Update on winter wheat projects from the agronomy project *Enhanced Economic Returns and Ecosystem Services with the Expansion of Winter Wheat*

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We are wrapping up our first field season of the winter wheat project and it has been a challenging year! The weather wreaked havoc for many but it was interesting to see that on many of the field day tours the winter wheat plots/crop usually looked the best. In some locations, it was the only viable experiment that remained from the excessive rain and subsequent floods. The following is a brief update of the project.

Human Resources.

We have a few notable changes to our science team. Dr. Randy Kutcher has accepted a position with the Crop Development Centre at the University of Saskatchewan. Randy was instrumental in planning the seed treatment studies. Dr. Gary Peng has will be assuming Randy's role on the team and we are looking forward to working with Gary. Colleen Kirkham, Randy and Gary's technician at Melfort deserves credit and thanks for managing the trials during the transition.

Dr. Byron Irvine accepted a position as Research Manager at the Brandon Research Centre. Byron has been the visionary of many winter wheat experiments and championed the studies related to crop residue and stubble management. Byron will remain as an advisor and Dr. Ramona Mohr has agreed to assume the science duties related to these winter wheat studies.

We welcome Gary and Ramona to the team and are thankful that they agreed to step in as the void would have been significant without their involvement.
It is also important to note that we are using this project as an opportunity to recruit and train graduate students. We are currently funding a student, Graham Collier, under the supervision of Dr. Dean Spaner at the University of Alberta; and we hope to do the same at the University of Manitoba next year.

Update on Sub-Activities.

Sub-activity 1.1 (Test 211)

Determine the influence of seed-applied fungicides and insecticides on fall stand establishment and overwinter survival of winter wheat.

Seed Treatment Results

A total of 8 sites were successfully grown this year to study the effects of seed-applied fungicides, insecticides or dual combinations. Plant stands did not differ, but plant growth and vigour appeared to improve with seed treatments if there was a response. A combined mixed model analysis of all 8 sites indicates the interaction of seed treatment and fall-applied foliar fungicide (Prothioconazole) strongly affected grain yield (P=0.04). The combination seed treatment combining Imidacloprid insecticide with Tebuconazole and Metalxyl fungicides (Raxil WW) improved grain yield over the check (no seed treatment) and Metalxyl alone (data not shown).

Fig. 1. Control treatment of CDC Buteo planted south of Lethbridge. No seed treatments applied.

Fig. 2. Raxil WW treatments of CDC Buteo planted south of Lethbridge.

Fall-applied foliar fungicides.

We were interested to see if fall-applied fungicides would have any effect on winter wheat stand establishment, particularly if pathogens such as stripe rust were present. A mixed model analysis of the three sites with confirmed stripe rust pressure (Lethbridge (rainfed), AB; Melfort and Scott, SK) indicates that applying foliar fungicides (Prothioconazole – *'Proline'*) will improve grain yield over no application of fungicides. A combined mixed model analysis over all sites also indicated improved grain yield with a fall-applied foliar fungicide (P=0.01)(Fig.3). These results are intriguing as it would appear that the fungicide application elicited a favorable plant physiological response even in the absence of the pathogen. For sites with stripe rust pressure, the results might indicate that the rust spores overwintered, and that perhaps a systemic mode of action of Prothioconazole persisted in the crop through the winter. Overwintering of stripe rust is plausible for Lethbridge as rust spores have been known to overwinter in the region; however, spores are not known to overwinter in regions near Melfort or Scott, SK (D. Gaudet, B. Puchalski personal communication).

