Impact of Residue Removal on Yield Response to Various Tillage and Starter Fertilizer Treatments for Second-Year Corn

Purpose:

It is well established that tillage influence corn yields, part of which may be through its influence on drying and warming soils in the spring. Managing residue may also influence drying and warming in the spring. The objective of this research was to investigate what impact residue quantity has on the yield response to different tillage and starter fertilizer treatments, and assess the ability of these treatments to maintain sufficient ground cover for conservation in a corn on corn system. This report summarizes the results for the 2012 growing season, the second year of this project.

Methods:

In the fall of 2011, two trials were established in recently harvested corn fields at Kenilworth and Moorefield, Ontario where interactions between three residue removal treatments, 10 tillage treatments, and two starter fertilizer treatments were investigated. (treatments are summarized in the results). The experiment was conducted as a strip split-split plot design with residue removal as the main plot, tillage as the split-plot and starter fertilizer as the split-split plot. All possible interactions were investigated with the main treatment strips being randomized and replicated in three reps. Stalk chopping and fall tillage was complete in November 2011, while spring tillage was completed in April and May 2012. Nitrogen was applied as a UAN injection at side-dress. A summary of trial characteristics is presented in Table 1. Harvest was completed by a combine custom equipped with a batch-weigh scale, where weights and moistures for each plot were collected for final yield calculations. Significant differences were determined at the 5% level; means followed by the same letter are not significantly different.

Figure 1. Appearance of different tillage and residue treatments at the Moorefield trial in fall, 2010.

Table 1. Soil characteristics and dates of field operations at the Kenilworth and Moorefield trial locations in 2012

	Kenilworth	Moorefield
Soil Texture	Silt Loam	Silt Loam
Soil pH	7.3	7.1
Soil Test P (ppm)	8	39
Soil Test K (ppm)	80	165
Planting Date	April 20	May 14
Side-Dress Date	May 28	May 29
Harvest Date	Oct 18-19	Oct 22

Results:

Residue coverage levels were determined by the line intercept method at the 6 leaf stage of corn. Residue cover decreased significantly with each level of residue removal. Residue cover of 30% is identified as the minimum amount required to achieve near-optimum soil conservation. Averaged across all tillage systems, this was attained for the 50% removal and no removal treatments at Kenilworth, but only for the no removal treatment at Moorefield.

When investigating ground cover by tillage type at Kenilworth, only conservation tillage treatments could maintain sufficient ground cover under no and partial (50%) residue removal systems (Table 2). Conventional tillage rarely achieved this even under no residue removal. At Moorefield, no tillage treatments except for no-till without stalk chop could maintain sufficient ground cover with partial removal (data not shown).

Table 2. Average residue cover for all tillage and residue removal treatments at Kenilworth, 2012

Tillage	Residue Removal		
	None	50%	100%
	------ Residue Cover (%) ------		
Fall 1X and Spring 1X RTS (no stalk chop)	53	34	2
Fall 1X and Spring 1X RTS + Stalk Chop	21	33	1
Fall Disc + Fall Cultivate (Stale Seedbed)	52	29	2
Fall Disc + Spring Cultivate	19	19	26
Fall Disc Ripper + Spring Cultivate	32	24	10
Fall Moldboard Plow + Spring Cultivate	15	7	4
Fall RTS 2X (no stalk chop)	74	43	7
No-till (no stalk chop)	72	37	6
No-till + Stalk Chop	41	37	25
Spring RTS 2X (no stalk chop)	43	36	7

No significant differences in plant populations were observed between any treatments for any of the experimental factors studied (residue removal, tillage, starter fertilizer) in 2012 (data not shown).

Early vegetative development was evaluated by leaf tip counts on June 6. Starter fertilizer was the only significant source of variation at both sites, where the high rate dry fertilizer was significantly more advanced at the Kenilworth site, and where the liquid in-furrow was significantly more advanced at the Moorefield site (Table 3). These results may have been related to soil test values.

Table 3. Number of corn leaf tips present on June 6, 2012 for the two starter fertilizer treatments averaged across all residue removal and tillage treatments at Kenilworth and Moorefield, Ontario

Starter Fertilizer	Kenilworth	Moorefield
	-------- *no. of leaf tips* --------	
5-20-20 @ 200lb/ac 2”x2” band	7.1 a	5.2 b
6-24-6 @ 5 gal/ac in-furrow	6.8 b	5.3 a

* LSD letter comparisons are valid within location only

Reproductive development was evaluated by recording silk emergence progress. Significant influences were observed from starter fertilizer, residue removal and tillage. Significant differences typically represent less than a day or two difference in progress. Kenilworth data is presented in Table 4. High rate fertilizer resulted in a slight acceleration in reproductive development at Kenilworth, but not at Moorefield (Moorefield data not shown) while residue removal accelerated silking at both sites. Moldboard plowing significantly accelerated silking above all other tillage treatments at Kenilworth by one or two days, and most conservation treatments at Moorefield.

