SHALLOW VERTICAL TILLAGE: IMPACT ON SOIL DISTURBANCE AND CROP RESIDUE

Kevan Klingberg and Curtis Weisenbeck [1]

Introduction

Wisconsin farmers have begun using a new generation of vertical tillage implements designed to conduct shallow tillage and better distribute crop residue. These machines cause minimal soil inversion. Their main working component is a set of straight and/or wavy coulters, which directs soil disturbance downward in slots, a couple of inches wide by a couple of inches deep. Some crop producers are interested in shallow vertical tillage because current corn hybrids have stalks that slowly decompose due to genetic enhancements for insect resistance. The high levels of previous year corn residue in 1-pass no-till planting systems can reduce yields due to cool wet soils, slow seed germination and the physical challenges of planting into previous year(s) crop residue. Crop consultants and farmers have recognized the value of conducting a small amount of tillage in order to size the existing residue, condition the seedbed, and/or incorporate livestock manure, lime or other nutrients. Some farmers are considering replacing their 1-pass no-till planting system with a 1-pass shallow vertical tillage + plant system.

As the use of shallow vertical tillage implements increases, their impact on soil and water conservation, as well as nutrient management needs to be evaluated. Crop producers intuitively believe these tillage tools have a less invasive and different impact on soil disturbance and residue management, compared to disking, field cultivating or chisel plowing.

Study

A representative to the UW-Discovery Farms Steering Committee, appointed by the Wisconsin Soybean Board, requested that the Discovery Farms Program evaluate the soil and water conservation impacts of these vertical tillage implements. Discovery Farms worked with a private crop consultant on 5 farms in Western Wisconsin to evaluate shallow vertical tillage on 14 crop fields (spring 2010). Staff worked with NRCS to design the study to measure soil and residue parameters used within RUSLE2. The crop consultant identified the farms, and worked with Discovery Farms staff to collect field data and summarize findings. Field data collected included soil disturbance and surface residue remaining within five days after a single-pass shallow vertical tillage operation conducted in the spring.

Methods

Participating farmers used their own vertical tillage implement, operated at usual speed and depth. All implements had 2 gangs of forward-facing non-concave blades, either straight or waved. Blades were spaced at 10 inches, with the back gang off-set from the front by 5 inches.

These machines created slices of disturbed soil in the same direction of travel, every 5 inches. The three machines represented in this study (not an endorsement or exclusive list, represents

---

[1] Outreach Specialist, University of Wisconsin – Discovery Farms Program, PO Box 429, Pigeon Falls, WI, 54760 and Owner, Agronomic Consulting, Inc., N7117 Arbor Ln, Durand, WI, 54736.
Presented at Wisconsin Crop Management Conference, Madison, WI, January 12, 2011.

participant's machines) included: 1) Great Plains Turbo Till with rolling spike and reel (TT); 2) Summers Supercoulter Plus with rolling spike and reel (SCP1); and 3) Summers Supercoulter Plus with rolling chopper (SCP2).

The line-transect method was used to estimate % crop surface residue cover. Soil disturbance was evaluated using parameters of the NRCS Soil Tillage Intensity Rating (STIR). Trenches were dug perpendicular to tillage travel line to measure individual coulter tillage depth and width, as well as associated non- disturbance areas.

Results and Discussion

Soil disturbance and remaining surface residue after 1-pass shallow vertical tillage varied by field and farm based on soil type, machine characteristics and operating depth. Deeper operation, more aggressive machinery, and sandier soil resulted in more soil disturbance and less surface residue. Table 1 shows field site, soil type, implement used, previous crop, residue remaining and soil disturbance depth and width for 14 crop fields where single-pass shallow vertical tillage had been conducted within the previous five days.

Table 1. Crop residue remaining and soil disturbance after 1-pass shallow vertical tillage

Farm	Soil	Implement *	2009 Crop	Residue (%)	Tillage Depth (inches)	Tillage Width (inches)
Go1	silt loam	TT	cgr	90	1.5	1.5
Go2	loamy sand	TT	sb	75	2	2
Go3	sandy loam	TT	cgr	90	1.5	2
Go4	silt loam	TT	cgr	94	1.5	1.5
Go5	silt loam	TT	cgr	90	1.5	1.5
Gr1	silt loam	TT	cgr	90	2.5	3
Cr1	loamy sand	TT	cgr	70	2.5	2
Cr2	loamy sand	TT	cgr	75	2.5	2
Ha1	loam	SCP 1	cgr	69	2.5	3 / 1
Ha2	f s loam	SCP 1	cgr	88	2.5	3 / 1
Ha3	silt loam	SCP 1	cgr	86	2.5	3 / 1
Ol1	silt loam	SCP 2	cgr	78	3	3 / 1
Ol2	f s loam	SCP 2	cgr	76	3	3 / 1
Ol3	silt loam	SCP 2	cgr	78	3	3 / 1

* TT = Great Plains Turbo Till with rolling spike and reel; SCP 1 = Summers Supercoulter Plus with rolling spike and reel; SCP 2 = Summers Supercoulter Plus with rolling chopper.

In general, it is safe to say that on silt loam soil, conservative 1-pass shallow vertical tillage created slices through the field such that every five inches of field width has a two inch wide by two inch deep tilled area and three inches of "undisturbed" soil. Conservative 1-pass shallow vertical tillage can result in 40% of field coulter tilled to a two inch depth, while 60% remains untouched by coulters and disturbed only by the rear attachments. Sandy soils tended to show similar depth and a more homogeneous horizontal soil disturbance.