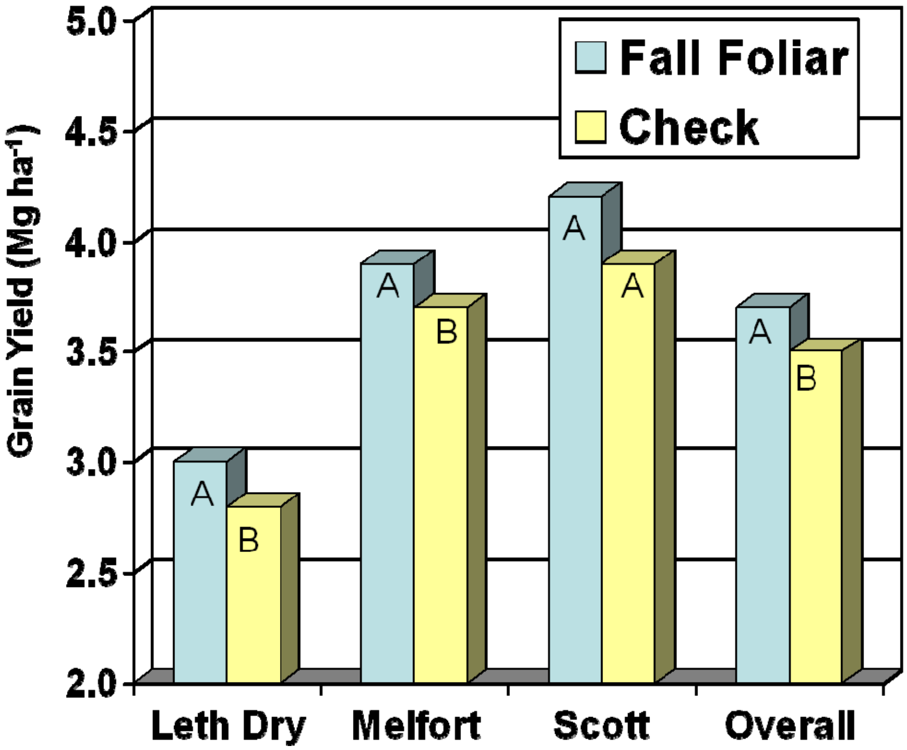

Fig. 3. Effect of fall-applied foliar fungicide (Prothioconazole) on winter wheat grain yield with confirmed stripe rust infection in the fall of 2010 or spring 2011. Means within a site not sharing the same letter are significantly different (P=0.05; Fisher Protected LSD).

Stability of the agronomic system.

By plotting the mean grain yield and the coefficient of variation for each of the seed treatment x fall-applied foliar combinations, we can assess how stable each system is for winter wheat production (Fig. 4). Averaged over all 8 sites, the combination seed treatment (Raxil WW) with or without the fall-applied foliar fungicide produced high grain yield with optimal stability. The lowest and most variable treatment was untreated grain that did not receive a fall application of foliar fungicide. The other seed treatments generally gained stability and some improvement to yield with the addition of the fall-applied foliar fungicide.