Table 4. Percentage of corn plants silking for each treatment for starter fertilizer, residue removal and tillage effects for four dates at Kenilworth, Ontario, 2012

Effect:	Jul-16	Jul-18	Jul-20	Jul-23
	---- percentage of plants silking ----			
Starter Fertilizer:				
5-20-20 @ 200lb/ac 2X2	8 a	40 a	74 a	92 a
6-24-6 @ 5gal/ac IF	4 b	21 b	51 b	83 b
Residue Removal:				
No Removal	4 b	26 b	55 b	84 b
50% Removal	5 b	27 b	60 b	86 b
100% Removal	9 a	37 a	73 a	93 a
Tillage:				
Fall 1X and Spring 1X RTS (no stalk chop)	3 b	24 bcd	52 cd	87 ns
Fall 1X and Spring 1X RTS + Stalk Chop	4 b	32 b	71 b	92 ns
Fall Disc + Fall Cultivate (Stale Seedbed)	8 b	34 b	67 bc	89 ns
Fall Disc + Spring Cultivate	4 b	27 bcd	63 bcd	89 ns
Fall Disc Ripper + Spring Cultivate	5 b	31 bc	64 bcd	87 ns
Fall Moldboard Plow + Spring Cultivate	27 a	68 a	89 a	97 ns
Fall RTS 2X (no stalk chop)	3 b	26 bcd	59 bcd	88 ns
No-till (no stalk chop)	2 b	17 d	49 d	83 ns
No-till + Stalk Chop	2 b	18 cd	52 cd	79 ns
Spring RTS 2X (no stalk chop)	4 b	27 bcd	60 bcd	85 ns

* LSD letter comparisons are valid for comparison of treatments within one effect for one date only

Residue removal did not have an impact on corn yields at either location in 2012 (Table 5). This was the case within tillage treatments as well, where residue removal did not enhance yields for conventional or conservation tillage treatments (Table 6).

Table 5. Average corn yields for three residue removal levels at Moorefield, Ontario, 2011

Residue Removed	Average Yield (bu/ac)
100%	144 a
50%	148 a
No Removal	146 a

Table 6. Average corn yields for three tillage treatments of varying intensity by three residue removal levels at Kenilworth and Moorefield, Ontario, 2012

Tillage	Residue Removal		
	None	50%	100%
	-------- *yield (bu/ac)* --------		
Moldboard Plow + Spring Cultivate	154	155	154
Fall RTS + Spring RTS	141	143	141
No-Till (no stalk chop)	144	144	145

A significant tillage effect was observed where moldboard plowing with spring cultivation yielded significantly greater than some other conventional tillage treatments and most conservation tillage systems when averaged across both sites (Table 7).

Table 7. Average corn yields for 10 different tillage treatments at Kenilworth and Moorefield, Ontario, 2012

Tillage	Yield (bu/ac)
Fall Moldboard Plow + Spring Cultivate	155 a
Fall Disc + Fall Cultivate (Stale Seedbed)	150 ab
Fall 1X and Spring 1X RTS + Stalk Chop	149 ab
Fall RTS 2X (no stalk chop)	146 bc
No-till (no stalk chop)	145 bc
Fall Disc + Spring Cultivate	144 bc
Fall Disc Ripper + Spring Cultivate	144 bc
Spring RTS 2X (no stalk chop)	144 bc
Fall 1X and Spring 1X RTS (no stalk chop)	142 c
No-till + Stalk Chop	140 c

A significant starter fertilizer effect was observed in 2012. At Kenilworth, banding a high rate dry fertilizer resulted in significantly higher yields than a low rate liquid fertilizer in-furrow, while at Moorefield no significant difference was observed (Table 8). These results may be due to differences in soil tests between the two fields. No significant starter fertilizer*tillage interactions were observed, suggesting yield response to starter fertilizer did not depend on the type of tillage in 2012.

Table 8. Average corn yields for the two starter fertilizer treatments averaged across all residue removal and tillage levels at Kenilworth and Moorefield, Ontario, 2012

Starter Fertilizer	Kenilworth	Moorefield
	-------- *yield (bu/ac)* --------	
5-20-20 @ 200lb/ac 2”x2” band	135 a	174 a
6-24-6 @ 5 gal/ac in-furrow	125 b	173 a

* LSD letter comparisons are valid within location only

Summary:

Residue removal significantly decreased residue cover for each progressive removal rate. Partial (50%) residue removal did not always leave a critical 30% residue cover, even for conservation tillage treatments, at all sites. Conventional tillage often failed to maintain 30% residue cover even where residue was not removed.

None of the experimental factors investigated had any impact on plant populations at the 6 leaf stage. Early season growth was enhanced by a high rate starter on the low fertility site only. Moldboard plowing enhanced growth beyond all other treatments at Kenilworth but no tillage effect was observed at Moorefield. Residue removal did not impact early season plant growth.

Reproductive development was significantly enhanced by high rate dry fertilizer at the low fertility site, and residue removal accelerated silk emergence timing at both sites. Conventional tillage, particularly moldboard plowing, was associated with earlier silk emergence than conservation tillage.

Corn yields were not influenced by residue removal. Significant tillage effects were observed, where moldboard plowing was generally the highest yielding treatment but several conservation systems were comparable in corn yield. No residue removal by tillage interaction was observed, demonstrating that residue removal did not enhance yields of any of these tillage systems in 2012. Overall, these residue impacts should be interpreted in context with the warm, dry conditions experienced during the 2012 planting and early growing season.

Next Steps:

This project will be repeated in a similar for a third year in 2013. Two new sites have been prepared with residue removal and fall tillage already completed at Milverton and Woodstock.

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Project Contact:

Greg Stewart, OMAFRA (greg.stewart1@ontario.ca)