Wheel Track Rutting Under Center Pivot Irrigation Systems

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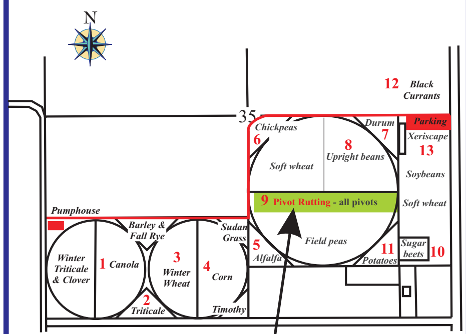

Wheel Track Problems Under Centre Pivot Irrigation Systems

Center pivot irrigation systems are often plagued by the formation of deep wheel tracks. Problems associated with the development of severe wheel tracks include pivot stoppage, structural damage to the pivot, crop yield loss, and water spills. Current wheel-track prevention techniques include using non-standard tire sizes to increase soil contact or reduce the dimensions of the rut, reducing the amount of water applied near the pivot tires, or using an implement to mechanically close the wheel track.

During 2001, a study was conducted by Warren Helgason to demonstrate a wide range of technologies that minimize wheel track problems associated with center pivot irrigation systems. Equipment was installed on three center pivots at the demo farm, sampling locations were established and rut dimensions were monitored. Sample rut dimensions were obtained for 11 unique combinations of equipment, using varying water application amounts.

Method

There are three center pivot irrigation systems on the demo farm. The two smaller pivots (pivots 1 and 2) each have a wetted area of 11.74 ha and have two wheel towers. The larger pivot (pivot 3) covers 27.11 ha and has five wheel towers. Each tower contains an electrical motor and gearbox that drives two wheels. High clearance tires (HCT) were installed on all pivots, and are the most widely accepted technology for reducing wheel tracks.

During the 2002 field season, new sampling locations had to be selected for the treatments demonstrated under pivots 1 and 2. The original pivot 1 location could not be used due to a conflicting research project. Pivot 2 sampling sites were relocated to an adjacent corn crop, with higher irrigation requirements.

Wheel track modifying equipment (track fillers or track closers) move soil displaced by the tire, back into the wheel rut. They are usually fastened to the center pivot tower and dragged behind the pivot as it rotates, but may also be mounted on a 3-point hitch system on a tractor. A disk-type track closer (IMPdt) made by Kirchner Machine Ltd. and a sled-type track closer (IMPst) made by New-Way Irrigation Ltd. were evaluated in this study.

IMP(st) treatment

IMPdt: The disk-type track closer, with two disks mounted on a frame, is fastened directly onto the tower of the center pivot. As the pivot rotates, the disks move soil into the wheel rut. The depth of cut and the disk spacing (to accommodate the width of the wheel) can both be adjusted. The disks are designed to work in one direction of pivot rotation only.

IMPst: The sled-type track closer consists of two thin rails, joined by a shaped blade. The sled is fastened onto the pivot tower with two chains. These attach to a bracket bolted to the tower. As the pivot rotates, the sled is pulled behind it. The rails of the sled straddle the rut and the blade relocates soil back into the wheel track. The pivot direction can be reversed by backing over the sled.

Tire flotation and **traction equipment** modifies the tire size or adds traction-improvement devices to the wheels. Common modifications involve tires that improve tire flotation, increase the clearance of the machine with respect to the ground, or add a cleat system to improve traction. The technologies evaluated in this study include narrow, high profile tires (HTC), flotation tires (MFT), and traction cleats (TR/OET).

HCT: The center pivots used in this study came equipped with high clearance tires. These tires (285 x 965 mm) offer increased soil-tire contact area and ground clearance compared to standard tires (285 x 610 mm).

MFT: Maxi-float, high flotation tires (429 x 610 mm) were installed at one tower location. This tire size offers the greatest soil contact area of all available tire sizes.

TR/OET: Traction rims, manufactured by Valmont Industries (Nebraska), were also evaluated. These rims bolt to the tire and provide extra traction in sticky soils. As the traction rim is only available for standard size tires, one pivot was re-equipped for this evaluation.

Soil moisture reduction techniques reduce the amount of moisture in the wheel track area. Most of the approaches direct the spray away from the pivot tower. In this study, directional nozzles (DN), boom-mounted sprinklers (BB/DN) and remote drain packages (RD) were evaluated.