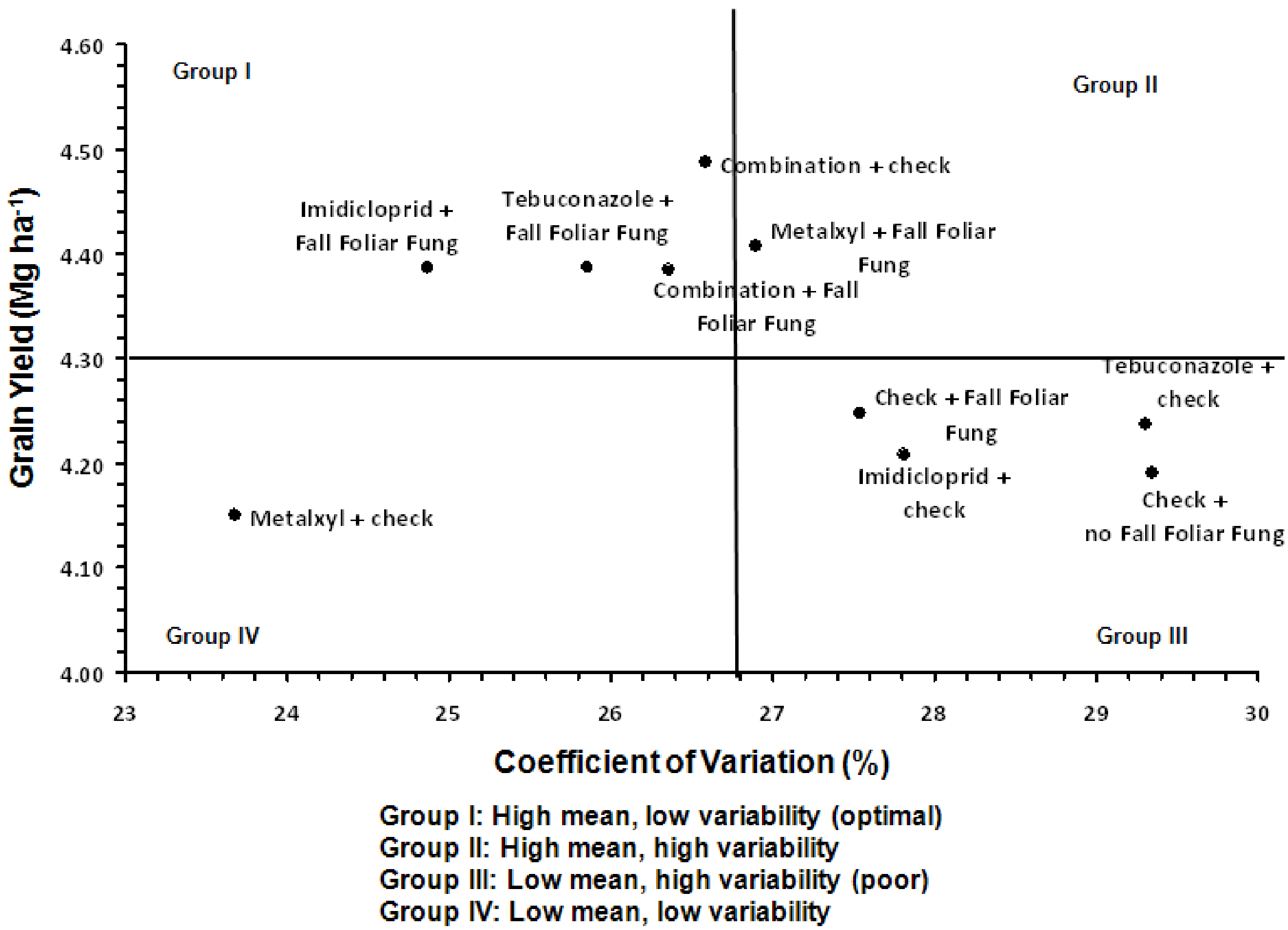

Fig. 4. Biplot of grain yield vs. coefficient of variation for each treatment combination of seed treatment and fall-applied foliar fungicide. The label 'Combination' is the seed treatment with both insecticide and the 2 fungicides (Raxil WW).

Sub-activity 1.2 (Test 212)

Improving the success of planting winter wheat into barley grain stubble.

One of the goals of this project is to successfully grow winter wheat in stubble other than canola. Barley would be a reasonable alternative, particularly in shorter season areas. We were interested to see what management strategies would be needed to control volunteer barley. In all sites planted in 2010, all volunteer barley was suppressed by the winter wheat growth and competitiveness cv. CDC Buteo. Therefore, we concluded that we should instead change the objective to:

Determine the efficacy of novel herbicides in controlling weeds in sub-optimal and optimal stands of winter wheat.

If a producer does experience reduced stand establishment, this study will help develop herbicide recommendations to optimize weed management. I like the new focus, which will involve wild oat and cleaver pressure; and a new chemistry, Pyroxylsulfone, compared to Group 2 and 4 industry standards.

Sub-activity 1.3 (Test 213)

Managing nitrogen when planting winter wheat on barley grain stubble.

