Vertical Tillage: Does it Help the Transition to No-till?

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Recently tillage manufacturers have been promoting vertical tillage systems claiming that their use can overcome production limitations associated with no-till while maintaining sufficient residue cover to provide erosion protection. Vertical tillage refers to systems where soil disturbance is confined to soil movement mostly in the upward direction and/or confined to a slot or strip where the next crop rows are to be planted using strip-tillage implements or coulter-based implements that perform full width tillage. This report summarizes some of the tillage research that has been conducted in Ontario and Indiana that has evaluated strip and coulter based tillage systems for corn and soybean production.

Research in Ontario comparing fall and spring strip-tillage systems for corn production started in the 1990's. The strip tillage implement used in research conducted in the 1990's was the Trans-till. A summary of this research is presented in Table 1 for corn produced in rotation with soybeans and wheat. Soils were imperfectly to poorly drained silt loam, silty clay loam and clay loams. All sites were systematically tile drained.

In the early research trials fall or spring strip-till systems often could not produce yields greater than no-till (Table 1). The strip-till implement used during this period often did not sufficiently contain soil in the immediate row area which, especially in fall strip till systems, resulted in a slight depression where corn rows were planted. Those in-row depressions sometimes resulted in corn yield reductions.. However, when significant trenching did not occur, it was observed that spring soil dry-down was faster resulting in soils following strip-till that were fit to plant 1 to 2 days earlier than in no-till systems following both soybeans and wheat.

Later research focused on improving the likelihood of creating satisfactory berms to minimize the risk of depressed in-row seedbeds when using strip-tillage systems. Yetter and DMI strip tillage implements were utilized during this period. Spring strip-tillage used lower disturbance anhydrous knives compared to the mole knives used in fall strip-tillage. Also, spring strip-tillage operating depths were shallower, at about 5" compared to the 6-8" depth used in the trials summarized in Table 1.

Generally, improved consistency of corn performance in strip-till systems occurred when an increased emphasis was put on creating a berm and using shallower depths for spring strip-tillage. Table 2 summarizes corn yields for fall and spring strip-till systems when compared to no-till and either fall chisel plowing (4 sites) or disk ripper (3 sites). These trials were conducted in 2002-2003 on imperfectly drained loam or silt-loam soils following winter wheat (straw baled). The results presented in Table 2 indicate that corn yield potential in both fall and spring strip-till systems can be similar to yield potentials in either fall chisel plow or fall disk ripper systems, and occasionally higher than no-till.

Following fall strip-tillage with a second strip-till pass in the spring also has been evaluated in Ontario. The results of these trials are summarized in Table 3 showing that some marginal yield increases may occur with performing a secondary spring strip-tillage operation. In most conditions spring strip tillage must not precede the planting operation by more than 6-24 hours in order to prevent excessive drying of the seedbed. Particularly on heavier textured poorly drained soils, performing the fall strip-tillage operation does enable earlier spring strip-tillage operations which could be performed in combination with in-row placement of fertilizer. Ontario research has not supported the idea of placing P or K in the strip in the fall for corn production, but current research is evaluating spring strip-tillage/fertilizer placement options.

Recent Indiana research agrees with Ontario research which suggests that occasionally corn yields in fall strip-till systems can be greater than no-till and often similar to fall chisel plow systems (Table 4). The Indiana research presented in Table 4 was conducted on clay loam soils following soybeans.

The Indiana research trials summarized in Table 4 also evaluated a coulter based tillage implement (Great Plains Turbo-Till) for preparing a seedbed following soybeans. A single or double pass of the Turbo-till was made just prior to corn planting. A single pass of the Turbo-till produced corn yields that were similar to spring tillage using a field cultivator and occasionally greater than no-till. The Turbo-Till maintained residue levels that were 10% greater than those following a spring cultivator. A second pass of the Turbo-Till did not increase corn yield.

In Ontario strip-till systems for soybean production have also been evaluated. Generally soybean yields in 30" rows can occasionally be increased using fall strip-till systems when compared to no-till 30" rows but rarely are yields in 30" strip-till systems as high as narrow-row (15" and solid seeded) no-till yields (data not shown). Attempts to plant twin-rows in fall strip-till systems often did produce higher yields when compared to single rows, but twin-row yields in fall strip-till systems were never greater than yields produced in narrow-row no-till systems (Janovicek et al., 2006).

A 40 site on-farm study was conducted in Ontario from 2003-2005 which evaluated soybean performance in no-till systems and following a single spring pass of a coulter based implement (Salford RTS). Soybeans were planted in narrow rows (7.5") using production practices that were typical for the cooperating farmer, and grain corn was the previous crop at most sites. There were 2 replications at each of the 40 sites. On average, across all 40 sites, RTS treatments increased soybean yields by slightly less than 2 bushels per acre. However, on 20% of the sites soybean yields following the RTS were increased over no-till by 3 to 5.4 bu/ac and the average yields from these sites are summarized in Table 5. Sites which tended to have higher RTS soybean yields tended to be finer-textured soils. The RTS occasionally (about 20% of sites) produced significantly higher yields for first-year beans planted following corn as well as for second-year soybeans. On sites where soybean yield following the RTS were more than 3 bu/ac greater than no-till, equipping the no-till drill (John Deere 750) with coulters tended to produce yields that were less than following a single spring pass of the RTS just prior to planting. Note, however, that running the drill-mounted coulters deeper (4”) than the operating depth of the single disc openers tended to produce yields higher than when coulters where operated at the shallower depth (2”). Higher soybean yields following the RTS could not be consistently explained by higher plant populations or less variable plant stands when compared to no-till.

