

Potential Impact of Group 2 (ALS Inhibitor) Herbicide Residue on Winter Wheat Survival – Early Reconnaissance.

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Abstract

Next to the coinciding harvest of spring crops, the biggest challenge winter wheat seeding faces is finding early matured and harvested crop land for seeding at the optimum window from late August to early September. Pulse stubble provides an opportunity to get winter wheat seeded in a timely basis. Growing winter wheat on pulse stubble is commonly discouraged due to the very limited residue and potential for snow trap. As overwinter success is connected to snow cover and subsequent insulation against cold temperatures. We propose another challenge that may be limiting success on pulse stubble. The repeated use ALS inhibiting (Group 2) herbicides and soil residual that can inhibit root growth, nutrient uptake and subsequent fall seedling establishment. A reconnaissance study was conducted on two locations, each with pulse stubble but with differing Group 2 herbicide residue. Soil temperature monitoring showed that of the three winter wheat cultivars examined, all should have easily survived the winter of 2010-11. Significant impact on stand survival and yield was observed on the soil having Group 2 residues. A cultivar interaction was also noted. Further investigation would facilitate identifying potential crop nutrition management techniques to overcome agronomic challenges of successfully growing winter wheat on pulse stubble. Investigation of winter wheat cultivar tolerance to ALS inhibiting herbicide residues would also be of value.

Introduction

To grow winter wheat has piqued the interest of many western Canadian farmers. In a survey of prairie farmers on the adoption winter wheat acres (Cole 2010), there were many reasons for growing winter cereals (Fig. 1) but the top three reasons were:

1. Improving farm logistical efficiency,
2. Crop rotation fit,
3. Profitability relative to spring wheat.

For all the positive reasons to grow winter wheat, seeded acres on the prairies have had great difficulty maintaining any momentum (Fig. 2). The greatest barrier to maintaining winter wheat in rotation is the logistics challenge of seeding during harvest (Fig. 3) (Cole 2010). A typical result of the time conflict is that the winter wheat is seeded near the end of, or after harvest. Late seeding has a number of impacts on the crop's viability to compete for acres for the following reasons:

1. Reduction of winter hardiness,
2. Delays in crop maturity,
3. Reduction in yield potential.

The implication to a farmer's bottom line include re-seeding costs, lost equipment efficiency and lost crop revenues.

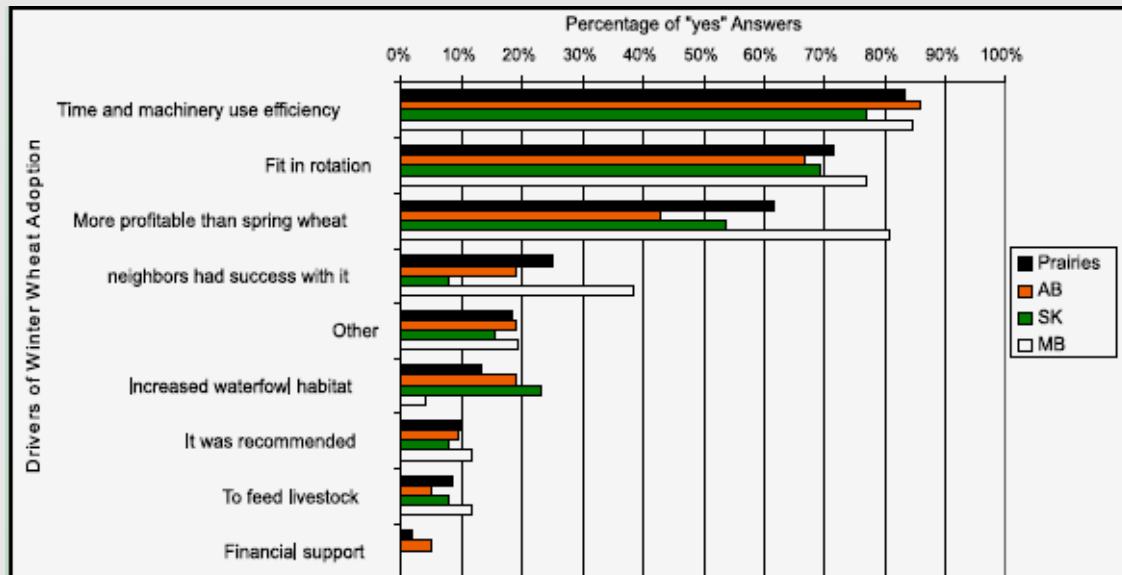


Figure 1. Drivers of Winter Wheat Adoption.