The major focus of this sub-activity is to determine if nitrogen management recommendations need to be altered when planting winter wheat into barley stubble. There is some concern that heavy trash left behind at barley harvest could lead to N immobilization and cause deficiencies in winter wheat. This study has been established and will be grown in Brandon, northern and southern Alberta.

Sub-activity 1.4 (Test 214)

Crop growth enhancement through improved residue management strategies.

This sub-activity builds upon 1.2 and 1.3, but expands to involve a wide array of potential alternative stubbles from barley to camelina. We have established this experiment at 4 locations and will be planting the winter wheat into the various stubble treatments this fall.

Sub-activity 2.1 (Test 221)

The interaction of seed treatments and fall-applied foliar fungicides on winter hardiness and plant health of winter wheat.

This sub-activity parallels the objective of 1.1 as we wanted to completely explore seed treatment effects in winter wheat. In this study, we also introduce seed size, which we use as a proxy for seed vigour and combine with 2 levels of seeding rate, 200 or 400 seeds m^{-2}. These two factors combined with a seed treatment factor represent a range of agronomic systems from weak (low seed rate, small/thin seed, no seed protection) to superior (high seed rate, heavy/plump seed, dual seed treatment).

The responses have been similar to what has been observed in 1.1, the seed treatment factor strongly affected grain yield (P=0.02). Seed lot and the interactions of seeding rate with seedlot and seed treatment weakly affected grain yield (P=0.07, 0.08 and 0.09, respectively). For this experiment (Test 221), responses were greatest in the weak agronomic system (Figs. 5 and 6) and tended to diminish with a stronger agronomic system (Figs. 7 and 8). However, the gains observed to grain yield by using seed treatments or plump seeds were significant but relatively modest ie. 4.4 vs. 4.3 Mg ha^{-1}, and 4.6 vs. 4.5 Mg ha^{-1}, respectively (data not shown). Therefore, we must take into consideration the economic implications for each system and the overall stability of the entire system to properly evaluate the risks and benefits each agronomic system can offer.

Fig. 5. Weak agronomic system without seed treatment (200 seeds m^{-2} + light/thin seed weight).

Fig. 6. Weak agronomic system (200 seeds m^{-2} + light/thin seed weight) with seed treatment Raxil WW.

Fig. 7. Superior agronomic system (400 seeds m^{-2} + heavy seed weight) without seed treatment

Fig. 8. Superior agronomic system (400 seeds m^{-2} + heavy seed weight) with seed treatment Raxil WW.

Stability of the agronomic system.

By plotting the mean grain yield and the coefficient of variation for each of the seed treatment x seed lot x seeding rate, we can assess how stable each system is for winter wheat production (Fig. 9). The field observations were confirmed with a combined analysis over the 7 sites in 2011. The stability and overall productivity of a weak agronomic system (thin seeds and low seeding rate) was improved with seed treatments. However, if seed size or lot was plump and a higher seeding rate was used, there was no gain in grain yield but a slight increase to system stability may occur with the seed treatment.

The results of both tests 211 and 221 would indicate, based on the data to date, that seed treatments could enhance productivity, particularly if the agronomic system is compromised with less than desirable seed lots, lower plant populations, or perhaps other components not assessed in this study. Therefore, it is important for producers to carefully assess seed lot quality, seeding rates, stubble quality, date of seeding in fall, soil moisture conditions; and then decide if flaws or less than desirable conditions exist in any of these components that would warrant the use of seed treatments. We hope to conduct an economic analysis of the results in order to fully understand how the added input of seed treatments will affect net returns to the farm gate.

