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Impacts of reduced tillage and diversified cropping sequences under organic management in the semi-arid Brown soil zone

(based on an article – Can reduced tillage work in Prairie soil? – published in the Organic Science Canada, Science for Producers magazine, Issue #1, March 2018)

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The research
Explore the effectiveness of reduced tillage and diversified cropping systems for organic grain growers, particularly those in the dry Brown soil zone.

Background
Although there has been an increase in the use of legume green manures, crop rotation, and reduced tillage in the Prairies, many producers still rely on summer fallow for water conservation and intensive tillage for weed control. This is particularly the case in the driest of the Prairie soil zones, the Brown. Here, water usage by a green manure crop can offset the benefits of the nitrogen they supply. However, the reliance on tillage can also contribute to soil drying and degradation of these soils that are already low in soil organic matter. Alternative cropping systems and tillage methods for growers in the most arid of the Prairie soil zones are needed, as producers seek information on the best methods for optimizing their production while minimizing their environmental impact.

What was Done
Led by Agriculture and Agri-Food Canada's Myriam Fernandez, the Prairie-based research team wanted to explore whether reduced tillage and diversified crop rotations are viable options for crop production in the water-constrained and variable environmental conditions of the Brown soil zone. They were particularly interested in whether these tactics can keep weeds at low levels, maintain soil fertility, produce healthy crops, and be profitable.

Trials at AAFC Swift Current were designed to explore two main factors: the diversity of the crop rotation and tillage intensity. Plots were established with all combinations of simplified (forage pea green manure – wheat) or diversified (forage pea green manure – oilseed – pulse – wheat) rotations with either high (worked twice before planting and forage peas terminated by tillage) or low (worked less intensively before planting and forage peas terminated by mowing) tillage. Fall tillage was added in the last years. The scientists then monitored soils, weeds, crop diseases, grain yield and quality.

What was Found
Soil nitrogen levels in the spring were at their highest when plots were managed with high tillage and the rotation was simplified. Soil organic carbon increased with time and tended to be the highest in the low tillage and

diversified rotation plots, treatments which were also found to have lower levels of erodible soil particles and thus would increase the soil's resistance to wind and water erosion.

Researchers observed that wheat yields decreased over the course of the experiment. Yields were, however, consistently highest under high tillage and in the simplified rotation (Table 1). Weeds tended to be more problematic in the low tillage treatment, with perennial thistles increasing their presence each year. The decreased yields were not found to be a direct result of weed pressure, but were instead attributed to precipitation and soil nitrate levels. Overall, yields under low tillage were about 75% of the yields of no-till conventionally-grown wheat. Protein concentration in wheat grain varied among years and was overall similar or higher than in conventional wheat. Protein did not follow the same trend as yield, and there was no negative association between them, which might be explained by the release of mineralized N throughout the season from a previous green manure or pulse crop.

Throughout the trial, which ran from 2010 to 2015, precipitation was higher than average in this typically dry region. Overall, the researchers concluded that, in years with above-average precipitation, low-till production is not a viable option for organic grain producers in the Brown soil zone for more than a few years. This is largely due to increasing Canada thistle populations. Had conditions been drier, as is typical for this region, the outcome may have differed.

Table 1: Average wheat yield with varying tillage and rotation treatments in an organic trial at Swift Current, SK.

Tillage and Rotation	Wheat yield (kg/ha)					
	2011	2012	2013	2014	2015	Average over all years
High Tillage, Simplified Rotation	3420.5[a]	2671.8[a]	2345.7[a]	2302.5[a]	1972.4[a]	2542.7[a]
High Tillage, Diversified Rotation	3171.9[a]	1927.9[b]	2460.4[a]	1424.7[b]	1129.4[b]	2023.0[b]
Low Tillage, Simplified Rotation	3534.0[a]	1805.4[b]	2015.2[a]	1532.6[b]	825.5[c]	1942.3[bc]
Low Tillage, Diversified Rotation	2493.0[b]	957.6[c]	1947.4[a]	1190.0[b]	920.4[bc]	1501.6[c]

Within a column, values with the same letter are not statistically different.

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