CHEMICAL FALLOW WATER STORAGE IN A
LOW PRECIPITATION ZONE OF NORTH-CENTRAL OREGON

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Abstract
Farmers in north-central Oregon use tillage fallow (TF) to store soil moisture for winter wheat produced the following year. Chemical fallow (CF) is an alternative to the conventional, tillage-based system. Utilization of CF has been limited due, in part, to concerns about soil water storage. This project was designed to compare CF and TF water storage in a production zone characterized by deep soils, limited annual precipitation (8-12 in), and dry, hot summers. Soil water storage in side-by-side CF and TF Ritzville silt loam profiles was compared at six sites in 2001 and at four additional sites in 2002. Water storage comparisons were made by evaluating the water content of samples collected from each ft of the soil’s profile. Water storage in CF, with 1.5 tons residue/acre, was similar to that observed in TF. Results from statistical analysis of a small data set indicate water storage in CF might be increased if the amount of residue from the previous year’s crop is approximately 4.5 tons/acre. Additional work is needed to verify effects of the quantity of post-harvest residue on water storage in CF.

Key Words
Chemical fallow, conventional fallow, soil water storage, tillage fallow, winter wheat
Introduction

Winter wheat production in north-central Oregon occurs mostly on deep soils and in areas where average annual precipitation ranges from 8 to 12 in. Summers are dry and hot. Wheat is normally grown after a year of tillage fallow (TF). An alternative to conventional, tillage-based fallow is chemical fallow (CF). A renewed interest in CF can be attributed to (1) improvements in direct-seed equipment, (2) limited success with annual cropping, (3) repeated failures to grow alternative crops economically, and (4) the recent availability of a soil-active herbicide that may improve control of troublesome weeds such as kochia (Kochia scoparia) and Russian thistle (Salsola kali). Optimism about this alternative fallow method, though, is tempered by speculation of inadequate water storage. The objective of this on-going project is to compare CF and TF water storage in representative fields of the region.

Materials and Methods

Plot Layout and Field Locations

Soil water storage in side-by-side CF and TF plots was compared at six sites in 2001 and at four additional sites in 2002. Most sites were located within a 6 mile radius of 45° 34’ 9” N, 19° 49’ 8” W (Morrow County, Oregon). Plot dimensions were 60 ft x 60 ft. Each plot was a subset of a large field and was managed with standard practices for the area. CF and TF fields at three sites were located adjacent to one another. The distance between CF and TF sampling areas ranged from 40 to 80 ft. CF and TF fields at the seven other sites were separated by either a county road or farm road. The distance between sampling areas at these locations ranged from 210 to 265 ft. This larger
separation distance was used in an attempt to avoid edge effects that might have been encountered next to the road or in areas where “outside rounds” were made.

**Growing Conditions**

The soil at each of the 10 sites is a Ritzville silt loam (course-silty, mixed, mesic *Calciorthidic Haploxeroll*) with a slope of less than 2 percent, an effective rooting depth of 4 or 5 ft, and an available water holding capacity of about 8 in. Total precipitation in 2000-2001 and 2001-2002 was 9.89 and 7.94 in, respectively. Rainfall during each of the April 1st to June 30th growing seasons ranged from 25 to 30 percent of the year’s total.

**Field Operations, Cropping History, and Chemical Fallow Residue**

TF was maintained with a single “sweep” operation in April or May, followed by rod-weedings as necessary. Stubble in CF was left “as is” following harvest. Weed control in CF was accomplished with applications of glyphosate, 2,4-D, and/or paraquat. CF and TF plots were weed-free during the experiment. Soil disturbance in CF occurred only at planting time and after sampling was completed.

The cropping history at three sites included 2 years of TF and 1 year of soft white winter wheat production, followed by either CF or TF (2001 project year). The estimated amount of residue in CF plots (based on visual observations only) was 4.5 tons/acre. Stubble height was 16-21 in. The cropping history at seven sites included 1 year of TF and 1 year of soft white winter wheat production, followed by either CF or TF (2001 and
2002 project years). The estimated amount of residue in CF plots, at these locations, was 1.5 tons/acre. Stubble height ranged from 4 to 7 in.

**Soil Sampling, Moisture Determinations, and Statistics**

Soil sampling was conducted on June 15\(^{th}\) (± 7 days) and again on September 1\(^{st}\) (± 3 days). Sampling took place at three randomly selected locations within each CF and TF plot. Samples were collected with a bucket auger, removed from each ft of the profile, and placed in a 5-gal bucket where they were mixed, by hand, for approximately 30 sec. A small portion of each mixed sample was placed into a 4-oz soil moisture can. Wet weights were determined in the field using a leveled and calibrated electronic balance. Dry weights were determined 24 hr after samples were placed in a 230°F oven. Volumetric water contents were calculated from gravimetric numbers and an assumed bulk density of 1.25 gm/cm\(^3\). Calculation of the total water content of soil profiles (Tables 1 and 2) was accomplished by summing the product of volumetric water contents and soil depth (12 in) for each 1-ft layer. The statistical significance of data was determined by an analysis of variance procedure for a randomized block design that used sites as replications. Treatment means were separated using Fisher’s protected least significant different test.

