Cover Crop Diversity in No-Till Systems

Project Final Report

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COVER CROP DIVERSITY IN NO-TILL SYSTEMS

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Summary

In 2013 and 2014, the UVM Extension Champlain Valley Crop, Soil and Pasture Team based in Middlebury,

2. Evaluate winter-killed cover crop mixes in comparison to winter-hardy mixes, as an option for farms with heavier soils to incorporate cover crops as part of a no-till system.

As our most successful planting site was on a Vergennes clay soil, this project provided a great opportunity to evaluate the winter-killed mixes in comparison to winter hardy mixes and straight winter rye. In addition, the participating farmer eventually decided to plant his subsequent corn crop in these plots with no-till methods. This enabled us to truly evaluate the system as it was intended. Additionally, he conventionally plowed (fall moldboard followed by spring chisel/finishing) the other half of the field for comparison. We were then able to monitor the progress of the corn crop the following summer to see the impacts of our treatments. PSNT's were taken during the summer and corn yields were measured prior to harvest this fall. One big takeaway was that proper termination of cover crops is key to making the no-till/cover cropping system work here in Vermont. The producer did not accomplish an adequate termination of the winter hardy cover crops, and as such saw reduced yields on these plots. Although not a function of the cover crop species themselves, it is an important

MATERIALS AND METHODS

Cover Crop Mixes in Corn Silage

We designed two identical experiments on two different farms. Farr Farms is located on a sandy loam soil in the Winooski River flood plain in Richmond, Vermont. Deer Valley Farm is located in Ferrisburgh, Vermont on a clay soil between the Otter Creek and Little Otter Creek Rivers near the mouths of Lake Champlain.

2013

On August 15th and 16th, respectively at Deer Valley Farm and Farr Farm, we seeded the following treatments with over-the-shoulder broadcast spreaders.

- 100 lbs/acre winter cereal rye
- Winter Kill Mix (56% Everleaf Forage Oats/33% Cow Peas/11% Tillage Radish) seeded @50 lbs/acre
- Winter Kill Mix @ 116 lbs/acre
- Winter Hardy Mix (56% Winter Triticale/33% Austrian Winter Pea/11% Bonar Forage Rape) at 50 lbs/acre
- Winter Hardy Mix at 116 lbs/acre

Plots were four corn rows wide (10-feet) by 100-feet long, with a row on each side of the seeded plots to allow for a buffer. See Figure 1 for a plot layout diagram. Seeds were mixed prior to seeding. All treatments were calibrated to apply the accurate pounds per acre desired for each seeding mixture. The treatments were laid out in a randomized complete block and replicated three times (on each farm). Corn was at the R1 stage at both farms. Plots were monitored for germination and growth. We saw good germina

Horticultural Research Farm. Once dry, all samples were weighed again, subsamples were combined for each plot, and then they were ground in a Wiley Mill through a 2 mm sieve. Samples were sent to the Dairy One Forage Lab in Ithaca, NY for the following analyses: percent dry matter, percent crude protein (as a measure of nitrogen), percent phosphorus, and percent potassium. All mineral extraction was done using wet chemistry methods in their lab. On October 28th and 30th, 2013, the Line Transect method (VT NRCS Agronomy Technical Note 1, http://efotg.sc.egov.usda.gov/references/public/VT/VT_AgronTN_1_LineTransectMethod.pdf) was used to measure percent residue cover for all plots in both the August and September seedings.

