**Northwest Columbia Plateau PM\textsubscript{10} Project**

**Objective 5:** Wind Erosion and PM\textsubscript{10} Emission Control Methods

**Title:** Integrated Crop Production of Spring Cereals in Semiarid Regions

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**Abstract of Research Findings**
The 2004-05 crop year was the driest of the last 4 years, receiving 7.07 inches of precipitation. When snowmelt was included (8.97 inches), total precipitation was still 2.5 inches lower than the historic average of 11.5 inches. Winter canola yielded 1955 lb/A despite 80 mile per hour winds prior to harvest and an economic threshold infestation of cabbage leaf aphid. Winter wheat yielded 50 bu/A, which was 10 to 15 bu/A higher than previous years. Facultative wheat following chemical fallow yielded 33 bu/A, compared with facultative wheat following spring wheat, which yielded 11 bu/A. Crop failures or near crop failures were realized for all spring planted cereal crops. Russian thistle was not as prevalent as it had been in past years. In spring wheat following facultative wheat, no-till spring barley, light-tilled spring barley, and hard white spring wheat following no-till spring barley, Russian thistle was the most prevalent weed ranging from 2.4 to 15.0 plants m\textsuperscript{-2}. Rhizoctonia root rot was present in all crops but severity of infection differed significantly among crops. Winter canola and winter wheat were not significantly affected by Rhizoctonia root rot. Stripe rust severely impacted spring wheat but not facultative wheat. High temperature adult plant resistance, characteristic to “Alpowa” and differences in plant maturity were responsible. Cereal leaf beetle larvae were present in spring oats, but they were not treated because it was not economical based on projected yield and pesticide cost.

**General Objectives**
1. Adjust and adapt the production of spring wheat, spring barley, and other spring cereals to semiarid regions to reduce wind erosion and improve or maintain crop profitability.
2. Compare wind erosion and PM\textsubscript{10} emission control methods of alternative cropping systems (tillage, crops, rotation, weed control), and evaluate their effectiveness through descriptive measurements and portable wind tunnel tests.
3. Determine and develop Best Management Practices (BMP’s) for spring crops, specifically pertaining to weed, insect, and disease management; fertility rate, timing, and placement; varietal selection; and environmental and economic evaluation of the cropping systems.
Specific Objectives
1. Ascertain the dust content of soils as influenced by cropping systems in the low precipitation zone of the Columbia Plateau.
2. Quantify dust emissions from various cropping systems in the low precipitation zone of the Columbia Plateau.
3. Quantify the incidence and impact of weeds, diseases, and insects in the no-till spring cropping systems and compare to traditional winter wheat-fallow.
4. Determine carbon storage and sequestration compare C and N cycling, and relative N use efficiencies.
5. Use standard crop production budgets to estimate the cost of production for each cropping system and rank each system by average profitability and income stability (risk).
6. Conduct field days and presentations to disseminate information.

Materials and Methods
The Ralston project consists of three phases: Phase I (1995-00), Phase II (2000-02), and Phase III (2002-Present). During Phase I, the cropping systems were: 1) winter wheat/reduced tillage summer fallow; 2) no-till spring wheat/chemical fallow; 3) continuous no-till spring wheat; and 4) no-till spring barley/no-till spring wheat. During Phase II, the cropping systems were: 1) winter wheat/reduced tillage summer fallow; 2) no-till spring canola/facultative wheat, established on plots previously under no-till spring wheat/chemical fallow; 3) continuous no-till hard red spring wheat; and 4) no-till spring barley/no-till hard red spring wheat. Treatments for Phase III include: 1) winter canola/reduced tillage summer fallow/winter wheat/reduced tillage summer fallow and two cycles of winter wheat/reduced tillage summer fallow; 2) no-till facultative wheat/no-till spring wheat and no-till facultative wheat/chemical fallow; 3) no-till spring triticale/no-till spring oat; and 4) no-till hard white spring wheat/no-till spring barley and no-till hard white spring wheat/single light tillage spring barley. For phase III, main plots of Phase II were divided in half and scientists are comparing plots within each of the new treatments as well as among all the treatments. All crops were grown every year. Each treatment was replicated four times.

