Excess moisture effects on the growth & yield of Spring Wheat

Project Duration
2019-2021

Objectives
The current study was planned to see the effect of early and late flooding on four commonly grown wheat varieties in Manitoba. Plots were also grown under no flooding conditions as control for comparisons.

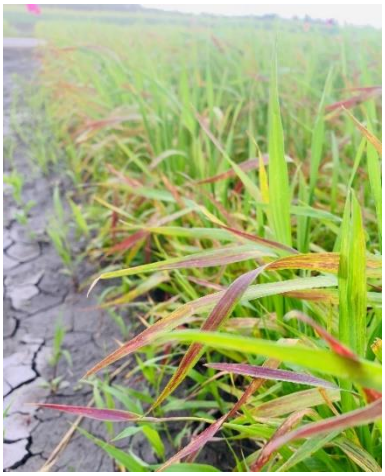
Collaborators
Canadian Agricultural Partnership funding
Curtis Cavers, AAFC Portage la Prairie

Results
Flooding influenced the days to maturity and yield of the wheat varieties tested at Arborg site (Table 1). Wheat plots flooded at early crop stage took more days to mature as compared to control wheat plots or plots flooded at later crop stage. However, lower yield was recorded in early and late flooding plots as compared to no flooding plots. Grain protein content was relatively lower when the plots were flooded at later crop stage. Varieties also differed in grain protein & AAC Cameron had less protein content (Table 2). Flooding did not have any effect on crop lodging.

Table 1. Effect of flooding on wheat growth and grain yield at Arborg site.

Treatment	Plant Stand (plants/1m row)	Days to Maturity	Lodging (1-5 Scale)	Yield (bu/acre)	Protein content (%)
Early Flooding	48.9	101.2b	1.15	42.7a	13.99b
Late Flooding	49.2	85.0a	1.10	73.1b	12.35a
No Flooding	52.8	85.5a	1.15	84.5c	14.57b
Significant Diff	**No**	**Yes**	**No**	**Yes**	**Yes**
P	**0.06**	**<0.0001**	**0.87**	**<0.0001**	**<0.0001**
CV%	**8.5**	**2.2**	**10.0**	**7.4**	**5.7**

The variety – flooding interaction was significant (p = 0.023) in the current evaluation (Fig 1). In general, all wheat varieties produced greater yield when grown under no flooding conditions. Variety AAC Brandon suffered yield loss (12.6 bushels/acre) when the plots of this variety were flooded at later crop stage. There was no yield reduction in other three varieties tested, when late flooding stress was imposed.



All wheat varieties suffered significant yield loss when their plots were flooded at early crop (2-3 leaf) stage. Wheat variety AAC Cameron, however, suffered comparatively less yield reduction as compared to other three varieties.

Table 2. Grain protein comparisons among tested wheat varieties.

Variety	Cardale	AAC Viewfield	AAC Brandon	AAC Cameron
Protein (%)	14.2a	14.0a	13.8a	12.5b
Significant difference	Yes			

Project Findings

Continuous flooding at 2-3 leaf stage delayed wheat maturity and exhibited significant yield loss. Flooding at later crop stage did not have any effect on maturity, although it also reduced yield. Flooding at early crop stage produced nutrient deficiency symptoms in tested wheat varieties. Nutrient deficiency symptoms, however, were not so evident in plots of variety AAC Cameron. This might be a reason why this variety did not suffer yield loss up to the extent as seen in other three wheat varieties. These tests will be repeated next year again.

