	0.75	2835	**27321***
LSD (0.10)**	2.1	0.63	NS	NS	NS	NS	3090

* Treatments that did not perform significantly lower than the top performing treatment in a particular column is indicated with an asterisk.
** See text for further explanation.
NS - None of the varieties were significantly different from one another.

RESULTS

Figure 4. Impact of cover crop termination studies on corn silage yield.



Hybrids with the same letter did not differ statistically in yield.

DISCUSSION

The amount of cover crop biomass was highest in the roller/crimper treatment. This makes sense because the rye cannot be rolled/crimped until the flowering stage. The other cover crop termination strategies were applied when the cover crop was still in the vegetative stages. Essentially the cover crops were worked under as soon as the cooperating farm was ready to start working the soil. Therefore the cover crop biomass was almost half as much as the roller/crimper treatment. The cover crops also scavenged a fair amount of nitrogen from the soil. Based on plant biomass samples the cover crops contained up to 3% nitrogen. Hence there was a considerable amount of potential nitrogen that could be made available to the corn crop. The roller/crimper treatment had the least amount of nitrogen in the cover crop biomass. The amount of nitrogen had decreased as the crop became more mature and the amount of carbon increased simultaneously.

Overall, the soil quality was improved by a single season of cover cropping. The cover crop improved active carbon and stable aggregate levels. Active carbon is the portion of organic matter that is readily available to soil microorganisms. If a soil has a high level of stable aggregates the physical properties of the soil are improved. Generally, these soils have better drainage capabilities. The level of potential N-mineralization was not statistically increased by cover cropping. The amount of potentially mineralizable nitrogen is an indicator of soil microbial activity. Increased microbial activity can improve nutrient cycling and soil physical properties. It is promising to see that even a single season of cover cropping can provide immediate benefits to the soil.

The level of soil nitrate-N was significantly higher in the plowed under cover crop treatment as compared to the other termination strategies (Table 5). This would indicate that if the rye crop is plowed under nitrogen conserved in cover crop biomass will be cycled and available for subsequent crop uptake. This also indicates that when a cover crop is terminated with an herbicide the cover crop

break-down may result in nitrogen losses to the atmosphere. In fact, the no-till may have also lead to a decline in overall corn yields. The roller/crimped cover crop plots had the lowest amount of soil nitrate-N. The rolled/crimped cover crop had a high C:N ratio. The ratio may have resulted in nitrogen tie-up and subsequent corn nitrogen deficiencies.

Corn silage yields were impacted by the type of cover crop termination. The cover crop that was plowed-under resulted in the highest corn yields, while the rolled/crimped cover crop resulted in the lowest yields. The herbicide termination strategy and the control did not differ statistically in yields. The rolled/crimped plots were planted over two weeks later than other strategies potentially contributing to lower yields. In addition, the thick mulch may have also contributed to slower warming of the soil and nitrogen tie-up and hence delayed corn development. Both the herbicide and rolled/crimped treatments were planted with no-till technology potentially contributing to lower yields. Overall, cover cropping can have positive results on soil quality and plant yields. Additional studies need to be conducted to continue to understand how to reap the benefits of each termination strategy.

UVM Extension would like to thank Roger Rainville and staff at Borderview Farm for their help implementing the trial. This trial was supported by funding through the Vermont Sustainable Jobs Fund and the Northeast USDA SARE program.

The UNIVERSITY of VERMONT EXTENSION