All four new treatments are being evaluated economically, environmentally, and agronomically. Because the government is interested in canola as a biofuel, the winter wheat/summer fallow/winter wheat/summer fallow system is being compared to the winter canola/summer fallow/winter wheat/summer fallow system. Numerous growers have stated that winter canola is an economically important crop and could be a feasible option for dryland producers. In the no-till facultative wheat rotation, yield, weed species shifts, disease incidence, and carbon sequestration is being compared between no-till facultative wheat/chemical fallow and no-till facultative wheat/no-till spring wheat. The no-till spring triticale/no-till spring oat rotation adds flexibility and marketing opportunities to growers in this region. Spring oats will be grown for grain or forage depending on existing soil moisture conditions at the boot stage of growth. In the no-till hard white spring wheat/single light tillage spring barley rotation, researchers will revisit the possibility of incorporating reduced tillage practices into troublesome areas encountered in continuous no-till systems. Rhizoctonia persists as a major pest and may be reduced effectively by light tillage. The incidence of Rhizoctonia in barley and hard white spring wheat are being compared between
the no-till hard white spring wheat/no-till spring barley and no-till hard white spring wheat/single light tillage spring barley systems. In addition to disease incidence, crop yield, weed species shifts, and soil quality parameters are also being measured.

Plant foliage and roots were analyzed by Oregon State University laboratory in Pendleton for quantitative scoring of disease incidence and severity. The primary focus was on four root diseases; take-all, Rhizoctonia root rot, Fusarium crown and root rot, and Pythium root rot. Soil samples taken in the spring and fall were sent to Western Laboratories in Parma, Idaho for quantification of all plant-parasitic nematodes, with a special focus on using two different extraction procedures appropriate for detecting populations of root-lesion and cereal cyst nematodes.

**Results and Discussion**

**Crop Production:** Precipitation for the 2004-05 crop year was 7.07 inches excluding snowmelt and 8.97 inches including snowmelt (Fig. 1). Even with snowmelt included, precipitation was 2.5 inches lower than the historic average of 11.5 inches. The 2004-05 crop year was the driest of the last 4 years (Fig. 1), and if compared to all crop years since the Ralston Project was established (1995), it is the driest.

![Fig. 1. Annual crop year precipitation for the 2004-05 crop year.](image)

In addition to having the least annual crop year precipitation, the 2004-05 crop year also had the most abnormal precipitation pattern of the last 4 years (Fig. 2). The precipitation pattern for the 2004-05 crop year was the most evenly distributed throughout the year compared with the previous three years. Peak precipitation for the growing season occurred in November, March and May. Monthly average precipitation never exceeded 1.5 inches. Almost no
rainfall was received in February. The pattern of peak precipitation in the winter months with a small peak in the spring is generally normal for the area, as depicted for the 2001-02, 2002-03 and 2003-04 crop years (Fig. 2).

Winter canola yielded 1,955 lb/A, three times as high as the spring canola yielded the previous year (Table 1). Winter canola yield had potential to be greater but high winds occurred during pod fill, folding the plants over and kinking the stems. As a result, flow of the vascular system was limited or stopped and pod fill was stopped prematurely. Fortunately, Spodnam pod sealer was applied prior to the windstorm so shattering of the pods

Fig. 2. Average monthly precipitation by crop year for the 2001-02, 2002-03, 2003-04, and 2004-05 crop years (snowmelt not included).
was minimal. Winter wheat yielded 50 bu/A compared to 40 and 35 bu/A in 2003-04 and 2002-03 crop years, respectively. Increased winter wheat yields were attributed to a new variety, as well as to establishment and maintenance of a uniform moisture line in the summer fallow, which the winter wheat was planted into, and to good pre-plant and in-crop weed control. The improved stand and yield of winter canola was due in part to the reasons mentioned above, but also because a new drill that improved crop emergence was used. In addition, weather was not excessively hot and dry during germination and emergence of winter canola, as it was in the previous crop year. Facultative wheat following chemical fallow yielded 33 bu/A, 1 bushel less than the previous year and 9 bushels less than in 2002-03. No-till and light-tilled spring barley yielded similarly, although crop failures were realized for all spring crops. This would have been a good year to take out crop insurance! Spring oat forage samples were not collected due to poor crop biomass and quality.