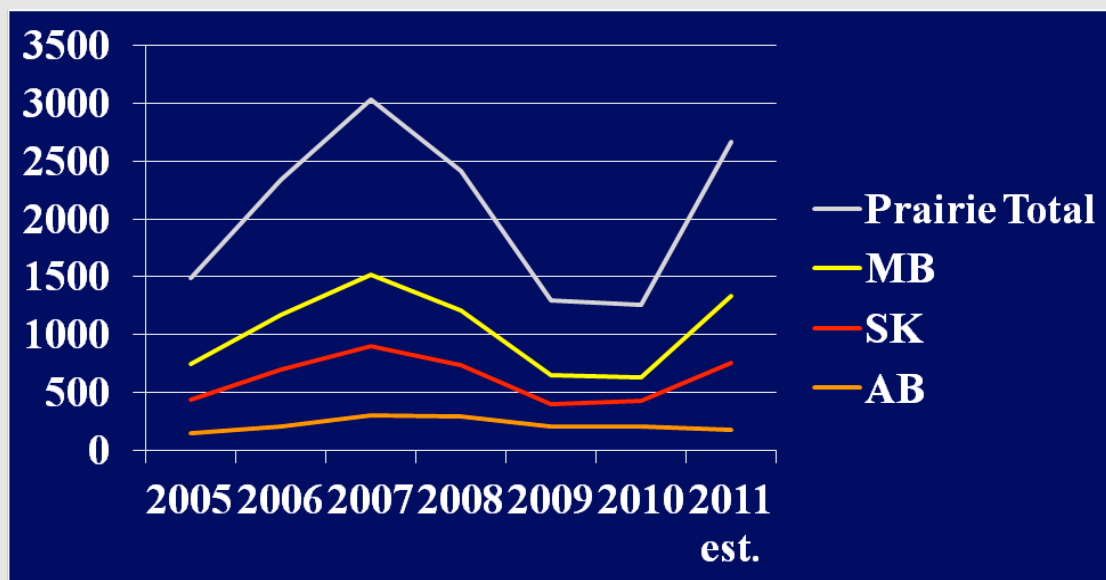


Figure 2. Winter wheat seeded acres (x 1000) for the Prairie Provinces.

Source: Statistics Canada Field Crop Reporting Series.

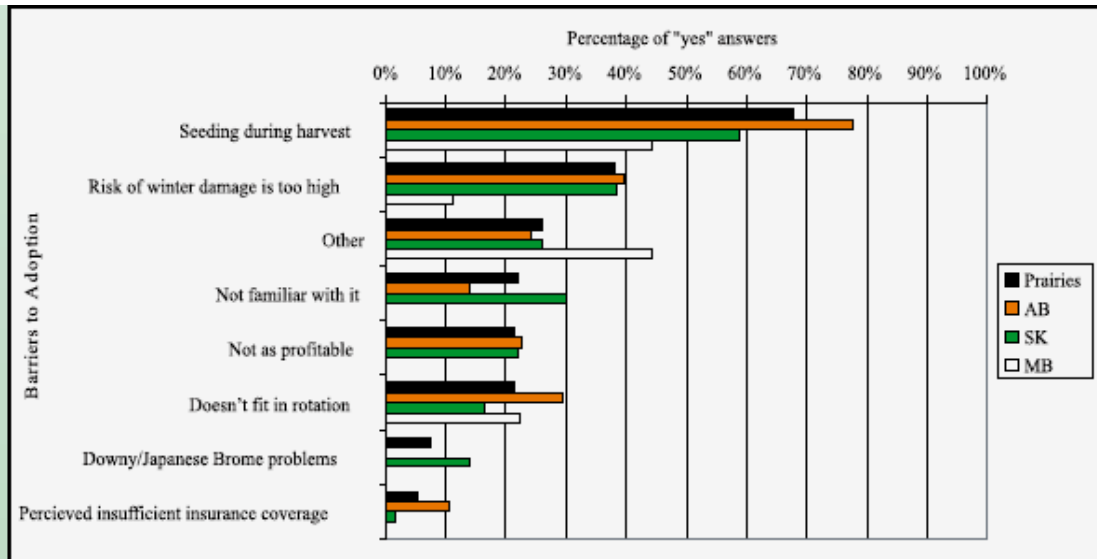


Figure 3. Current barriers to winter wheat adoption by non-growers.

