2011 MINIMUM TILLAGE CORN TRIAL

Reduced tillage practices have tremendous potential to reduce farmer expenses, maintain yields, and reduce potential negative environmental effects caused by cropping operations. Conventional tillage practices require heavy machinery to plow and groom the soil surface in preparation for the planter. The immediate advantage of reduced tillage is less fuel expense, less equipment and labor required. It's also clear that intensive tillage increases nutrient and soil losses to our surface waterways. By turning the soil and burying surface residue, more soil particles are likely to detach from the soil surface and run off from agricultural fields. Reducing the amount and intensity of tillage can help build soil structure and reduce soil erosion.

Figure 1. Strip tillage.

Many growers are interested in different minimum till methods and equipment, including 'no-till,' 'strip-till,' and 'zone-till.' No-till implements do not till the soil, but rather use a metal coulter to cut the soil and plant a seed into the slit created. A heavy press wheel follows this coulter and maximizes seed to soil contact to facilitate germination. Strip tillage cultivates an 8-10" strip of soil along either side of the planted row (Figure 1). Strip tillage allows the soil in close proximity to the seed to dry out and warm up faster than it would without tillage. Zone tillage works a much smaller area than strip tillage, only tilling 5-6" of the soil directly adjacent to the seed (Figure 2). Zone-till implements can be attached to the front of a corn planter. Over time, it has been found that reduced tillage systems can improve nutrient cycling, soil drainage, and crop yields.

Figure 2. Zone tillage.

In 2011, the University of Vermont Extension's Northwest Crops and Soils Program conducted a corn trial at Borderview Farm in Alburgh, VT. The objective was to evaluate the impact of no-till, zone-till, and strip-till on corn silage yield and quality.

MATERIALS AND METHODS

In 2011, a study evaluating three reduced tillage methods was conducted at Borderview Farm in Alburgh, VT (Table 1). The soil was a rocky Benson silt loam. The cover crop into which the corn was planted was a winter rye. The experimental design was a randomized complete block with four replicates. The plot length was 45'. Treatments were no-till, zone-till, and strip-till. All plots were planted to the variety Mycogen TMF2Q298 (89-RM) at a seeding rate of 34,000 seeds per acre on 31-May. No-till plots were planted with a John Deere 1750 corn planter; zone-till plots were planted with a White 6100 zone-till planter; strip-till plots were prepared with a Blujet Coulter Pro and planted with a John Deere 1750 corn planter. No-till and strip-till plots had four 30” rows and were 12’ wide. Zone-till plots had six 30” rows and were 15’ wide. A 10-20-20 starter fertilizer was applied at 260 lbs per acre to the strip-till and no-till plots. A liquid 9-18-9 starter fertilizer was applied at 5 gallons to the acre in the zone-till plots. A pre-plant glyphosate herbicide, Roundup®, was applied at a rate of 2 quarts per acre to all plots.

Table 1. Agronomic information for the 2011 Minimum Tillage Corn Trial at Borderview Farm.

Location	Borderview Farm – Alburgh, VT
Soil type	Benson rocky silt loam
Previous crop	Winter rye
Plot size	10’ x 45’ (no-till and strip-till); 15’ x 45’ (zone-till)
Replicates	4
Seeding rate	34,000 seeds ac^{-1}
Row width	30”
Planting date	31-May 2011
Starter fertilizer	260 lbs ac^{-1} of 10-20-20 (no-till and strip-till), 5 gal ac^{-1} of 9-18-9 (zone-till)
Pre-plant herbicide	Roundup®, 2 qts ac^{-1}
Additional fertilizer	100 lbs available N ac^{-1} of ammonium sulfate (21-0-0), 8-July 2011
Harvest date	7-October 2011

Ammonium sulfate (21-0-0) was applied as a sidedress at a rate of 100 lbs available N per acre on 8-July, according to pres-sidedress nitrate test results. Populations were again counted immediately before harvesting the corn plots on 7-October. A John Deere two-row chopper was used to harvest corn, and whole-plant silage was collected in a forage wagon and weighed on drive-up platform scales. A subsample of chopped silage was taken to determine moisture and quality of the forage.

Silage quality was analyzed using wet chemistry at Cumberland Valley Analytical Services in Hagerstown, MD. Plot samples were analyzed for crude protein (CP), starch, acid detergent fiber (ADF), and neutral detergent fiber (NDF). Mixtures of true proteins, composed of amino acids, and nonprotein nitrogen make up the CP content of forages. The CP content of forages is determined by measuring the amount of nitrogen and multiplying by 6.25. The bulky characteristics of forage come from fiber. Forage feeding values are negatively associated with fiber since the less digestible portions of plants are contained in the fiber fraction. The detergent fiber analysis system separates forages into two parts: cell contents, which include sugars, starches, proteins, nonprotein nitrogen, fats and other highly digestible compounds; and the less digestible components found in the fiber fraction. The total fiber content of forage is contained in the neutral detergent fiber (NDF). Chemically, this fraction includes cellulose, hemicellulose, and lignin. Because of these chemical components and their association with the bulkiness of feeds, NDF is closely related to feed intake and rumen fill in cows.

