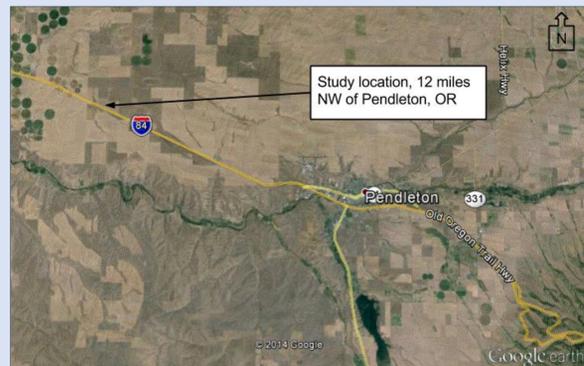


Abstract

Plant available water is of vital importance in dryland farming regions, so it is necessary to identify farming practices that allow plants to optimize water use and maximize crop yields. Soil water measurements were taken during the 2014 growing season to discern the soil water balance and water use efficiency for four crop rotations in a dryland cropping system study near Echo, OR. Soil moisture, rainfall, and yield were compared among spring and winter crops, tillage systems, and cropping systems. The rotations and crops examined in this study were then ranked according to their water use efficiency and yield. Post-harvest soil water content did not significantly differ between various spring and winter crops nor among winter wheat-summer fallow and more intensive three-year rotations comprised of reduced tillage fallow, winter cereal, and spring oilseed; and reduced tillage fallow, winter oilseed, and spring cereal. Oilseeds potentially can help diversify the traditional winter wheat-summer fallow system.

Methods

In season soil samples were taken at depths of 30 cm, 60 cm, 90 cm, and 120 cm for each phase of four rotational schedules of a long term dryland cropping study located near Echo, OR. The soil type at the experimental location is a Ritzville series silt loam, and the area averages 34 cm (10.25 in) yearly precipitation. Soil samples were taken from August 2013 to August 2014, representing one crop year. Samples were massed before and after drying to determine gravimetric soil moisture, adjusted for soil bulk density, and converted to centimeters of water per 120 cm. Rainfall data were taken from a nearby weather station and used to calculate water use efficiency. The critical minimum soil moisture was identified as the lowest in-season soil moisture. In-season water use was calculated and used to compare tillage practices, spring and winter crops, and two-phase vs. three-phase rotations. Water use efficiency was also compared to yield for each cropping system.



Rotation	Phases
2A	Winter Wheat, Summer Fallow
2B	Winter Wheat, Reduced Tillage Fallow
3B	Reduced Tillage Fallow, Spring Oilseed, Winter Wheat
3C	Reduced Tillage Fallow, Spring Wheat, Winter Oilseed

