Evaluating the Effectiveness of Vertical Tillage in Managing Slug Populations in No-till Corn Systems—First Year, 2011

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This study was conducted to identify and document the conditions associated with vertical tillage that help reduce slug populations and/or the damage caused by slugs in no-till corn systems. In addition, we wanted to document the impact of vertical tillage on overall soil health and identify potential water quality benefits of using vertical tillage in no-till corn systems. This is a start toward developing a process to document the impact of vertical tillage.

Management of slugs in no-till corn systems continues to present major challenges to producers and threatens the viability of no-till production systems. Since no-till has been identified as important for maintaining the quality of the watersheds in the region, the identification of strategies that maintain a viable agriculture as well as healthy environment are needed. Vertical tillage was identified by producers and NRCS at the local level as one way to potentially address both of these needs. This demonstration has begun the collection of information to document the effectiveness of vertical tillage as a slug management tool and assess its impact on soil health.

***Summary of Procedures*:**

Demonstration plots were established by three growers in a total of four fields comparing no-till and vertical till. Each of the demonstration plots were arranged in paired plots of vertical-tilled and no-tilled strips. Six paired strips were established at location one and three paired strips at locations 2, 3 and 4. An AerWay strip was also established at location 2. Prior to performing the tillage treatments, each demonstration plot was sampled using shingle traps to establish a baseline for slug densities. Once the tillage treatments were established, treatment effects on soil health were observed including soil compaction, percent cover, bulk density and infiltration rate. Immediately after planting, shingle traps were placed in each of the demonstration plots to monitor slug densities. Once the plants emerged, stand counts were taken and the plants were evaluated for slug feeding damage. Harvest data was collected in two of the four locations.

Pre-Tillage Slug Densities

In mid-March, five shingle traps of $1ft^2$ size were randomly placed in each field to establish a baseline for slug population densities. The traps were checked on a weekly basis for adult and juvenile slugs until mid-April. The total number of eggs observed under the shingle traps was also recorded (Table 1).

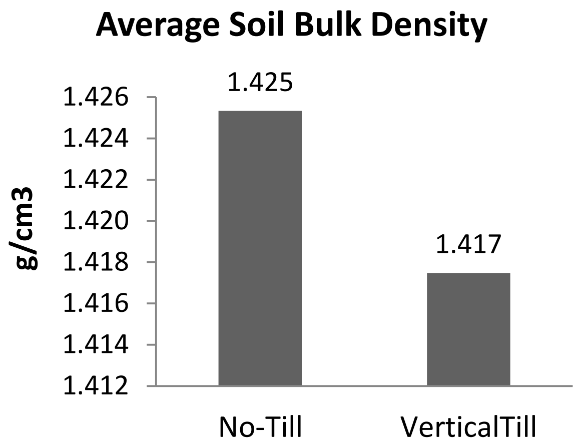
Shingle Trap Survey Results

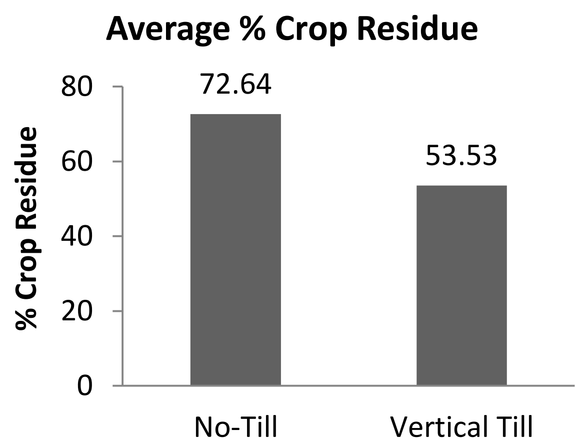
Table 1. Total number of slugs/eggs per 5 shingle traps.