Where the “idealized” stubble for winter wheat is canola, it is a crop creating logistical challenges. The logical tendency for farmers to select for high yielding hybrid cultivars selects for varieties with higher days to maturity. In addition, canola has a lower risk of losing grade and yield due to inclement harvest weather thus quality sensitive crops are harvested first if poor weather is imminent. The resulting delay in field availability is causing the logistical bottleneck.

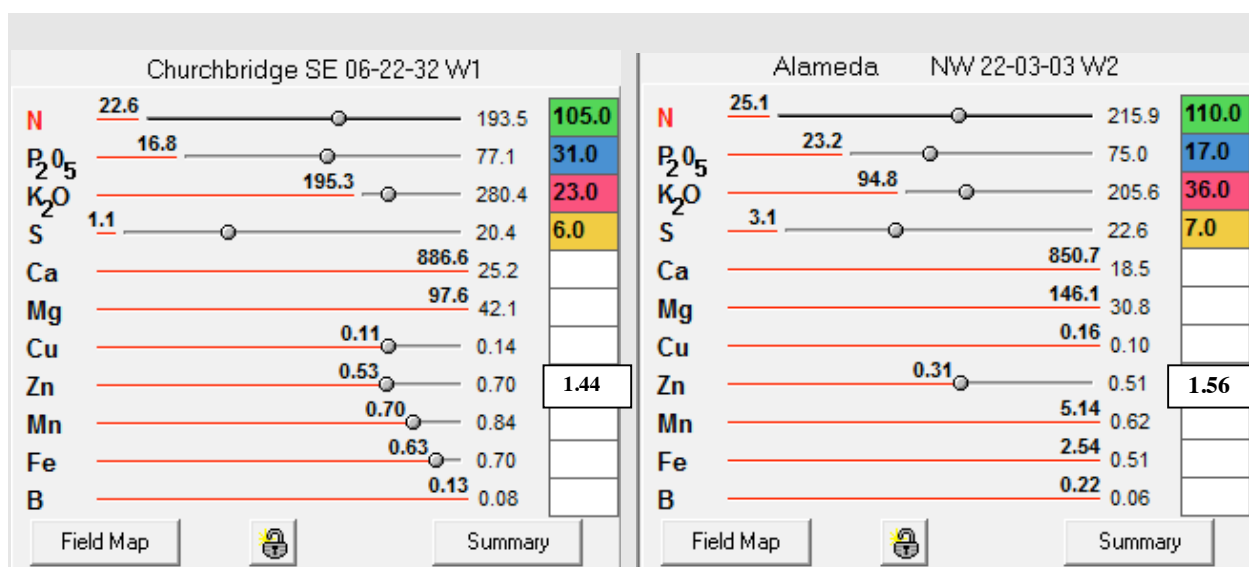
A possible option to this logistical challenge is to look at early maturing, early harvested crops. Pulses, specifically peas and lentils, fit this characteristic. Anecdotal reports suggest varying degrees of success growing winter wheat on pulse stubble. Crop failures are most commonly blamed on the lack of snow cover. The question is, are there other circumstances at play and are there management strategies that can improve winter wheat outcomes on pulse stubble?

Method

In a reconnaissance effort, two study locations were found to have soil characteristics of interest. Trial sites were located near Churchbridge and Alameda, Saskatchewan. Both locations had a recent history of pulses in rotation and were pea stubble at the time of plot establishment.

The study locations were soil sampled and analyzed for nutrient supply rates using the PRS Probe technology at Western Ag Labs Ltd. A description of the application of the PRS Probe technology can be found in Greer et.al. 2003. The Churchbridge location (legal land location (SE 6-22-32 W1) was situated on a sandy loam classified as a Whitesand Association. The Alameda location (NW 22-3-3 W2) was established on a solodi shale loam classified as an Estevan Association.

Nutrient supply rates and fertilization rates for the respective locations are shown in Figures 4 and 5. Bold numbers above red line represents modeled nutrient supply rate for the growing season. Numbers in the coloured boxes represent fertilizer added (in pounds actual). Nitrogen not coming from the P-K-S blend was top dressed in spring. Supplemental zinc fertilization rates are also shown.



Figures 4 and 5. Nutrient supply rates and fertilization rates as determined using PRS (Plant Root Simulator) technology.