2014

The following spring, all plots were analyzed for performance again. On April 25th visual assessments were made to determine the overwintering su

In addition to the formal demonstration plots, we also had one farmer utilize our 'Winter Kill' cover crop mix on a 70-acre field. Senesac Farm planted 55 pounds per acre on August 9th, 2013. The mix was comprised of 25 pounds of forage oats, 25 pounds of soy bean and 5 pounds of forage radish. Cover crop height and forage samples were collected at three locations on September 3rd, September 30th and October 25th. Another thing we gained from this planting was a great example of why using sound agronomic practices is important, even when planting cover crops. The producer had broadcast his seed over the entire field. To initiate good seed to soil contact, he was rolling the field with a brillion type pulvimulcher. After rolling half the field, he had an equipment breakdown and had to stop. It then rained for a couple of days, the cover crop seed germinated, and he decided not to roll the second half to avoid damaging newly emerged seedlings. Later that fall, you could visually see the differences between the two halves of the field with cover crop biomass, weed pressure, etc.. This made for a great educational opportunity and we have used this in many presentations since then (see Figure 2). In addition Mr. Senesac offered to let us use this same field to do some reduced tillage comparison plots the following spring. Unfortunately, field conditions in the spring prohibited this from happening. However, he has stayed engaged and will continue to work with us on demonstration projects.

Cover Crop Mixes in Organic Winter Wheat

One trial was planted on an organic winter field operated by Elysian Fields Dairy in Shoreham, Vermont. Winter wheat was drilled in the fall of 2012. In April 2013, our test plot perimeters were established just prior to the farmer frost-seeding yellow sweet clover into the rest of the winter wheat field. Wheat was combined, straw harvested, and manure applied in late July. Our plots were 10-feet by 58-feet. At this site, we planted three replications of the following 10 treatments, for a total 30 plots, on August 12, 2013:

- 100 lbs/acre winter rye
- Winter Kill Mix (56% Everleaf Forage Oats/33% Cow Peas/11% Tillage Radish) at 30 lbs/acre
- Winter Kill Mix at 50 lbs/acre
- Winter Kill Mix at 80 lbs/acre
- Winter Kill Mix at 116 lbs/acre
- Winter Hardy Mix (56% Winter Triticale/33% Austrian Winter Pea/11% Bonar Forage Rape) at 16 lbs/acre (this was a mistake on the first replication, so we repeated for all three reps)
- Winter Hardy Mix at 30 lbs/acre
- Winter Hardy Mix at 50 lbs/acre
- Winter Hardy Mix at 80 lbs/acre
- Winter Hardy Mix at 116 lbs/acre

We monitored plots for growth through the fall of 2013. Our observations were that we had little cover crop growth in our plots. The seeded cover crops were out competed by weeds. In fact, the only place we saw cover crop growth was outside the plots where we had drilled into the frost seeded sweet clover. We did not collect any further data from this site. The 3(nter Ko:7 in)5.8(to th)5.2iof, etc.. t seedd this bTJects.

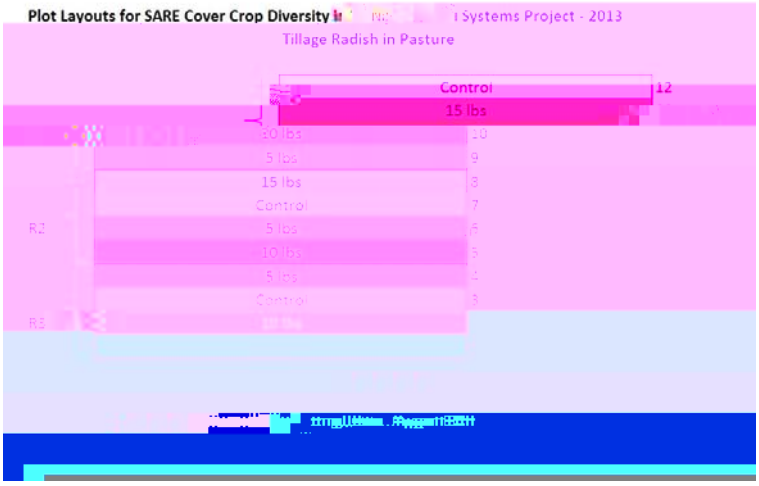
Tillage Radish in Pasture

One trial was planted into an existing organic dairy pasture on Scholten Family Farm in Weybridge, Vermont. We used a Haybuster 170C No-Till Grain Drill to seed Tillage Radish at three different rates on two different dates. Our plots were 10 by 100 feet wide. Our 'early' planting date was delayed by wet field conditions created by our extremely wet spring and the heavy clay soils on this farm. We seeded the following treatments in three replications on both August 12 and August 30, 2013 (See Figure 3 for a plot layout diagram).