Table 1. Average crop yield for each treatment at Ralston, Washington. †

<table>
<thead>
<tr>
<th>Crop</th>
<th>Yield (bu/A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WW</td>
<td>35</td>
</tr>
<tr>
<td>WC</td>
<td>NA</td>
</tr>
<tr>
<td>FW following ChF</td>
<td>42 a</td>
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<tr>
<td>FW following SW</td>
<td>Na a</td>
</tr>
<tr>
<td>SW following FW</td>
<td>23</td>
</tr>
<tr>
<td>NTSB</td>
<td>1364 (lb/A)</td>
</tr>
<tr>
<td>LTSB</td>
<td>1248 (lb/A)</td>
</tr>
<tr>
<td>HWSW following SB</td>
<td>19</td>
</tr>
<tr>
<td>SO</td>
<td>40</td>
</tr>
<tr>
<td>ST</td>
<td>1102 (lb/A)</td>
</tr>
</tbody>
</table>

†WW = winter wheat, FW = facultative wheat, ChF = chemical fallow, SW = spring wheat, SB = spring barley, NTSB = no-till spring barley, LTSB = light-tillage spring barley, SO = spring oats, ST = spring triticale.  a There were no FW following SW plots. All FW plots were planted into plots previously planted to spring canola that failed, effectively ChF. b Winter canola was planted but failed so plots were replanted with roundup ready SC.

Weeds were counted in crop prior to herbicide application in mid April to early May for all crops. Russian thistle was not as prevalent as it had been in past years, primarily due to effective post harvest and in-crop weed control. Flixweed and volunteer winter wheat were the most prevalent weeds present in fallow following winter wheat (55 and 41 plants m⁻², respectively). Few weeds were found in fallow following spring canola, with flixweed being most prevalent (5 plants m⁻²). Winter wheat and winter canola had few weeds throughout the year and were essentially weed free prior to harvest. Downy brome was the most prevalent weed in the winter wheat and winter canola at the time of the in-crop weed count (< 1 plants m⁻² for both species). Weeds in chemical fallow were present at densities < 1 plant m⁻² and were kept at minimal levels throughout the year with a Spartan application early in the spring for residual broadleaf weed control, a Roundup application in June, and an application of Surefire using the Patchen Weed Seeker in August. Flixweed was the most prevalent weed present in facultative wheat following spring wheat (2 plants m⁻²). Prickly lettuce was the
most prevalent weed present in facultative wheat following chemical fallow (2 plants m⁻²). No herbicide application was made in facultative wheat following chemical fallow during the growing season. Downy brome was not present in either facultative wheat crop, although it was present in spring wheat following facultative wheat (5 plants m⁻²). Russian thistle was the most prevalent weed in no-till spring barley (10 plants m⁻²) and light-tilled spring barley (15 plants m⁻²). All other weeds were present at densities < 1 plant m⁻² in both barley crops. Russian thistle was the most prevalent weed present in spring wheat following no-till spring barley (4 plants m⁻²). Slimleaf goosefoot population in spring wheat following light-tilled spring barley was 5 plants m⁻². Russian thistle was present at a slightly lower density than in the spring wheat following no-till spring barley (3 plants m⁻²). Downy brome was present at 12 plants m⁻² in no-till spring triticale. Salsify was the most prevalent in no-till spring oats (5 plants m⁻²).

