The Effect of Tillage System, Nitrogen Fertility, and Crop Rotation on Hard Red Spring Wheat (HRSW) Production for Cycle Five (2003-2006) of a Long-Term Cropping Systems Study

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Abstract

The study consisted of three, four-year crop rotations with three replicates. Each crop in each rotation occurred in every year. Within each crop (main plot) in a rotation, four fertility treatments were imposed (sub-plots). They were 0, 45, or 90 kg of nitrogen (N) per hectare of composted beef feedlot manure (M) applied once in the spring at 180 kg of N per hectare the first year of each four-year rotation. The tillage systems were conventional (CT), minimum tillage (MT), and no till (NT) and created 12 sub-sub plots.
Data was analyzed using SAS GLM procedures with significant differences expressed at the P<0.05 level. The data presented in this abstract are the effect of treatments on HRSW yield.

Tillage systems significantly impacted HRSW yield with minimum till greater than no-till. The 0 N fertility treatment resulted in significantly lower grain yield than the 45, 90, and M fertility treatments. HRSW grain yield was influenced significantly by the previous crop in rotation with the highest yields attained when wheat was planted after field pea. Tillage system influenced the response to N fertility. The M fertility treatment resulted in higher grain yield than other N treatments within the NT tillage system. The 0 and 90 N fertility treatments resulted in similar grain yield under the conventional till (CT) system. Tillage systems also impacted the response of previous crops on HRSW grain yield. The positive effect of field pea on HRSW yield was indicated in both the conventional till (CT) and no-till (NT) systems. Previous crop in rotation did not impact HRSW yield in the minimum-till (MT) system. An interaction between N fertility and previous crop was identified. The addition of 45 or 90 kg ha^{-1} of N resulted in similar grain yield regardless of the previous crop. When N fertility was 0 or Manure (M) the previous crop of field pea resulted in significantly higher yield than canola or HRSW.

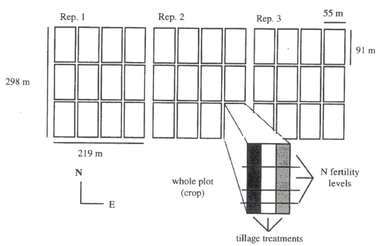
Objectives

Investigate the effects of Cropping Systems on crop yield and quality, crop pest frequency and severity, and soil fertility and quality.

Materials and Methods

This study was initiated in 1987 and is conducted at the North Dakota State University Carrington Research Extension Center near Carrington, North Dakota, on a Heimdal-Emrick loam soil. It consists of three, four-year crop rotations with three replicates. Each crop in each rotation occurs in every year. Within each crop (0.45 ha main plot) in a rotation, three tillage systems (0.15 ha sub-plots) are imposed, four N fertility treatments are imposed perpendicular to the tillage systems (0.0375 ha sub-sub-plots) (Figure 1.). The crop rotations for the 2003-2006 crop cycle were the traditional rotation Hard Red Spring Wheat (HRSW) (Triticum aestivum L.) /Sunflower (Helianthus annuus L.)/Barley (Hordeum vulgare L.) /Soybean (Glycine max L.) (Soybean 1), the alternating grass-legume rotation HRSW/Soybean/ Corn (Zea mays L.)/Field Pea (Pisum sativum L.) (Field Pea 2), and the compound or stacked rotation HRSW/HRSW/Soybean/Canola (Brassica napus L.) (HRSW 3 and Canola 3). The tillage systems are conventional (CT), minimum tillage (MT), and no-till (NT). The N fertility treatments are ammonium nitrate broadcast applied each spring to non-leguminous non-fallow plots at 0, 45, or 90 kilograms (kg) of nitrogen per hectare (ha) or as manure (M) applied at 179 kg/ha of N the first spring of each four-year rotation to all. The crop rotations were designed to test varying crop types and water use intensities on crop yield, diseases, insects, weeds, and soil nitrogen (N), phosphorous (P), organic matter (OM), and pH against the traditional crop rotation in the area. The crops are planted and harvested each year in a timely fashion as weather and time permit. Plots were soil sampled each fall after harvest.

Figure 1. Layout of the study.



Results

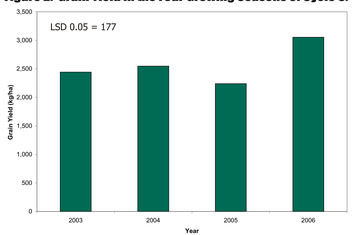
Year
Differences in HRSW grain yield occurred during the four growing seasons of cycle five (Fig. 2). Grains yields in 2005 were reduced due to high levels of fusarium head blight that impacted wheat production all across the region. The 2006 growing season was very productive for wheat as the complex of wheat diseases that often occur were absent.

Rotation
The crop that preceded HRSW significantly affected grain yield (Fig. 3). Previous crops of HRSW and canola resulted in similar yield. HRSW planted after soybean resulted in a significant grain yield increase. A previous crop of field pea had the most impact on HRSW grain yields as HRSW after field pea produced higher yields than the other three crop sequences evaluated.