- Control (no radish)
- Tillage Radish at 5 lbs/acre
- Tillage Radish at 10 lbs/acre
- Tillage Radish at 15 lbs/acre

In addition to the treatments, we seeded a high rate of 20 pounds per acre around the perimeter of the plots. We fenced off the plots (as the farmer would be grazing the remainder of the pasture later in the season). We checked back often, but did not see any measurable results. However, this pasture also did not show much growth in total, even from the cool season grasses. We had also drilled some radish along with other brassicas and summer annuals in a few other demonstration sites throughout the valley as a part of another project on varying soil types and saw similar results. We did not collect forage samples.

Figure 3. Tillage Radishin Pasture Plot Layout



Drilling Tillage Radishinto Pasture at Scholten Farmsin Weybridge, Vt. *Photo credit: K. Workman*

RESULTS AND DISCUSSION

Although we were not able to gather data from all of the sites or studies that were part of this project, the data we did gather has been very useful and given us a lot of insight as we move forward and design future studies. Some of the challenges we encountered were unavoidable due to the very wet early growing season of 2013. That said, this project has been a great catalyst for many farmers around the Champlain Valley, particularly those on heavier soils. At the one site where we were able to capture plentiful data (Deer Valley Farm, Ferrisburgh), we measured the following parameters for the cover crop mixes: percent cover (as a measure of erosion protection), Biomass production (measured in dry matter yield per acre), and nutrient uptake (measured in pounds of nitrogen, phosphorus and potassium per acre). In addition, we were also able to measure cash crop performance following the cover crop treametns by measuring plant population and silage equivalent yield of a corn silage crop. A description of the results from the Deer Valley Farm site are as follows:

Percent Cover

One measure of a cover crop's performance is its ability to cover the bare soil and protect it from sheet and rill erosion. The higher percent cover we can achieve from the cover crop in the fall and the spring, the northeast's highest erosion potential seasons, the better off we are from an environmental standpoint and from an overall farm sustainability standpoint. As discussed in the Methods section above, we utilized a Line Transect Method to estimate the percent of the ground surface covered by plant residue. We did this for all plots on October 22, 2013 as a report card measurement for fall and on May 8, 2014 just prior to termination. Refer to Figure 4A and corresponding table to see the results of these fall 2013 measurements.

	Broadcast (planted 8/15/13)	Drill (planted 9/26/13)
Winter Rye	58%	38%
Mix		

In summary, we saw that both cover crop mixes were comparable to our winter rye control in percent cover at the lower seeding rates or exceeded the winter rye control at the higher seeding rates. This was true for the earlier seeded broadcast treatments and the later drilled treatments. In the spring, however, winter rye outperformed all the cover crop mix treatments. Refer to Figure 4B and corresponding table to see the results of these spring 2014 measurements.

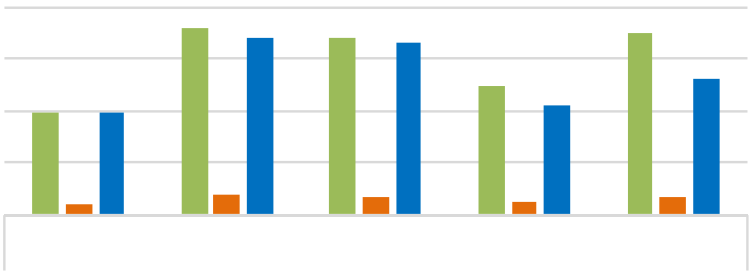
BRDCST Drill

Nutrient Uptake

Nutrient uptake was calculated by measuring biomass and percent nitrogen, phosphorus and potassium of forage samples in the fall and the spring. Calculations were then done to figure pounds per acre of all three of these nutrients. This is important as a measure of reduction of nutrient losses to the environment and nutrient cycling for subsequent cash crops when these cover crops are terminated.