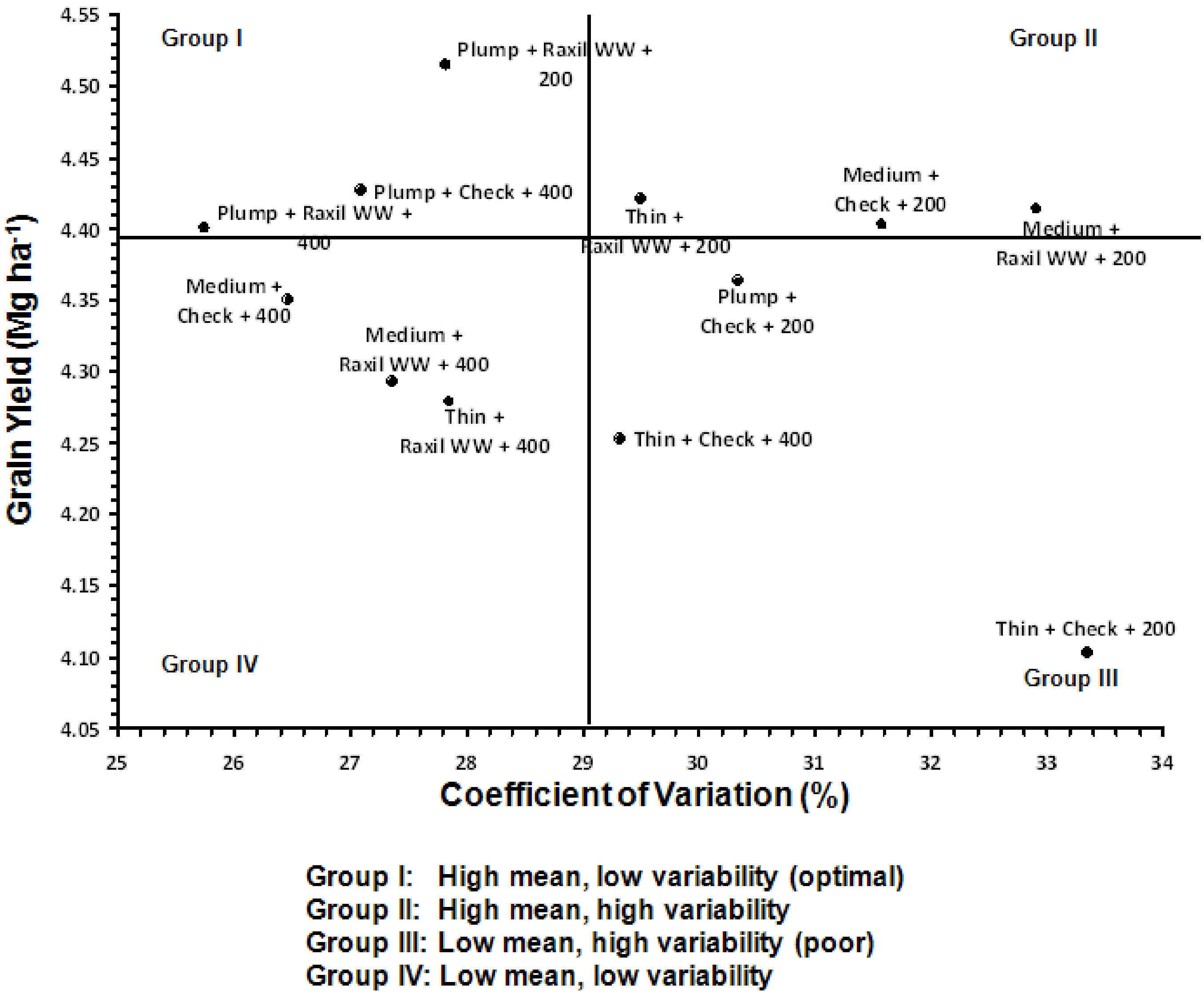

Fig. 9. Biplot of grain yield vs. coefficient of variation for each treatment combination of seed size (Plump, thin, or medium), seed treatment (Raxil WW vs. no seed treatment) and seeding rate (200 seeds m^{-2} or 400 seeds m^{-2}).

Sub-activity 2.2 (Test 222)

Integration of microbial control strategies to manage the cereal leaf beetle in winter wheat.