The trial sites also underwent a bioassay test to determine the degree of acetolactate synthase (ALS) inhibiting (Group 2) herbicide residues remaining in the soil. The bioassay method employed is described by Szmigielski et.al. 2008. Bioassay results from Alameda indicated significant herbicide carry over, where as the Churchbridge location was revealed to have low residues of ALS inhibiting herbicides (results not shown).

Study treatments (Table 1) consisted of three cultivars of winter wheat (CDC Kestrel, CDC Ptarmigan and Sunrise). Two seeding depths (2.5 cm and 5 cm) were also employed (CDC Kestrel excepted) to induce greater stress on the cultivars in the hopes treatment effects might be magnified. The varieties were seeded with and without a zinc treatment. Treatments were replicated four times. Cultivar treatment blocks were randomized in the trial area.

The zinc treatments were intended to assess whether enhanced nutrition management could facilitate improved winter survival, crop competitiveness and ultimately yield. The presence of ALS inhibiting herbicide residues could magnify nutrient deficiencies through the inhibition of root growth.

Table 1. Trial treatments showing cultivar, seeding depth, and zinc combinations.

| Treatment # | Cultivar & Seeding Depth | Treatment # | Cultivar & Seeding Depth |
|-------------|--------------------------|-------------|--------------------------|
| 1 | CDC Kestrel 1" - Zn | 7 | Sunrise 1" – Zn |
| 2 | CDC Kestrel 1" + Zn | 8 | Sunrise 1" + Zn |
| 3 | CDC Ptarmigan 1" - Zn | 9 | Sunrise 2" – Zn |
| 4 | CDC Ptarmigan 1" + Zn | 10 | Sunrise 2" + Zn |
| 5 | CDC Ptarmigan 2" - Zn | | |
| 6 | CDC Ptarmigan 2" + Zn | | |

Temperature monitoring posts were established at each trial location. Soil temperatures were recorded at a 2.5 cm depth. The temperature data, recorded in a data logger, was downloaded

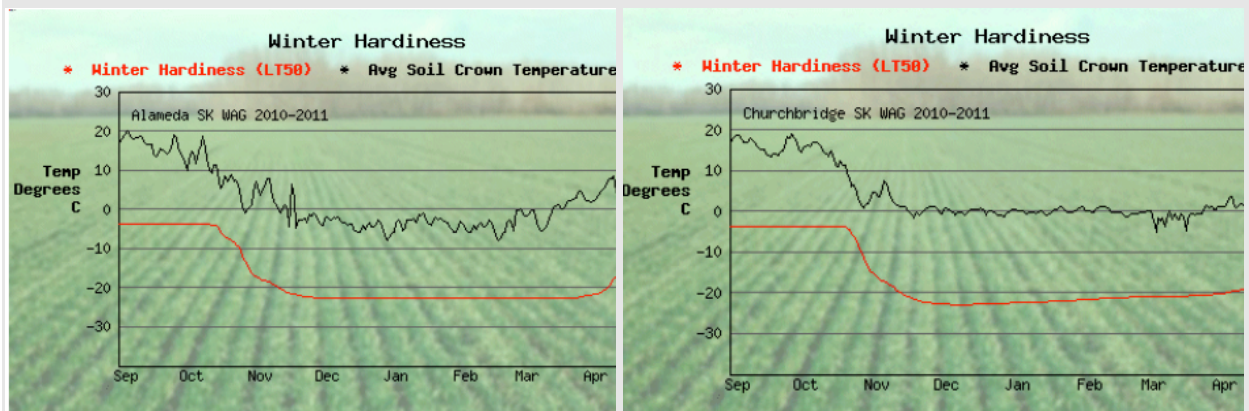
from time to time and prepared for utilization in the Winter Cereal Survival Model (www.wheatworkers.ca/FowlerSite/winter_cereals/WWModel.php). The model provides a management tool for farmers and researchers to assess cultivar winter survival based on selected current and historical databases.

The trials were taken to yield. Plots were hand harvested and later threshed. Plot area harvested was 1 m x 2.4 m. Treatment yields were averaged.

Results and Observations

The winter of 2010-2011 was a mild one as far as the winter cereals are concerned. Shown below in Figures 6 and 7 are the Winter Hardiness graphs generated by the Winter Cereal Survival Model. Indicated in the graph are the average daily soil temperature at crown depth (black line) and the cold temperature acclimation temperature (red line). High levels of soil moisture and the relatively early arrival of significant snow should have protected the winter wheat from any threat of cold temperature stress. This is demonstrated by the separation between the crown temperature and winter hardiness lines.