In the fall 2013 measurements (which only included the early planted broadcast treatments), the low rate of the winter kill mix (oat/pea/radish) performed the best with 35.73 pounds of nitrogen, 3.64 pounds of phosphorus and 33.90 pounds of potassium per acre. All of the cover crop mixes (high and low seeding rates planted early) outperformed the winter rye control treatment in the fall. See Figure 6A and Table 6A for fall results by treatment.

Although there were no measurements collected for the later planted drilled plots in the fall, it is safe to assume that they would have been significantly lower in pounds per acre of all the nutrients based on the very small amount of biomass accumulated at the time of sampling. In the spring 2014 measurements (which only included winter hardy treatments), winter rye broadcast at the early date performed the best with 31.39 pounds of nitrogen, 5.68 pounds of phosphorus and 36.52 pounds of potassium per acre. For all winter hardy treatments, the early planted broadcast plots outperformed the later planted plots for all nutrients. See Figure 6B and Table 6B for spring results by treatment (attached). Interestingly, the early planted winter kill mix had the most nitrogen in pounds per acre of all treatments for both planting dates and sampling dates, despite the fact that it was lower in biomass overall than the early planted winter rye cover crop (See Figure 6C). One question this raises is that with a cover crop that is made up entirely of winter killed species, what happens to those nutrients during the early spring when soils warm up and there is no living crop there to take up those nutrients until the subsequent cash crop is planted. This is in contrast with winter rye, which has comparable nutrient content, but isn't terminated until just prior (or even after) the cash crop is planted. We have two new research projects which will look into this, as we have planted several cover crop plots that combine winter killed and winter hardy species this last fall (2014) and we will measure results in spring 2015.



Additional Results

Although many of our plots did not yield data, we were able to collect additional data outside the formal research/demonstration plots as a part of this project. Circumstances arose that led to an additional producer (Jeff Senesac) to plant an entire 70 acre field with a cover crop mix very similar to our Mix 1/Winter Kill Mix. Due to the very wet spring/summer conditions in 2013, Mr. Senesac had a field that was unable to be planted to its intended soybean grain crop. He had already prepared the field for planting (tillage, fertilizer, etc) and did not want to leave it fallow. Knowing of our project, he consulted with project staff and planted 55 pounds per acre as follows: 25 pounds soybeans, 25 pounds forage oats and 5 pounds of forage radish. This was

field, this could be considered a success. Even without manure, the farmer would have gained savings in time and money from the reduced field operations required from no tilling into the winter killed residue and not having to do any tillage. He would also realize the soil health benefits of reduced tillage and cover crops. Even though cover crop

Farmer Adoption

In general over the last two years, we have seen noticeably higher rates of adoption from local dairy producers and other forage crop growers for cover crops and reduced tillage on their farms. This is a result of a multipronged effort on the behalf of UVM Extension, NRCS, local Conservation Districts, and the Vermont Agency of Agriculture Food & Markets promoting these practices and providing technical and financial assistance to increase adoption. However, we have seen many farmers trying new things on their farms after seeing the results of this project. Most obviously the participating farms were able to learn directly and adopt practices. Deer Valley Farm is a prime example. As a result of our research plots, Ray Brands of Deer Valley Farm decided to plant the entire half of the field that included our plots using no-till methods the subsequent season (the remainder of the field was moldboard plowed to incorporate manure), which enabled us to further evaluate the practical applications of cover mixes in no-till systems. Jeff Senesac, who was not part of the

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http://www.uvm.edu/extension/cvcrops