Gen4-2011 - On-The-Go Tire Pressure Adjustment for Manure Tankers

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On-The-Go Tire Pressure Adjustment for Manure Tankers

Purpose:

The purpose of this project was to investigate automatic tire inflation systems to reduce the soil compaction potential of manure tankers in Ontario and to assemble a prototype tanker for testing the functionality of the system. In addition, soil compaction and crop response experiments were conducted to evaluate the potential impact of field-edge inflation pressure adjustment on compaction risk and crop productivity.

Methods:

In fall 2010, a field study was set up to investigate the interaction of compaction timing, tillage, and tire pressure on corn yields and soil bulk density. The plots were set up as a split-split-split plot design, with compaction timing (spring or fall) as the main plot, followed by primary tillage (fall chisel plow or no-till) as the split plot, followed by secondary tillage (spring tillage or no spring tillage) as the split-split plot, followed by inflation pressure (no trafficking, 14 PSI, 28 PSI) as the split-split-split plot. The treatments were replicated three times and were planted on May 13. Bulk densities were measured during the second week of August. Yields were calculated by hand harvesting two 8m row lengths of corn, one from each tire track within each plot on October 31.

Table 1. Specifications for the Michelin CargoXBIB tire (850/50R30.5 TL 182D) used in this project

Inflation Pressure	Travel Speed			
	5 mph	**15 mph**	**25 mph**	**30 mph**
	-------- Load Capacity (lbs/tire) --------			
14 psi	14,180	11,840	10,190	9,060
17 psi	15,750	13,310	11,440	10,190
23 psi	18,900	16,230	13,970	12,420
29 psi	22,040	19,150	16,480	14,670

An additional compaction investigation was also conducted on September 21 at the Elora Research Station on a moist wheat stubble field. A John Deere 7530 tractor was used to pull a 5000 gallon Nuhn liquid manure spreader equipped with an Agri-Brink AAID system for tire inflation and deflation and Titan “Torc Trac” 30.5LR32 radial tires (Figure 1). The tanker was operated full of water at three tire pressures (14, 28 and 42 PSI), which was replicated three times in a randomized pattern. Immediately after tanker tracking, soil bulk densities were conducted to a depth of 5cm. Control measurements for both measures of compaction were made between tire tracks. Tire surface contact area for each tire pressure was also estimated by outlining the tire contact zone with chalk dust, and recording the approximate number of lug marks which were in full contact with the ground multiplied by the surface area of each lug.

Figure 1. A tanker complete with compressor, airlines and control system for field edge inflation pressure adjustment.

Results:
Little difference in corn yields was observed for the various treatment combinations at the intensive corn site (Table 2). When looking within the various compaction timing and tillage combinations, significant differences between the tire pressure treatments were rarely observed. No clear yield trends or rankings were apparent.

Table 2. Corn yields in response to compaction timing, fall tillage, spring tillage and tire pressure at Arthur, Ontario in 2011

Compaction Timing	Fall Tillage	Spring Tillage	Tire Pressure		
			Control	14 PSI	28 PSI
			------- yield† (bu/ac) -------		
Fall Compaction	No Fall Chisel	No Spring Cultivate	167 B	180 A	171 AB
		Spring Cultivate	176 AB	180 AB	182 AB
	Fall Chisel	No Spring Cultivate	173 AB	178 AB	170 AB
		Spring Cultivate	175 AB	186 A	177 AB
Spring Compaction	No Fall Chisel	No Spring Cultivate	171 AB	170 AB	171 AB
		Spring Cultivate	169 B	173 AB	179 AB
	Fall Chisel	No Spring Cultivate	171 AB	173 AB	170 AB
		Spring Cultivate	182 A	179 AB	183 A

† yields within the same letter groups are not significantly different at an LSD of 10% when compared to other yields within the same row

Similarly, 5cm bulk density data did not demonstrate any strong differences between treatments (Table 3). The control pressure (no trafficking) tended to have the lowest values, but was not always the case for all treatment combinations, and often the differences were marginal. No consistent rankings of bulk densities between the high and low tire pressures were apparent. For the 20cm bulk density data (not shown), no clear relationships were observed.

Table 3. Bulk density measurements (5cm depth) in response to compaction timing, fall tillage, spring tillage and tire pressure at Arthur, Ontario in 2011

Compaction Timing	Fall Tillage	Spring Tillage	Tire Pressure		
			Control	14 PSI	28 PSI
			------- bulk density (g/cm^3) ---		
Fall Compaction	No Fall Chisel	No Spring Cultivate	1.39	1.40	1.43
		Spring Cultivate	1.38	1.44	1.41
	Fall Chisel	No Spring Cultivate	1.34	1.44	1.38
		Spring Cultivate	1.34	1.33	1.42
Spring Compaction	No Fall Chisel	No Spring Cultivate	1.48	1.38	1.49
		Spring Cultivate	1.40	1.32	1.38
	Fall Chisel	No Spring Cultivate	1.40	1.46	1.45
		Spring Cultivate	1.31	1.37	1.47

In the additional soil compaction investigation, 5cm soil bulk densities were observed to increase with tire pressure when they were made in moist soil immediately after compaction (Table 3). Estimates of the surface contact area of the tires demonstrated that decreasing tire pressure did increase the surface area, but not in a linear fashion. Decreasing tire pressure from 42PSI to 28PSI increased the lug area in contact with the ground from 1,310cm^2 to 1,410cm^2 (Figures 2 and 3 respectively), while reducing to 14PSI increased lug contact area to 2,090cm^2 (Figure 4).

Table 1. Soil bulk densities for no trafficking (control) and three different tire pressures immediately after manure tanker trafficking on moist soil in Elora, Ontario in 2011

Tire Pressure (PSI)	Bulk Density (g/cm^3)
Control	1.50
14	1.52
28	1.54
42	1.57

Figure 2. Footprint of 30.5LR32 radial tanker tire at 42 PSI, approx. lug surface area of 1,310cm^2

Figure 3. Footprint of 30.5LR32 radial tanker tire at 28 PSI, approx. lug surface area of 1,410cm^2

Figure 4. Footprint of 30.5LR32 radial tanker tire at 14 PSI, approx. lug surface area of 2,090cm^2

Summary and Next Steps:

Based on one field trial conducted in 2011, corn yield differences between compaction treatments (timing, pressure) have been very difficult to show. Similarly at the same site, compaction treatments did not appear to have a strong influence on soil bulk densities. For the tire used in this experiment, halving pressure did not appear to double the tire contact surface area; it is not known how other radial tires may influence this relationship.

The soil property and corn yield response measurements will be repeated at an experimental site in 2012.

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