**Results and Discussion**

Data from this research provides preliminary evidence of a relationship between potential water storage in CF and the quantity of post-harvest residue. Subsequent comparisons of water storage for the two fallow methods are discussed accordingly. Plots with small
amounts of residue (≈1.5 tons/acre) will be referred to as “light-residue” CF. Plots with substantially more residue (≈4.5 tons/acre) will be referred to as “heavy-residue” CF.

**Light-residue Chemical Fallow**

Water storage in the two fallow systems was statistically identical (Table 1). There was, however, a consistent trend of decreased storage in CF. Water storage in CF was 0.55 in less than that in TF on June 15th. Increased water storage in TF, on the earlier sampling date, is probably a consequence of primary tillage operations conducted in April or May.

**Table 1.** Average water content of seven side-by-side chemical fallow (*light-residue*) and tillage fallow plots in Morrow County, Oregon.

<table>
<thead>
<tr>
<th>Date</th>
<th>Chemical fallow</th>
<th>Tillage fallow</th>
<th>LSD&lt;sub&gt;(0.05)&lt;/sub&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>June 15</td>
<td>5.48</td>
<td>6.03</td>
<td>NS&lt;sup&gt;+&lt;/sup&gt;</td>
</tr>
<tr>
<td>Sept. 1</td>
<td>5.18</td>
<td>5.85</td>
<td>NS&lt;sup&gt;+&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

+ Not significantly different

A single “sweep” operation reduces the bulk density of the top 6 in of the soil profile. The reduction in bulk density inhibits upward migration of water and minimizes evaporative losses. The “moisture cap” was maintained by rod-weeding operations conducted in July and/or August.
The distribution of water in soil profiles was similar for light-residue CF and TF (Figures 1 and 2). Maximum water contents were measured in the second ft. Values above and below this depth were very low and a sharp decrease in moisture, over time, was noted in samples removed from the top ft of the profile.

![Water content diagram](image)

**Figure 1.** June 15th water content, by depth, for chemical fallow (*light-residue*) and tillage fallow plots. Data are from three Morrow County, Oregon sites where soil depth is equal to five ft.
**Figure 2.** September 1st water content, by depth, for chemical fallow (*light-residue*) and tillage fallow plots. Data are from three Morrow County, Oregon sites where soil depth is equal to five ft.

*Heavy-residue Chemical Fallow*

The average water content of heavy-residue CF was significantly greater than that observed in TF (Table 2). Increased CF water storage is probably the result of a reduction in evaporative water loss, compared to light-residue CF, during July and August.
Table 2. Average water content of three side-by-side chemical fallow (*heavy-residue*) and tillage fallow plots in Morrow County, Oregon.

<table>
<thead>
<tr>
<th>Date</th>
<th>Chemical fallow</th>
<th>Tillage fallow</th>
<th>LSD&lt;sub&gt;(0.05)&lt;/sub&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>June 15</td>
<td>7.05</td>
<td>6.13</td>
<td>0.77</td>
</tr>
<tr>
<td>Sept. 1</td>
<td>6.41</td>
<td>5.46</td>
<td>0.86</td>
</tr>
</tbody>
</table>

Stem, leaves, and fractured pieces of stubble on the soil surface formed a fairly dense mat in some field (plot) locations. The overall effect of this mat on evaporation, however, was probably minimal, since it was observed infrequently. Thick, standing stubble likely played a more significant role in reducing evaporation. A portion of the sun’s incoming radiation, which is absorbed by the stubble, never reaches the soil. Heat input to the soil, relative to that of soils with little residue, is reduced during the summer. Standing stubble also reduces wind turbulence above the soil surface. Lower soil temperatures and reduced air movement decrease the vapor pressure gradient between the soil and the atmosphere. The effect is less evaporation.

The distribution of water in CF and TF profiles was similar on June 15<sup>th</sup> (Figure 3). Maximum water contents ranged from about 9.5 percent to almost 11 percent in the second ft. Soil moisture values above this depth decreased by approximately 1 percent. Minimum water contents were observed in the 4- to 5-ft layers.
The distribution of September 1st water in CF and TF profiles was not alike (Figure 4). Maximum CF water contents occurred in the second and third ft. Soil moisture values below 3 ft decreased by an average of 0.2 in/ft. The maximum water content in TF occurred in the second ft of the profile and decreased by an average of 0.08 in/ft in the 3-, 4-, and 5-ft layers. Soil moisture was minimal (≈ 7 percent) in the first and fifth ft. The

**Figure 3.** June 15th water content, by depth, for chemical fallow (*heavy-residue*) and tillage fallow plots in Morrow County, Oregon.
dissimilar distribution of water may be related to differences in heat transfer (temperature gradients) between soil layers.

**Figure 4.** September 1st water content, by depth, for chemical fallow (*heavy-residue*) and tillage fallow plots in Morrow County, Oregon.
Conclusions

It is worth noting that increased water storage with heavy-residue CF was observed at a very limited number of sites. Verification of results presented in this report will require additional research. Results from this project apply to CF and TF on Ritzville silt loams only. The storage of water and the distribution of water in heavy-residue CF will almost certainly be different for “heavier” and “lighter” soils. Year-to-year variations in temperature and precipitation will also influence soil water storage.

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