Net energy for lactation (NE_L) is calculated based on concentrations of NDF and ADF. NE_L can be used as a tool to determine the quality of a ration, but should not be considered the sole indicator of the quality of a feed, as NE_L is affected by the quantity of a cow’s dry matter intake, the speed at which her ration is consumed, the contents of the ration, feeding practices, the level of her production, and many other factors. Most labs calculate NE_L at an intake of three times maintenance. Starch can also have an effect on NE_L, where the greater the starch content, the higher the NE_L (measured in Mcal per pound of silage), up to a certain point. High grain corn silage can have average starch values exceeding 40%, although levels greater than 30% are not considered to affect energy content, and might in fact have a negative impact on digestion. Starch levels vary from field to field, depending on growing conditions and variety.

Non-fiber carbohydrate (NFC) and nonstructural carbohydrate (NSC) are also totaled and reported. NFC is comprised of starch, simple sugars, and soluble fiber, and is digested more quickly and efficiently than fiber. NFC provides energy for rumen microbes, once it is fermented by volatile fatty acids. NFC and NSC are sometimes referred to almost interchangeably, but pectin levels are included in NFC and omitted from NSC. In addition, NFC is calculated by difference [100 – (% NDF + % crude protein + % fat + % ash)], whereas NSC is determined through enzymatic methods. NSC should be in the 30-40% range, on a dry matter basis. NFC is generally between 35-40% in a high milk production ration, though levels as high as 42% are acceptable, due to the variability of particle size, frequency of feeding, dry matter intake, and other factors.

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 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 the example below, 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.

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

RESULTS

The 2011 growing season included many weather extremes in Vermont (Table 2). In April and May, excessive rainfall left soils saturated and, in many cases, delayed planting. June and July, in contrast, were hot and dry. July had 0.29 inches less precipitation than the 30-year average. In August, precipitation levels were extremely high (10.23 inches for the month, which is 6.38 inches above average). Tropical Storm Irene brought severe wind and record rainfall. While lodging damage was minimal at the site of the corn trial in Alburgh, VT, 2011, in general, it was by no means an ideal growing season. Weather data is based on National Weather Service data from a cooperative observer station in South Hero, VT, which is in close proximity to the trial. The historical average is based upon 30 years of data (1971-2000).

Table 2. Data from a weather station in close proximity to Alburgh, VT (South Hero, VT).

	June	July	August	September	October
Average temperature (°F) ±	67.1	74.4	70.4	63.8	51.5
Departure from normal	1.3	3.3	1.6	5.8	4.5
Precipitation (inches) *	3.52	3.68	10.23	5.56	2.68
Departure from normal	0.09	-0.29	6.38	2.10	0.10
Growing Degree Days (base 50°F)	513	732	563	392	330
Departure from normal	39.0	79.5	-27.0	79.5	228

± Average temperature for August-October is taken from Burlington, VT.

* Precipitation records for June and July are taken from Burlington, VT.

Reduced tillage method did not have a significant impact on corn populations at harvest on 7-October. There was also no significant difference in the moisture levels or yields of corn silage by reduced tillage method (Table 3). Though it was no statistically significant, the highest yield was in strip tillage corn (16.9 tons per acre)

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Table 3. Impact of minimum tillage on corn silage population and yield, 2011.

Tillage method	Harvest population	DM at harvest	Yield at 35% DM
	plants ac^{-1}	%	tons ac^{-1}
No-till	25555	48.4	13.9
Strip-till	**26717**	**48.7**	**16.9**
Zone-till	23329	46.1	14.0
LSD (0.10)	NS	NS	NS
Trial mean	25200	47.7	14.9

Treatments indicated in bold had the top observed performance.

NS – No significant difference was observed between treatments.

Corn silage quality was not affected by tillage method in this trial. There was no significant difference in CP, ADF, NDF, starch, TDN, NE_L, NFC, or NSC. Trial averages were comparable to corn grown using conventional tillage practices.

Table 4. Impact of reduced tillage on corn silage quality, 2011.

Tillage method	CP	ADF	NDF	Starch	TDN	NE_L	NFC	NSC
	%	%	%	%	%	Mcal lb^{-1}	%	%
No-till	7.6	**22.0**	**38.9**	**38.8**	**73.3**	**0.77**	**49.0**	**39.7**
Strip-till	8.0	23.1	41.1	36.9	72.4	0.76	46.6	37.7
Zone-till	**8.1**	22.6	40.4	37.0	72.6	0.76	46.8	37.8
LSD (0.10)	NS	NS	NS	NS	NS	NS	NS	NS
Trial mean	7.9	22.6	40.1	37.6	72.8	0.76	47.5	38.4

Treatments indicated in bold had the top observed performance.
NS – No significant difference was observed between treatments.

DISCUSSION

It is important to note that the results of this trial represent only one year of data, and only in one location. However, a few generalizations can be made. The three tillage methods evaluated in this study had little impact on the corn yields and quality. Harvest population was very low (25,500 plants per acre) compared to the initial seeding rate (34,000 plants per acre). Reduced plant populations may have been a result of poor germination. Reduced tillage fields have been noted to be colder and wetter as compared to conventional tillage. These environmental variables could easily cause reduced populations. The average yield was 14.9 tons per acre, which is low compared to yields of corn with similar relative maturity planted by means of conventional tillage. This indicates that corn yields may be reduced in first years of transition to reduced tillage practices. Although not significant, it does appear that strip-till systems may help alleviate some yield drag often seen when transitioning to reduced tillage.

Corn silage quality characteristics were not significantly different based on tillage treatment. This indicates that strip tillage, zone tillage, and no tillage have comparable effects on corn yields and quality. The corn silage harvested in this trial was similar in quality to corn planted conventionally. Additional years of reduced tillage trials in this area will help determine if yield drag will be reduced as soil health improves as a result of this practice.

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