Results & Discussion

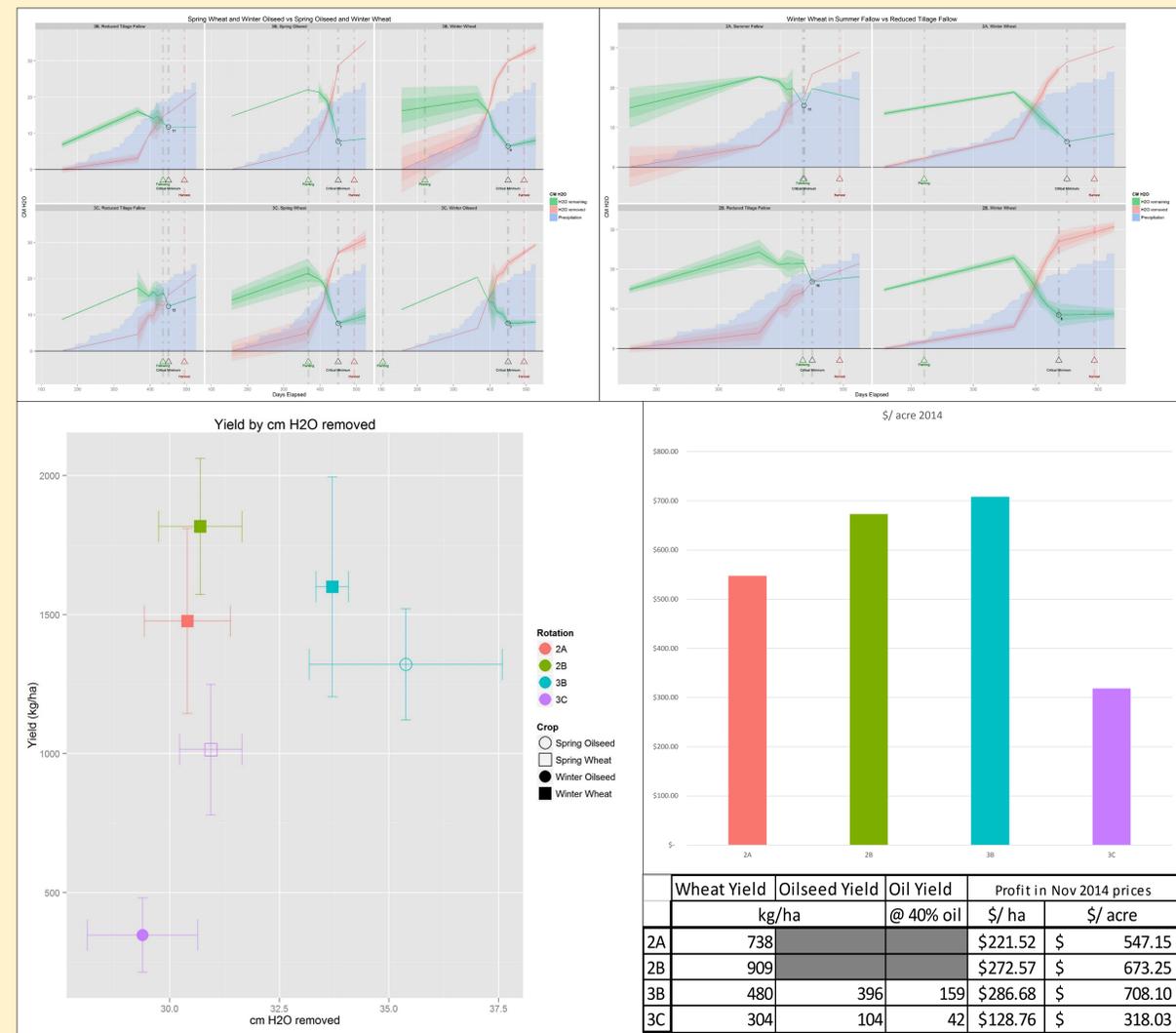
Among the four cropping rotations evaluated, there was variation in the amount of soil moisture at the start of the growing season. The 3B spring oilseed and winter wheat phases started the season with about 15 and 16.5 cm of water respectively, while the 3C spring wheat and winter oilseed started with about 14 and 12 cm of water per 120 cm. Despite these beginning of season differences, each of these phases ended the season with about 8cm of soil moisture. The same was true of the two-phase winter wheat rotations: Even though the 2B wheat phase following reduced tillage fallow reached a higher in-season maximum water content compared with the 2A wheat following summer fallow, both phases ended the season with about 8 cm of water remaining.

The traditional winter wheat-summer fallow system removed more water from the soil during the summer fallow phase (28 cm) than the reduced tillage fallow phase (22 cm) of the winter wheat-reduced tillage fallow system. Similarly, the reduced tillage fallow phases of the 3B and 3C rotations each failed to retain about 22 cm of water.

When yield (kg/ha) is compared with the amount of water removed (cm), the winter wheat in both two-phase and three-phase rotations yielded similarly (1476-1818kg/ha), despite the 3B rotation having removed more water from the soil overall. The winter wheat two-phase rotations and the spring wheat three-phase rotation ended the season with a similar amount of water removed from the soil (~31 cm), but the winter wheat was higher yielding.

The 3B rotation was slightly more profitable (\$708/acre) than the 2B rotation (\$673/acre). The 3C rotation was less than half as profitable (\$318/acre) as the 3B rotation because of the low winter oilseed yield.

These preliminary results suggest that intensified cropping systems in the dryland regions of the Columbia plateau have the potential to increase water use efficiency when compared to conventional cropping systems. These data will continue to be collected over the next several years to determine the long term viability of intensified cropping systems in the Pacific Northwest.



Conclusions

As this is a continuing study, the patterns we see now will likely become more conclusive in future years. For now, we can draw preliminary conclusions about the patterns in water use among the various cropping systems. It is likely that it can be profitable to intensify traditional winter wheat-summer fallow cropping systems by adding an oilseed phase, and that this is not likely to have an adverse effect on the soil moisture available to plants. Currently, this experiment is entering the third year of these rotations. Continuing this study will help elucidate the relationship between soil moisture and yield benefits associated with an oilseed rotation.

It is important to note that very cold temperatures in fall 2013 prevented good stand establishment of winter oilseed (3C), so CY2014's yields are lower than expected. This impact was experienced regionally, and should be considered when comparing spring versus winter rotations. Challenging conditions for establishing winter oilseed are not uncommon however, so for the purpose of this study, these data were not omitted.

Continuing this study will help determine the long term viability of these rotations, accounting for the challenging conditions present in farming the inland Pacific Northwest.

Acknowledgements

Thank you to Stewart Wuest for guidance in our analysis.
We would like to thank Steve Umbarger for performing all farming operations, including field preparations, planting and harvesting.
We would also like to thank all those who participated in our data collection during the 2014 field season and look forward to the 2015 field season.