Tillage
The conventional till (CT) and no-till (NT) systems resulted in similar HRSW grain yields (Fig. 4). However, the minimum-till (MT) resulted in grain yield that was significantly higher the yield associated with the NT system.

The impact of previous crop had minimal affect on HRSW grain yield when the tillage system was MT. (Fig. 5). Field pea grown as a previous crop resulted in higher grain yield than HRSW after soybean, canola, or HRSW in a NT tillage system. In the CT tillage system, HRSW planted after field pea resulted in higher yield that HRSW after canola.

Figure 2. Grain Yield in the Four Growing Seasons of Cycle 5.



Fertility
HRSW responded significantly to the addition of nitrogen as grain yields increased with applications of 45 and 90 kg ha^{-1} of N or the manure (M) fertility treatments (Fig. 6). Generally, the response to nitrogen fertility was similar among tillage systems (Fig. 7). In the NT tillage system the M fertility treatment resulted in significantly higher yield than other N fertility treatments. Wheat response to N fertility within the conventional tillage (CT) system indicates a similar yield between the 0 and 90 N treatments.

The interaction between N fertility and previous crop was significant for grain yield response (Fig. 8). The impact of the previous crop on HRSW grain yield was similar within the 45 and 90 nitrogen fertility treatments. When no additional N fertility (0) was added or when N fertility was supplemented with manure (M) the impact of previous crop differed. A previous crop of field pea resulted in significantly higher grain yield than previous crops of canola or HRSW in the 0 and M fertility treatments. The trend of yield response with soybean as the previous crop was similar to that for field pea. These results suggest that the addition of 45 or 90 kg ha^{-1} of N fertilizer annually, minimized the effect of the legumes as previous crops.

Figure 3. Influence of Previous Crop on HRSW Grain Yield.

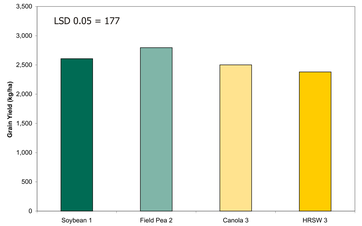


Figure 4. Influence of Tillage System on HRSW Grain Yield.

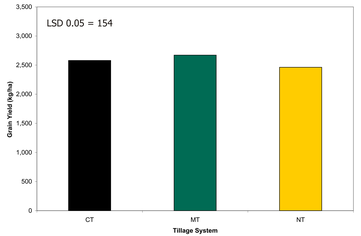


Figure 5. Influence of Tillage System and Previous Crop on HRSW Grain Yield.

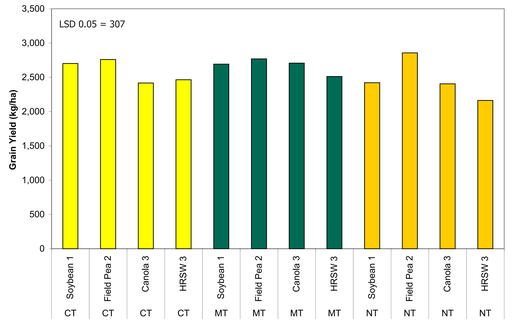


Figure 6. Influence of Fertility Treatment on HRSW Grain Yield.

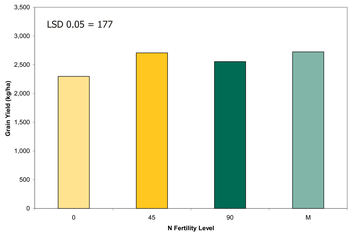


Figure 7. Influence of Tillage System and N Fertility Treatment on HRSW Grain Yield.

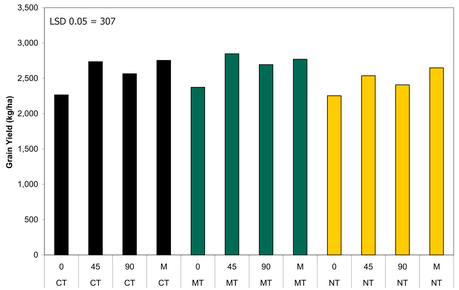
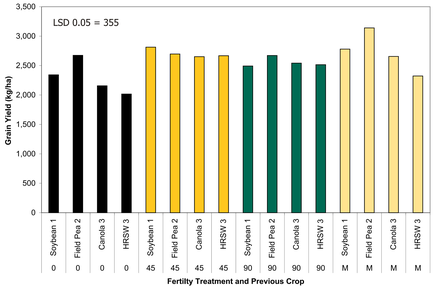


Figure 8. Influence of Fertility Treatment and Previous Crop on HRSW Grain Yield.



Summary

HRSW grain yield was significantly impacted by the crop planted previous to wheat in rotation.

The minimum-till (MT) system resulted in higher overall grain yield compared to the no-till system.

HRSW grain yield increased with the addition of N fertility and the response was similar across N treatments.

Tillage system and N fertility treatment both impacted the influence of previous crop on HRSW grain yield.