Winter wheat plots appeared healthy when walking through the plots but necrotic lesions, caused by *Fusarium/Bipolaris* crown and root rot complex, were found on 94% of the winter wheat roots. The mean severity rating of 2.5 indicated that the lesions were moderately severe, and were likely to have affected the uptake of water and nutrients by the seminal roots of mature plants. Winter wheat was not affected or minimally affected by the other diseases. Like winter wheat, facultative wheat appeared healthy above ground. Unlike winter wheat, no lesions caused by *Fusarium/Bipolaris* crown and root rot complex were found on the facultative wheat. The other diseases affected facultative wheat minimally, and for the most part were found at lower levels when compared to winter wheat. Rhizoctonia root rot was present on roots of 47% of the winter canola plants but the severity of infection was very minor, with a mean rating of 0.8. No other diseases were found on the winter canola. When looking at diseases and disease incidence in the spring cereals (no-till spring wheat, triticale, oats, hard with spring wheat, barley and light-tilled spring barley) percentages of plants with subcrown internode lesions caused by *Fusarium/Bipolaris* crown and root rot complex differed significantly among treatments but the mean severity ratings did not differ significantly (ratings from 0.3 to 1.5). The highest incidence of lesions occurred on light-tilled spring barley (25%), no-till spring triticale (21%) and no-till spring oats (16%). Fewer lesions occurred on no-till spring barley (8%), and the three no-till spring wheat treatments (1 to 3%). Rhizoctonia root rot incidence and severity on coronal roots did not differ significantly among treatments. For seminal roots, the incidence but not severity of Rhizoctonia root rot differed among treatments. Pruning of lateral roots, thought to be caused by a complex of *Pythium* and *Rhizoctonia* species, differed significantly among treatments. There was no evidence of take-all or other diseases on plants in any of the treatments.

Populations of root-lesion nematodes detected were considered to be very low and always below the threshold for economic damage. Populations did not differ significantly among cropping or fallow treatments. However, in no-till annual cropping systems it was interesting that soft white spring wheat and oats had higher mean numbers (100 to 140/kg of soil) than hard white spring wheat (33 to 73/kg of soil), or spring barley (10/kg of soil). Numbers in the winter wheat and summer fallow were also relatively low (0 to 50/kg). Other species of nematodes were minimal in all plots.
Foliar diseases, with the exception of stripe rust, were absent in the 2004-05 growing season. Stripe rust symptoms were observed in several crops, but the spring wheat was most heavily affected. There was a significant difference in the severity of infection between the spring wheat and facultative spring wheat. Facultative wheat was minimally affected by stripe rust because high temperature adult plant resistance, characteristic of “Alpowa”, was activated. High temperature adult plant resistance was activated in facultative wheat only because the fall planted facultative wheat was more mature compared to the normal spring planted wheat. Although stripe rust infection was high in spring wheat it was not economical to apply a pesticide.

Only two insects were found to cause problems in some of the crops. Cereal leaf beetle larvae were found in spring wheat, barley, triticale and spring oats. The larvae were more prevalent in spring oats, inflicting damage to many of the leaves including the flag leaf. Damage cause by the cereal leaf beetle was minimal in other crops. Although populations were high in the spring oats it was not economical to spray for the insects. Winter canola was heavily infested with Cabbage leaf aphids during pod fill. Levels were above the economic threshold and the foreseen yield for the crop was excellent so the canola was sprayed with Dimethoate.

**Planned Research:** The winter wheat/summer fallow/winter wheat/summer fallow and the winter canola/summer fallow/winter wheat/ summer fallow systems will be continued through 2007 in order to complete the full cycle. The no-till hard white spring wheat/no-till spring barley and no-till hard white spring wheat/single light tillage spring barley systems will be continued through 2006. All information (economic, environmental, and agronomic) will continue to be gathered on these rotations. Facultative wheat, oats, and triticale will be planted again for the 2005-06 crop year but only yield data will be collected on these crops.

**Publications and Presentations**

**Published Abstracts**

**Popular Publications and Oral Presentations**