The cereal leaf beetle is considered an emerging pest of cereals, including winter wheat in the prairies. It was reported east of Lethbridge in 2005, in the Swan River region of northwest Manitoba in 2009 and south of Edmonton in 2011. Current efforts as part of this winter wheat DIAP, include integration of microbial pesticide control strategies with an effective parasitoid insect biocontrol agent (a natural enemy). In 2010 and 2011, Dr. Héctor Cárcamo and his team conducted laboratory studies testing Botanigard, an insect killing fungus that is registered in green houses for a number of horticultural pests. Results from the lab suggest that this product is effective and may have low toxicity to the natural enemy. A field study completed in 2011 is being analyzed and will be repeated in 2012

Sub-activity 2.3 (Tests 223a and 223b)

Development of alogorithms using optical sensors to create yield potential models for integrated nutrient management.

The goal of this sub-activity is to develop an algorithm specific to the winter wheat grown in western Canada, which would be integrated into a Greenseeker optical sensor and used for precision in-crop fertility management. In 2010, experiments were initiated to develop a range of responses from western Canadian winter wheat cultivars. This fall, a second experiment has been initiated to validate the model created from the data collected this past season.

Sub-activity 2.4 (Tests 291 and 292)

Optimizing seed quality and net returns through enhanced N management strategies for milling and general purpose winter wheat production in the Canadian prairies.

We have now completed this study and are in the process of preparing manuscripts for this sub-activity. A preliminary report was circulated earlier this year and is available from myself or Jake Davidson. Since the release of the report, we have worked on nitrogen uptake by Radiant and CDC Ptarmigan, as well as the various controlled release products. In terms of nitrogen utilized that was added during planting or in-season, Radiant appears to be more efficient. However, CDC Ptarmigan was more efficient at scavenging to recover soil nitrogen (Fig.10). Nitrogen uptake tended to be greatest in spring broadcast or split-application situations, using Agrotain or Super U. However, the results are not likely to be much different from urea, but they are likely to be better than the recovery observed in the ESN plots. This is likely due to the slower release rate typically observed in ESN in the northern Great Plains (Fig. 11).