Winter wheat seeded in commercial fields near both trial sites survived the winter well and yield at or above long term average. Upon inspection in the spring, significant crop damage was noted at the Alameda location where as Churchbridge appeared ok though suffering from excess moisture.



Figures 6 and 7. Winter Cereal Survival Model graphs showing soil temperature at crown depth and winter hardiness acclimation at Alameda and Churchbridge trial locations.

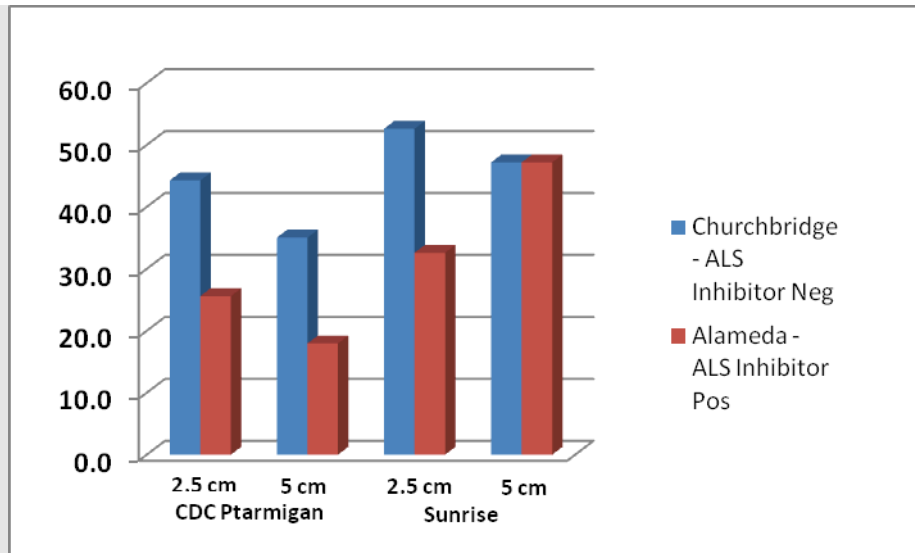


Figure 8. Winter wheat yields by cultivar, and seeding depth at Churchbridge and Alameda. All differences shown are significant at $p > 0.05$.

The treatments at Alameda (ALS inhibitor residue positive) yielded consistently less than the Churchbridge location (Fig. 8). The variable of residual ALS inhibitor was significant between the locations. What was unexpected was the degree of cultivar effect.

There is a difference in the Field Survivability Index (FSI) between the cultivars tested. The FSI was developed by Dr. Brian Fowler to provide relative winter hardiness rankings between winter cereal cultivars to facilitate cultivar development and selection. Differences in cultivar FSI represent the average percent differences expected in field survival. The higher a cultivar's FSI, the greater its winter-hardiness potential (Fowler 2002). For example, following high stress winters, CDC Kestrel (FSI 499) is expected to have a eight percent ($499 - 491 = 8$) higher survival rate than Sunrise (FSI 491) and ten percent higher survival than CDC Ptarmigan (FSI 489) ($499 - 489 = 10$). Possible explanations for the cultivar variance observed in this study include:

1. Cultivar specific rooting characteristics,
2. Early season growth habit,
3. Cultivar sensitivity to ALS inhibiting herbicide residues.

CDC Kestrel's yields (data not shown) were similar to that of Sunrise. By the yield data shown in Figure 5, the small difference in FSI between varieties proved to have an impact on CDC Ptarmigan's viability.

Including a deep seeding depth was successful in magnifying the ALS inhibitor stress response with in CDC Ptarmigan and Sunrise. This brings the point further emphasizing shall seeding in soil pulse stubble.

The impact of supplemental zinc fertilization proved inconclusive as data variance was too large. Mechanistically, there is some rational that supports using zinc to improve survival of winter wheat under stress conditions.

Conclusions and Recommendations

Though winter wheat can and is a financially rewarding crop, its appeal is trumped by logistical pressures connected to seeding during harvest. Determining management strategies that would facilitate consistently viable winter wheat crops on pulse stubble would greatly increase the interest in this crop.

This reconnaissance study has identified areas where further investigation could bring valuable opportunities to Saskatchewan farmers. Factors for consideration include:

1. Can crop nutrition management overcome some of the cold temperature stress losses experienced by winter wheat on low residue stubble?
2. How sensitive are different winter wheat cultivars to ALS inhibitor residues?
3. Can crop nutrition management resolve constraints imposed by ALS inhibitor residues in the soil?

References

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