Agronomic and Economic Comparison of Annual-Cropped Conventional Tillage and No-tillage. III. Spring Barley

S. Machado, S.E. Petrie, and K. E. Rhinhardt, Oregon State University

Introduction
Winter wheat tillage-based summer fallow under conventional tillage (CT) is the predominant cropping system in the dryland PNW where precipitation is 425 mm. Seventy percent of annual precipitation is received between September and March. Tillage fallow is practiced to control weeds, accumulate nutrients, and slow the evaporative loss of soil moisture. However, tillage accelerates biological oxidation and loss of soil organic matter. Conservation tillage and annual cropping have the potential to reduce loss of SOM and soil erosion and improve soil productivity. No-tillage (NT) systems increase surface residues that protect the soil from erosion; increase soil organic matter; and increase water infiltration. Nutrient deficiencies and pest pressures may, however, increase under NT cropping systems resulting in reduced yields. Since the introduction of NT cropping systems, there has been a renewed interest in annual cropping of spring cereals. Information on crop productivity and profitability of continuous spring barley (Hordeum vulgare L.) under CT and NT cropping systems in the PNW is limited. Spring barley offers advantages over spring wheat including more rapid soil coverage in the spring and earlier maturity that helps barley avoid the terminal drought that is common in the PNW. The objective of our experiment is to determine the effects of annual mono-cropping of spring barley on grain yield and profitability under CT and NT cropping systems.

Materials and Methods
The experiment was conducted at the Columbia Basin Agricultural Research Center (CBARC), Oregon State University (OSU), near Pendleton, Oregon. The soil is a coarse, silty, mixed, mesic Typic Haploxeroll (Walla Walla silt loam); the soil is 1.2 cm to caliche and about 2.4 m to bedrock. Average annual precipitation is about 400 mm. CT and NT spring barley plots were established in 1982 on land that has been in continuous summer fallow since 1931. Since 1977, the plots have received 90, 10, 16 kg N, P, S ha⁻¹, respectively, annually. A zero fertilizer control was imposed in 1993. NT companion plots, which received 100, 10, 16 kg N, P, S ha⁻¹ and a control, were established adjacent to the CT plots in 1998. Plots were seeded in March at 280 and 312 seeds m⁻¹ for the CT and NT, respectively. A double disk drill was used to seed CT plots and a hoe drill was used to seed the NT plots. Weeds were controlled by glyphosate, glufosinate = 2,4-D, and bromoxynil. Grain was harvested by a plot combine and weighed. Yield components were determined from a 1-m quadrat in each plot. PROC MIXED and REPEATED PROCEDURES (SAS) were used to analyze data. A partial economic analysis was performed. Fixed costs, crop insurance costs or government program benefits were excluded. Variable costs were assigned to residue management and tillage for seeded establishment, seeding, fertilizing, weed control, and interest. Variable costs were based on the OSU Enterprise Budget for Winter Wheat. Fertilizer and pesticide costs were based on local dealers. Prices for feed barley were the Portland, OR November average price for the harvest year crop.

Results and Discussion: Agronomy
Grain Yield
Grain yields of unfertilized CT spring barley were positively correlated with winter precipitation while grain yields of unfertilized barley were negatively correlated with winter precipitation (Table 1). Unfertilized CT barley yields closely followed trends in winter precipitation while yields of unfertilized NT barley decreased drastically in the first three years of the experiment when winter precipitation was increasing (Fig. 1). The decline in NT yields was attributed to a decline in fertility and increase in disease and weed pressures. Unfertilized CT spring barley produced significantly higher grain yields than unfertilized NT spring barley in all the six years of study (Fig. 1).

Applying N, P, and S significantly increased the grain yield of CT spring barley from 1998-2003. The mean partial net return of $190.61 ha⁻¹. The partial net returns from the NT plots ranged from $202.44 ha⁻¹ to -$5.51 ha⁻¹; the average annual partial net return was $93.32 ha⁻¹.

Grain yields of unfertilized CT spring barley were positively correlated with winter precipitation while grain yields of unfertilized barley were negatively correlated with winter precipitation (Table 1). Unfertilized CT barley yields closely followed trends in winter precipitation while yields of unfertilized NT barley decreased drastically in the first three years of the experiment when winter precipitation was increasing (Fig. 1). The decline in NT yields was attributed to a decline in fertility and increase in disease and weed pressures. Unfertilized CT spring barley produced significantly higher grain yields than unfertilized NT spring barley in all the six years of study (Fig. 1).

Applying N, P, and S significantly increased the grain yield of CT spring barley from 1998-2003. The mean partial net return of $190.61 ha⁻¹. The partial net returns from the NT plots ranged from $202.44 ha⁻¹ to -$5.51 ha⁻¹; the average annual partial net return was $93.32 ha⁻¹.

Table 1. Correlations between grain yield of unfertilized and fertilized continuous spring barley grown under conventional tillage and no-tillage systems

<table>
<thead>
<tr>
<th></th>
<th>Grain yield (Mg ha⁻¹)</th>
<th>Grain yield (Mg ha⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CT</td>
<td>NT</td>
</tr>
<tr>
<td></td>
<td>1998</td>
<td>2001</td>
</tr>
<tr>
<td>Crop year precipitation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Winter precipitation</td>
<td>0.71**</td>
<td>0.46**</td>
</tr>
<tr>
<td>Spring precipitation</td>
<td>0.81**</td>
<td>0.05</td>
</tr>
</tbody>
</table>

** Significant at 0.05 and 0.01 probability levels, respectively

Summary and Conclusions
- Continuous CT spring barley was more productive than continuous NT spring barley regardless of the fertilization rate.
- Low NT yields indicate problems associated with NT systems that need to be addressed. Breeding and agronomic research should be conducted to improve the yield potential of spring barley varieties under NT conditions.
- Continuous CT spring barley had lower variable costs of production, especially herbicides, and markedly greater economic returns than NT spring barley.

Table 2. Crop yield, crop value, variable costs, and partial returns from fertilized CT and NT spring barley at CBARC, 1998-2003

<table>
<thead>
<tr>
<th>Year</th>
<th>Crop Value</th>
<th>Variable Costs</th>
<th>Partial Net Return</th>
</tr>
</thead>
<tbody>
<tr>
<td>1998</td>
<td>5.11</td>
<td>546.11</td>
<td>476.04</td>
</tr>
<tr>
<td>1999</td>
<td>4.37</td>
<td>369.30</td>
<td>369.30</td>
</tr>
<tr>
<td>2000</td>
<td>4.29</td>
<td>420.20</td>
<td>390.00</td>
</tr>
<tr>
<td>2001</td>
<td>3.38</td>
<td>387.00</td>
<td>387.00</td>
</tr>
<tr>
<td>2002</td>
<td>3.18</td>
<td>441.25</td>
<td>341.25</td>
</tr>
<tr>
<td>2003</td>
<td>3.21</td>
<td>305.68</td>
<td>305.68</td>
</tr>
</tbody>
</table>

![Graph showing crop yields and profitability](image-url)