Conclusions

1) Vertical tillage - strip tillage or full-width coulter based tools do provide a transitional tillage opportunity for producers of corn and soybeans. These transition options may be most appropriate for producers wanting to embrace reduced tillage but not no-till, but, in other cases, vertical tillage is being adopted by producers who are abandoning no-till but are unwilling to forfeit the benefits of high residue cropping systems.

2) Strip-tillage systems often do not produce yields that are consistently greater than no-till for corn planted following either soybeans or wheat (straw baled). However, faster spring dry-down rates in fall strip-till systems can result in soils that are fit to plant 1 to 2 days earlier than no-till. Corn yield advantages in strip-till over no-till will mostly occur because of an increased likelihood of timely planting thereby avoiding the yield losses associated with later than optimum planting dates.

3) Use of coulter based implements such as the Great Plains Turbo-Till or Salford RTS can occasionally produce corn and soybean yields that are greater than those after no-till. These coulter based systems are better suited for high residue environments than field cultivators and will retain more residue cover than field cultivator or spring disk systems. The tendency for soybean yield improvement (over no-till) for single passes of these vertical tillage tools was strongest on heavier (clay) textured soils that were slower to dry in the spring.

Reference:

Janovicek, K. J., W. Deen, and T. J. Vyn. 2006. Soybean response to zone tillage, twin-row planting, and row spacing. Agron. J. 98:800:807.

Table 1. Grain corn yields (at 15.5%) as affected by various tillage systems on imperfectly to poorly drained silt loam, silty clay loam and clay loam soils in Ontario from 1998-2000. Yields are the average of 6 trials following soybeans or wheat on fields with a long-term history of no-till production.

	Previous Crop	
Tillage	Soybeans	Wheat
	Corn Yield (bu/ac)	
Fall Moldboard	144.7	150.6
Spring Disk	136.9	136.4
Fall Strip-till	134.4	146.3
Spring Strip-till	127.5	140.8
No-till	137.8	148.7
LSD(P=0.05)[+]	9.2	12.5

+ Least Significant Difference required between tillage systems for a less than 5% chance that the observed yield differences occurred because of non tillage effects.

Table 2. Grain corn yields (at 15.5%) as affected by various tillage systems on imperfectly drained silt loam or loam soils in Ontario from 2002-2003. Yields are the average of 4 trials that include a comparison to Fall Chisel plowing (operating depth - 7") and 3 sites that include a comparison to Fall Disk Ripper systems (operating depth - 12").

Tillage	Yield	Tillage	Yield
	bu/ac		bu/ac
Fall Chisel	154.4	Disk Ripper	138.6
Fall Strip-till	155.1	Fall Strip-till	137.7
Spring Strip-till	153.5	Spring Strip-till	132.6
No-till	148.3	No-till	128.4
LSD(P=0.05) [+]	7.4(ns)		6.6

+ Least Significant Difference required between tillage systems for a less than 5% chance that the observed yield differences occurred because of non tillage effects. A "ns" following the LSD value indicates that differences among tillage systems were not significant at the 5% probability level.

Table 3. Grain corn yields (at 15.5%) as affected by various tillage systems on imperfectly drained silt loam or loam soils in Ontario from 2002-2003. Yields are the average of 6 trials following wheat (straw baled).

Tillage	Yield (bu/ac)
Fall Moldboard	150.6
Fall Strip-till Only	141.7
Fall + Spring Strip-till+	147.9
No-till	147.0
LSD(P=0.05) ++	11.2(ns)

+ System consists of a fall strip-tillage operation followed by a spring secondary strip-tillage operation.
++ Least Significant Difference required between tillage systems for a less than 5% chance that the observed yield differences occurred because of non tillage effects. A "ns" following the LSD value indicates that differences among tillage systems were not significant at the 5% probability level.

Table 4. After planting residue cover and grain corn yields at 15.5% for various tillage systems following soybeans on clay loam soils at the North-East Purdue Agricultural Center (Columbia City, IN), from 2004-2006.

	Residue Cover (%)	Corn Yield (bu/ac)		
Tillage	2005	2004+	2005	2006
Spring Field Cultivator (single pass)	20	184.5	160.0	186.6
Strip-till	16	172.3	152.8	185.0
Chisel Plow plus field cultivator	14	184.5	152.2	181.2
Great Plains Turbo-till (single pass)	29	197.3	159.5	178.1
Great Plains Turbo-till (double pass)	32	174.9	157.6	178.5
No-till	51	184.5	158.2	170.9
LSD(P=0.05)++	19	21.9	18.7(ns)	12.0

+ Strip-tillage in 2004 was conducted in the spring using a DMI and in the previous fall using a Remlinger for the 2005 and 2006 corn crop. Similarly, chisel plowing was conducted in the spring in 2004 and in the previous fall for the 2005 and 2006 corn crop.
++ Least Significant Difference required between tillage systems for a less than 5% chance that the observed yield differences occurred because of non tillage effects. A ns following the LSD value indicates that differences among tillage systems were not significant at the 5% probability level.

Table 5. Average soybean yield at 13.0% on 8 of 40 sites with the largest yield response over no-till associated with a single spring pass of the Salford RTS and drill-equipped coulters at various operating depths in Ontario from 2003-2005.

Tillage	Soybean Yield
	bu/ac
Salford (RTS)	50.8
No-till	46.6
No-till (Single Coulter 2" deep)	46.5
No-till-Single Coulter 4" deep)	48.0
LSD(P=0.05)[+]	1.9

+ Least Significant Difference required between tillage systems for a less than 5% chance that the observed yield differences occurred because of non tillage effects.