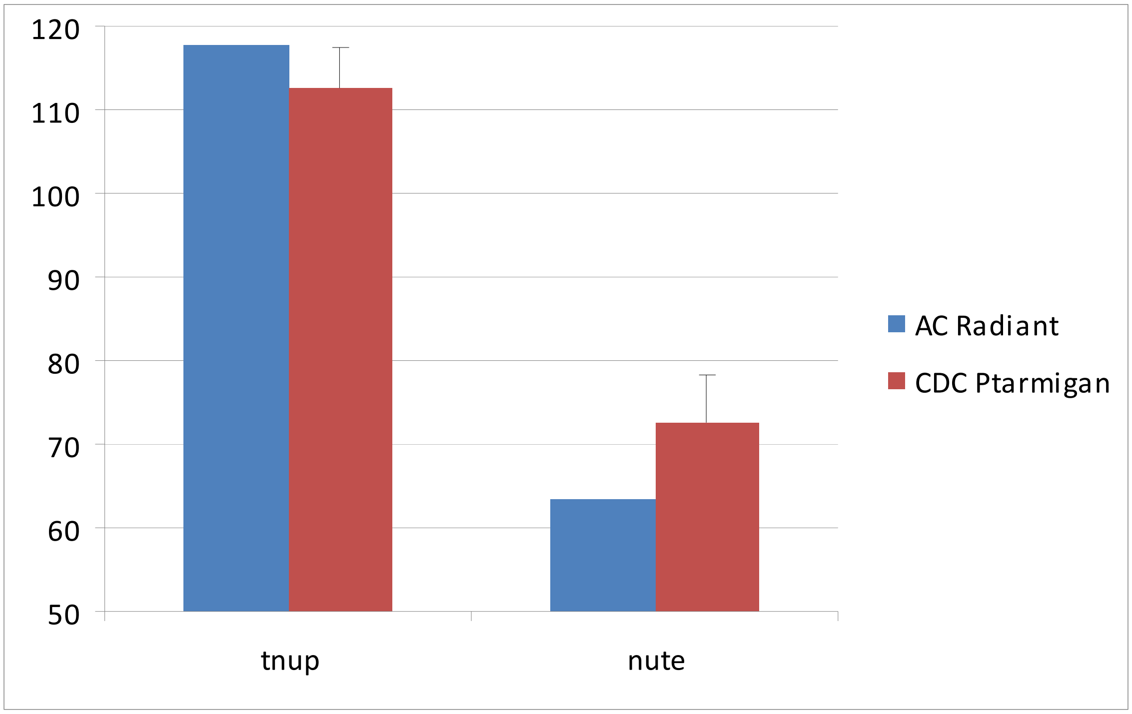

Fig. 10. Influence of cultivar on nitrogen recovery.

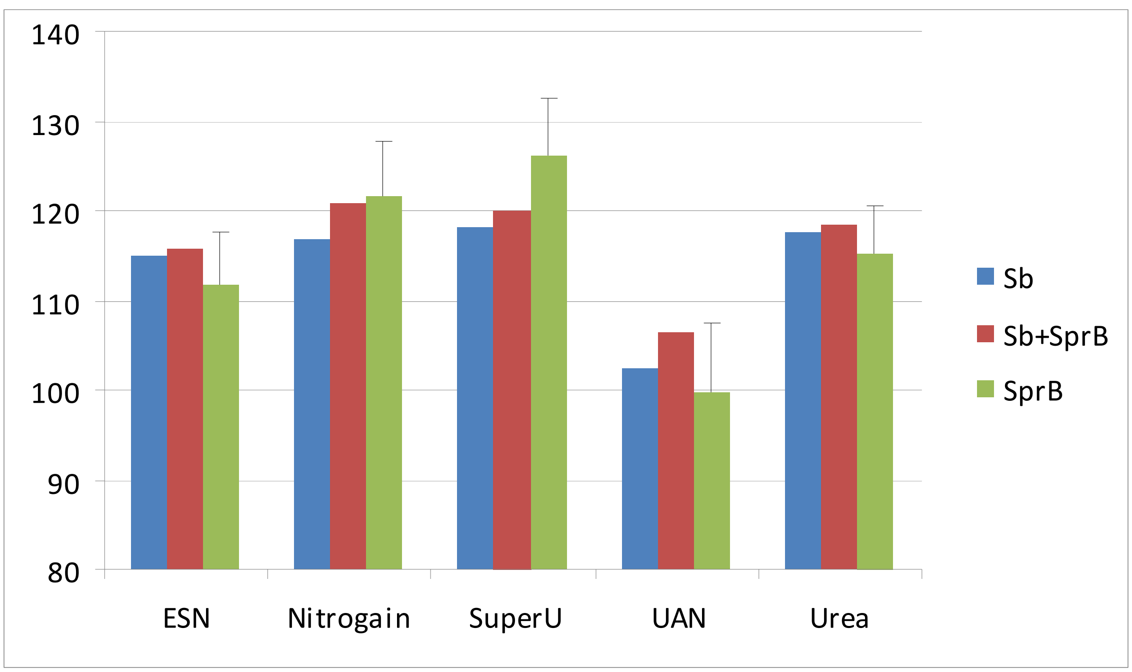

Fig. 11. Influence of nitrogen form and timing on total nitrogen uptake. Abbreviations: Sb, all sidebanded at seeding; Sb + SprB, ½ of product sidebanded at seeding, ½ applied in early spring; SprB, all nitrogen applied in early spring.