TR treatment

DN: All standard center pivot sprinkler packages have sprinkler outlets near the tower and wheels. While irrigating, these sprinklers wet the ground around the wheels, causing saturated, mucky conditions that lead to the formation of ruts. By installing sprinkler heads with a 180° sprinkler pattern, it is possible to apply most of the water behind the pivot wheels. To demonstrate this, 180° directional nozzles were mounted on rigid drop tubes at the sprinkler locations nearest to the wheels. The nozzles were directed so the spray would hit the ground behind the wheels.

BB/DN: Directional nozzles on booms (boom-backs) that extend from the original sprinkler location to a distance behind the pivot were installed as a modification of the DN treatment.

RD: Remote drain packages, that move the drain valve away from the tower, were also installed and evaluated. With this equipment, when the pivot stops, the water within the pipe does not hinder traction.

Prior to the first irrigation, sampling locations were chosen in areas expected to produce ruts. Soil cores (50 mm diameter) were taken directly adjacent to the wheel track at each location. Particle size distribution was evaluated for varying depths. Soil samples were obtained to determine bulk density.

Continuous measurements of rut dimensions were taken using a rillmeter. The apparatus was placed across a rut and a number of steel pins were lowered into the track. The depth of travel was then recorded for each pin.

Results

Depth profiles of the wheel ruts created under each treatment were drawn up for each of the 11 treatments as the two growing seasons progressed. The profiles indicate how the size of the wheel track changed with increasing irrigation application, as well as differences related to the equipment used.

The 2002 field season was characterized by receiving above-average rainfall, decreasing the amount of irrigation water required. This sharply contrasts with the 2001 season, where the majority of the crop water requirements were delivered through irrigation. This disparity allowed for an effective demonstration of the performance of each treatment under differing conditions.

HCT - During 2001, the rut was deepest under pivot 3 as it received more irrigation applications than pivots 1 or 2. The resulting ruts for all three HCT treatments were much shallower during 2002, than during the previous year. No measurable rut formed under pivot 1 during the 2002 HCT treatment, but ruts 8-12 cm deep formed under pivots 2 and 3. In all cases, for both years, the resulting ruts were the narrowest of all treatments, typically resulting in about a 30 cm depression and a disturbed area of approximately 40 cm.

MFT - In both years, this treatment resulted in the formation of relatively wide, deep ruts. Slightly deeper ruts were observed during 2001, where more irrigation water was applied.

TR/OET - The profiles of this treatment were very similar in both years, despite different watering regimes and sampling locations. Visual observations confirmed this, as the track shape was relatively consistent around the entire track circumference. The resulting track was generally less than 10 cm wide, but measured wider than most other treatments. Overall, the traction cleats left a very rough rut profile, as the cleat lugs tended to churn the soil.

D**N/HCT -** The DN/ HCT/RC treatment on pivot 1 exhibited ruts greater than 10 cm deep in both years. It was affected by having a sprinkler directly over the wheel track. The frame of the pivot tower deflected a large portion of the water coming from the directional nozzle and caused it to run into the wheel track. The DN/HCT treatment installed on pivot 2 had relatively shallow ruts in 2001, and almost negligible ruts in 2002. The pivot tower frame did not affect the spray pattern of the directional nozzles.

Rillmeter being used to measure the dimensions of a center pivot wheel track

BB/DN/HCT - During 2002, both BB/DN/HCT treatments showed shallower ruts than the previous year, in response to fewer irrigation applications.

IMPdt - The IMPdt treatment produced a rut with a characteristic hump, representing the material that passes between the disks. In 2001, this treatment produced the deepest rut of all, measuring approximately 25 cm. In 2002, the rut was considerably shallower. Most significantly, there was no material displaced above the natural ground surface, as seen in most other treatments. The disks were not adjusted throughout either season.

IMPst - The rut profile produced by the IMPst treatment was very variable, as the sled occasionally went off-track. Generally, this treatment resulted in the widest track of all those demonstrated, with a disturbed area measuring over 100 cm.

The 2001 field season was uncharacteristically dry, while the 2002 season received much-above-average precipitation. This provided a useful demonstration, allowing researchers to see how the different technology performed in extremely dry and quite wet situations. However, it would be most beneficial to have the equipment demonstrated under typical southern Alberta conditions. For this reason it is recommended the equipment be demonstrated at the CACDI site for one more year.

IMP(dt) treatment

For more information, or to obtain a copy of the research report, contact Warren Helgason, Irrigation Specialist,

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