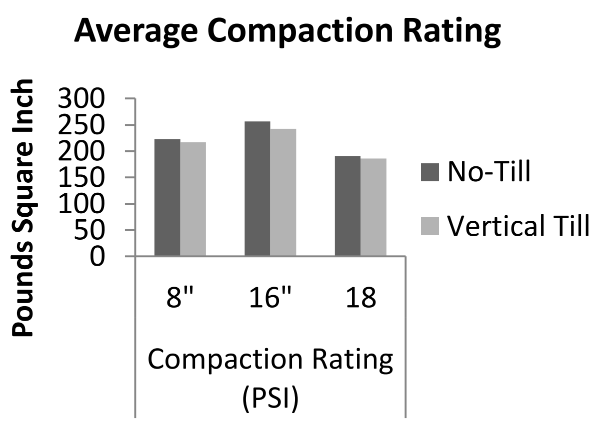
Sample Date	Marsh		Grey Garden		
	Adult	Juvenile	Adult	Juvenile	Eggs
Location 1					
21-Mar	0	0	1	0	3
29-Mar	1	0	2	0	3
4-Apr	1	0	2	0	3
11-Apr	0	0	2	0	0
20-Apr	0	0	0	0	14
Location 2					
21-Mar	1	0	3	0	6
29-Mar	0	0	2	0	2
4-Apr	2	0	0	0	5
Location 3					
21-Mar	0	1	0	0	12
29-Mar	2	0	2	0	2
4-Apr	1	0	2	0	28
11-Apr	0	0	7	7	11
20-Apr	0	2	0	6	7
Location 4					
21-Mar	0	0	0	0	0
29-Mar	1	0	0	0	5
4-Apr	1	0	2	0	11
11-Apr	0	0	0	7	11
20-Apr	0	2	0	6	7

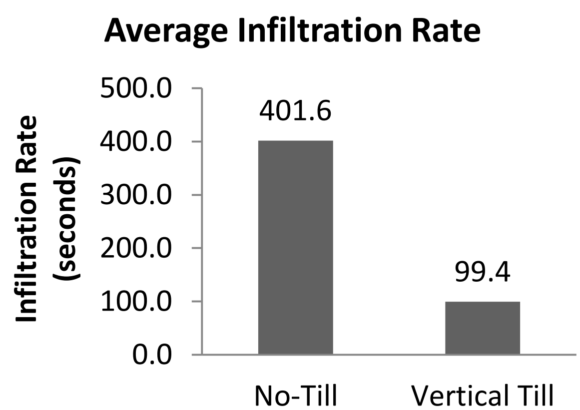
Pre-Planting Soil Health Measurements

Soil compaction was measured using a penetrometer. Readings were taken in three random locations in each paired strip. Readings were recorded at 6", 12" and 18" in pounds per square inch (psi). The percent of crop residue was estimated in three random locations in each paired strip using the line transect methods. Water infiltration rates were estimated in two random locations in each strip by removing vegetation and crop residue from the soil surface and driving a cylinder 6” in diameter into the soil approximately 4” deep. The soil surface within the cylinder was gently firmed and 1000 ml of distilled water was poured into the ring. The amount of time required for the water to infiltrate into the soil was recorded in seconds. Soil bulk density was also measured in each of the demonstration plots using the cylindrical core method and reported as grams/centimeter^3.









Discussion of Soil Health Measurements

The average compaction rating represented in pounds square inch (psi) at each of the three depths, 6”, 12”, and 18” indicates that the no-tilled plots were slightly more compacted compared to the vertical tilled plots. However, subsoil compaction was found to be severe in each of the demonstration plots regardless of the tillage treatment.

Vertical tillage reduced the percent of crop residue on average by 19 percent. However, the range of reduction was from six percent to twenty nine percent and the average cover even on the vertical tillage plots was greater than 50 percent.

Vertical tillage also had a significant impact on infiltration rates compared to no-tilling. The average rate of infiltration for the no-till demonstration plots was 402 seconds and the average rate of infiltration for the turbo-tilled plots was 99 seconds. Bulk density is a factor of the mineral composition of the soil and the degree of compaction. A compacted soil has fewer pores and therefore, a higher bulk density. On average, the vertical tilled plots had a slightly lower bulk density at 1.417g/cm^3 compared to the no-tilled plots at 1.425 g/cm^3.

The agronomic and soil health benefits observed in the vertical till treatments compared to the no-till treatments including an increase in water infiltration rate and a slight reduction in bulk density are based on one year's worth of data. These practices need to be evaluated over multiple years and multiple locations to determine the long term effects of these treatments on soil health and to identify any draw backs that may develop from continued use of vertical tillage.

Table 2. Comparison of slug numbers per shingle, injury ratings, and percent damaged plants for multiple sampling dates at four locations in Delaware in 2011.