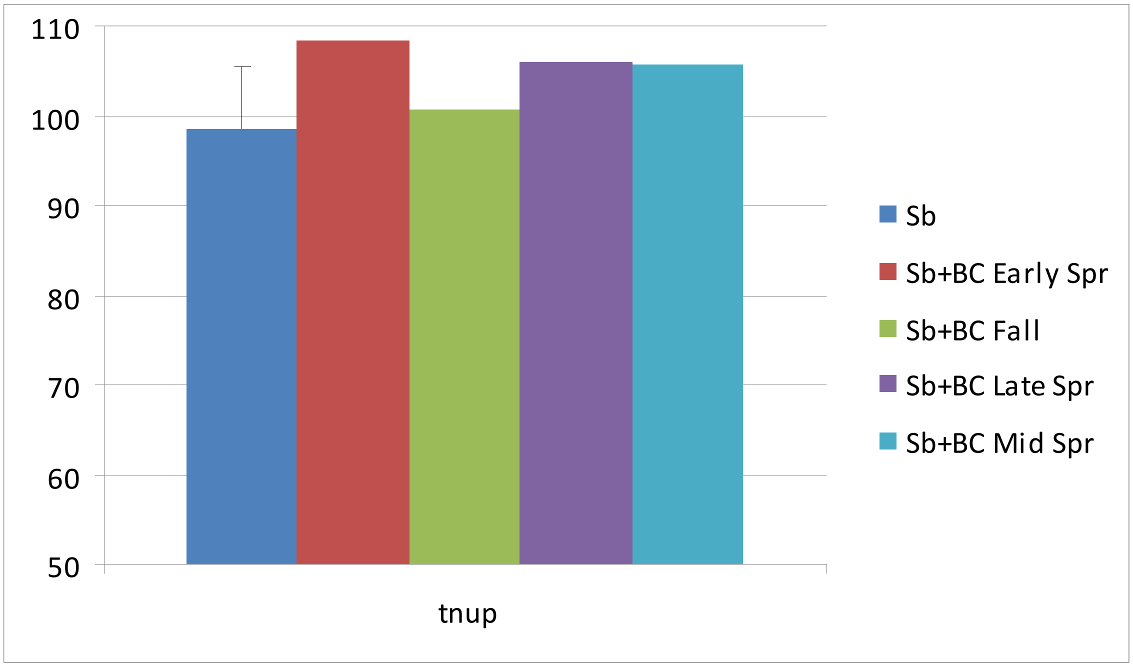

Fig. 12. Influence of timing on total nitrogen uptake. Abbreviations: Sb, all sidebanded at seeding; Sb + BC Early Spr, ½ of product sidebanded at seeding, ½ applied in early-spring; Sb + BC Fall, ½ of product sidebanded at seeding, ½ applied in late-fall; Sb + BC Late Spr, ½ of product sidebanded at seeding, ½ applied in late-spring; Sb + BC Mid Spr, ½ of product sidebanded at seeding, ½ applied in mid-spring.

In terms of timing, split applications when topdressing is performed in spring were most effective at nitrogen recovery over sidebanding all nitrogen at the time of seeding or topdressing later in the fall (Fig. 12).

Sub-activity 2.5 (Test 225)

The interaction of herbicide selection and timing of application on suppression of Japanese and downy brome in winter wheat.

Downy brome has resurged and a new species, Japanese brome, has become established in southern Alberta and has infested a great portion of the winter wheat acres. We were interested to see if winter wheat would respond tp timing (fall vs. spring applications) and product (Simplicity, Everest, or Velocity) interactions. Across all three sites in 2011, Simplicity and Everest provided the highest and similar efficacy ratings, which would fall into the category of 'suppression'. Control in the Velocity plots was not as good. Based on the data collected to date for timing, we would recommend that producers apply in spring as some of the Everest treatments applied in fall exhibited toxicity effects at the Lethbridge site.

Summary

It has been a very rewarding experience thus far working with Duck's Unlimited, Winter Cereals Canada, Winter Cereals Manitoba Inc, Saskatchewan Winter Cereals Development Committee, and the Alberta Winter Wheat Producer's Commission. I think we have created some momentum for interest in winter wheat production and have established a great synergy between the agronomy research community and the industry partners. I hope this momentum can carry forward for several more years!