The NRCS - RUSLE2 soil loss model offers implements within its field operations database for shallow vertical tillage machines. They are referred to as seedbed conditioners, and are presented as a combination of: 1) coulter caddy; 2) coil tine or rotary or spike harrow; and/or 3) rolling basket.

Conservation planners choose the seedbed conditioner combination most appropriate to the vertical tillage implement being used by the producer they are working with. All of these implement components, plus others, are listed individually within the RUSLE2 field operations database and can be chosen to create an ala carte tillage operation - based on machinery characteristics, crop residue and soil disturbance.

Depths and surface area disruption values observed through this project were comparable to those defined in RUSLE2 for various seedbed conditioner combinations. Shallow vertical tillage can disturb 100 % of the soil surface area due to a combination of coulters plus rear attachments. The degree of soil and residue disturbance created by shallow vertical tillage is influenced by depth, speed and machine characteristics.

Sometimes vertical tillage machinery is equated with tandem disking when discussing soil disturbance. The concave configuration of most disk blades, along with angled gangs, moves soil laterally, cuts and buries residue and dislodges most prior year root systems. Tandem disks create complete lateral soil movement compared with what this project showed to be very limited lateral soil movement for 1-pass shallow vertical tillage. Subsequent visits to study fields revealed that as soon as producers begin running a 2-pass shallow vertical tillage + planting system, soil disturbance increases and similarities with tandem disking become more apparent.

One-pass shallow vertical tillage maintained significant amounts of prior year corn plant roots, intact, anchored and still in place, post tillage. Regardless of soil type, 22,000 – 25,000 in-place corn roots per acre were observed. This was based on traditional population count methods for defined row widths. These anchored corn roots represented as much as 80% of common corn planting rates.

Post emergence observations showed that one-pass shallow vertical tillage did not bury much residue, yet residue was sized smaller to move through high residue planters, leaving 75 - 80 % of previous corn residue in place, as well as 80 % of last year's corn roots intact and still in the ground.

Conclusion

Tillage has numerous functions, including residue management, soil mixing and weed control. Most crop producers in Wisconsin have dramatically reduced tillage to save soil, time and fuel. Some have implemented 1-pass no-till planting systems with various attachments for residue management in front of seed placement. Still others want to maintain the soil and water conservation benefits of high residue planting systems, yet desire prior season residue to be cut smaller and/or they desire a small degree of soil mixing.

Crop consultants and agricultural producers intuitively know that conservative operation of vertical tillage implements has less of an impact on soil disturbance and residue management than disking or field cultivating. Producers who are serious about using these tillage tools as a 1-pass + plant system should invite their soil and water conservation planning professional, along with their crop consultant to do field observations with them to properly evaluate prior season residue remaining, along with depth and width of soil disturbance. In cropping scenarios where the desired rotation depends on very limited or no tillage in order to maintain conservation compliance, conservative 1-pass shallow vertical tillage might be an option, on a site specific basis. Conservative and shallow are key phrases when considering the use of these implements on cropland landscapes that have high soil loss potential. As soon as producers begin making 2 or more passes with vertical tillage implements prior to planting, similarities with tandem disking become more apparent as soil disturbance increases.

Future Research Needs

Two observations from within this project need additional study: 1) evaluate the soil quality and conservation value of maintaining intact prior year root systems after 1-pass shallow vertical tillage; and 2) field-validate the similarity of soil loss prediction between shallow vertical tillage and tandem disking + field cultivating systems.

Additional studies should be initiated to evaluate the impact / effectiveness of shallow vertical tillage for 1) Minimizing soil loss; 2) Water infiltration; 3) Fertilizer, lime and manure incorporation; 4) Season of operation; 5) Early season soil drying and warming; 6) Use on tile drained preferential flow – critical sites.

References and Resources

Great Plains Manufacturing, Inc., Salina, KS. Turbo-Till Series II information sheet. Available at http://www.greatplainsmfg.com/products/tillage/turbotillseriesII.pdf (verified Dec. 13, 2010).

Schuler, R.T. 2007. Residue Management – Horizontal vs. Vertical Tillage. Proceedings of the 2007 Wisconsin Fertilizer, Aglime & Pest Management Conference, Vol 46:179-181. Madison, WI.

Summers Manufacturing Company, Inc, Devils Lake, ND. Supercoulter Plus information sheet. Available at http://www.summersmfg.com/products/supercoulter2.htm (verified Dec. 13, 2010).

U.S. Dept. of Agriculture – Natural Resources Conservation Services, WI. 2005. Soil Tillage Intensity Rating (STIR) information sheet. Available at ftp://ftp-fc.sc.egov.usda.gov/WI/Pubs/STIR_factsheet.pdf (verified Dec. 13, 2010).

U.S. Dept. of Agriculture – Natural Resources Conservation Services, WI. 2005. Tillage Practice Guide information sheet. Available at http://www.wi.nrcs.usda.gov/technical/consplan/tillagepracticeguide.pdf (verified Dec. 13, 2010).

Wagner, L.E., and R.G Nelson. 1995. Mass Reduction of Standing and Flat Crop Residues by Selected Tillage Implements. Trans. ASAE 38(2):419-427.

Wolkowski, R.P. 2010. Is Vertical Tillage a Practice for Wisconsin Soils? Proceedings of the 2010 Wisconsin Crop Management Conference, Vol 49:132-136. Madison, WI.