Sample Date	**Tillage**	**Stand 1/1000/Acre**	**Injury Rating**	**% Damaged Plants**	**#Slugs/Shingle**
Location 1					
May 6	NT	28.33	--	0.93	0.23
	VT	28.00	--	0.80	0.03
May 16	NT	--	0.70	1.57	0.20
	VT	--	0.57	1.77	0.03
May 24	NT	--	0.33	0.70	1.80
	VT	--	0.27	0.60	1.23
Location 2					
May 18	NT	25.53	0.53	1.07	0.89
	VT	25.00	0.33	0.47	0.89
	Aerway	24.8	0.8	0.8	--
June 3	NT	--	0.77	1.8	0.56
	VT	--	0.3	0.53	0
	Aerway	--	0.40	0.60	--
Location 3					
May 9	NT	26.20	1.50	6.73	1.78
	VT	24.65	1.43	4.47	0.22
May 16	NT	27.53	1.33	4.07	1.22
	VT	28.27	0.67	1.73	0.22
May 24	NT	--	0.73	3.40	0.00
	VT	--	1.10	4.67	0.00
June 3	NT	--	0.07	0.07	0.00
	VT	--	0.07	0.27	0.00
Location 4					
May 9	NT	--	--	--	1.33
	VT	--	--	--	0.44
May 16	NT	26.53	1.93	7.60	0.78
	VT	26.93	1.67	6.33	0.00
May 24	NT	--	1.54	7.17	0.39
	VT	--	1.37	6.07	0.22
June 3	NT	--	0.67	2.42	0.39
	VT	--	0.47	1.13	0.00

Post-Planting Data

Once the demonstration plots had been planted, three shingle traps were placed in each paired strip to determine slug population densities and tillage treatment effects (Table 2). Stand counts were taken by counting the total number of corn plants in 17'5" of linear row in five random locations per plot. The percent of damage plants was determined by counting the number of plants out of ten consecutive plants exhibiting leaf feeding damage in five random locations per plot. A corn plant injury rating was assigned for each plant based on a scale from 0-4 and averaged for each location. *Corn Plant Injury Rating Scale*: 0 = no damage, 1 = only 1 leaf showing damage (less than 25% defoliation), 2 = all leaves showing moderate damage (25-30% defoliation), 3 = all leaves consumed except one remaining intact (greater than 75% defoliation), 4 = seedling completely cut off at the ground level.

Discussion of Post Planting Data

The tillage treatments did not appear to have any significant affect on stand counts in any of the demonstration plots (Table 2). There does appear to be a trend suggesting that there is a slight increase in the percentage of damaged plants and the severity of damage in the no-tilled plots compared to the vertical tilled plots. A slight increase in the number of slugs per shingle trap in the no-tilled plots compared to the vertical tilled plots was also noted. This suggests that vertical tillage may be an effective cultural control strategy when managing slugs in corn. More information is needed to document when benefits are likely to occur.

The agronomic and soil health benefits seen in the vertical till treatments compared to the no-tilling treatments including an increase in water infiltration rate and a slight reduction in bulk density are based only on one year's worth of data. These practices need to be evaluated over multiple years to determine the long term effects of these treatments on soil health and to identify any draw backs that may develop from continued use such as a compaction layer just beneath the soil surface.

Beneficial Insect Sampling

Beneficial arthropods can play an important role in preventing crop pest populations from reaching levels high enough to cause significant economic damage. However, little is known about the beneficial arthropod complex found within crop fields that prey on slugs. In an attempt to identifying the abundance of these beneficial arthropods within crop fields and to determine the effects minimum tillage practices may have on them, a pitfall trapping survey was conducted in locations 2, 3, and 4.

Of the demonstration plots surveyed, three trapping locations were established in each treatment. Traps were constructed of 18 oz plastic beverage cups buried within the soil profile so that the lip of the cup was even with the soil surface. A roof, approximately 1 ft^2, was placed over the traps at an elevation of 1-2 inches above the soil surface to prevent contamination from rain water. Pitfall traps were placed in the survey fields in mid-April and checked weekly until early-June. The arthropods collected were then combined for each treatment, identified, and tallied for each sampling date (Table 3).

Table 3. The average number of arthropods per tillage treatment.				
Date	**Tillage ID**	**Aranae**	**Carabidae**	**Opilione**
Location 2				
24-May	NT	5.00	1.67	3.00
	VT	1.67	2.67	3.67
3-Jun	NT	9.67	10.33	4.00
	VT	7.33	5.00	3.33
Location 3				
3-June	NT	5.67	22.00	0.00
	VT	4.67	25.33	0.00
Location 4				
3-June	NT	3.67	2.00	0.00
	VT	12.33	3.00	0.00

Based on the limited number of sample dates, it does not appear that the tillage treatments had any significant effect on the beneficial arthropod populations in any of the demonstration plots (Table 3). Additional research, including a more extensive sampling period is needed to determine the potential long term effects of tillage on beneficial arthropods.

Table 4. Yield data for no-till and vertical till treatments at two locations averaged over treatment strips.		
Location #	**No-Till**	**Vertical Till**
1	102.77	104.05
3	97.13	94.32

Yield data were very limited and were not analyzed statistically (Table 4). Observed differences were very minor.

Current plans call for fewer locations in 2012 but with more intensive soil health evaluations.