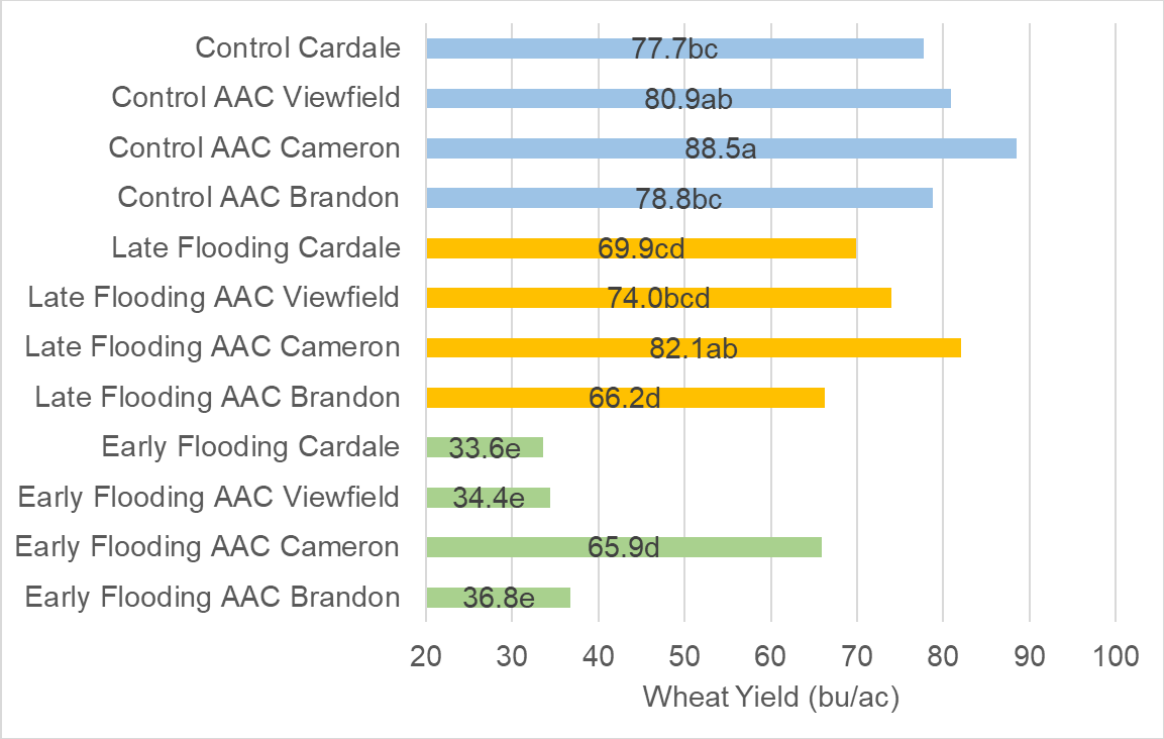


Fig 1. Variety-Flooding interaction results from the 2020 Arborg test.

Background/References/Additional Resources

Wet soils cause an oxygen deficiency and reduction in nutrient uptake. Early flooding can significantly reduced tillering, plant height, delayed head emergence significantly affecting the grain yield. Excessive soil moisture also delays agronomic operations. The impact of these losses on farm net income is significant. During 1966-2015, excess moisture accounted for 38% of all crop losses in Manitoba (MASC).

Manitoba crop insurance data from 1965-1972 showed clay soils subjected to excess moisture in July experienced the highest yield loss (2-6 bu/ac/day) for barley, oats, wheat and flax crops (Rigaux and Singh,1977).

Additionally, farmers experience loss of nutrients due to extreme moisture as well as loss of soil. Excess water conditions may impact the ability of a plant to take up inorganic nutrients due to the effects on processes associated with solute movement across membranes (Barrett-Lennard 2003). Uptake of essential nutrients such as N, P, and K takes place against gradients of chemical and electrical potential, which requires energy inputs from aerobic respiration; respiration is inhibited under anaerobic conditions making nutrient uptake energetically

unfavorable (Greenway and Gibbs 2003). For example, Huang et al. (1995) reported reduced concentrations of N, P, K, Mg, and Zn in wheat shoots under waterlogged conditions (and an increased concentration of these same elements in the wheat roots).

Barrett-Lennard, E. G. 2003. The interaction between waterlogging and salinity in higher plants: causes, consequences and implications. Plant Soil 253: 35-54.

Greenway, H. and Gibbs, J. 2003. Mechanisms of anoxia tolerance in plants. II. Energy requirements for maintenance and energy distribution to essential processes. Func. Plant Biol. 30: 999-1036.

Huang, B. R., Johnson, J. W., Nesmith, D. S. and Bridges, D.C. 1995. Nutrient accumulation and distribution of wheat genotypes in response to waterlogging and nutrient supply. Plant Soil 173: 47-54.

Rigaux, L. R. and Singh, R. H. Benefit-cost evaluation of improved levels of agricultural drainage in Manitoba, Volume 1-3, Research Bulletin No. 77-1, Department of Agricultural Economics and Farm Management, University of Manitoba, June 1977.

Materials & Methods

Experimental Design – Replicated block design with three replications
Treatments – Four wheat varieties were grown in flooded (early- and late-crop stage) and non-flooded set ups. Early flooding plots were flooded between June 20-July 4 and a total of 5 inches of flooding was applied in addition to natural precipitation. Flooding was started, when the wheat crop was at 2-3 leaf stage.
Flooding was started in late-flooded plots on July 8, when the crop was at soft dough stage. Flooding continued until July 29 and a total of 7.5 inches of flooding was applied in addition to natural rainfall.
Varieties –AAC Brandon, AAC Cameron, AAC Viewfield and Cardale
Plot size – 9.12m^2
Data collected – Plant stand, days to maturity, lodging, grain yield

Agronomic information
Stubble, soil type – Fallow, Heavy clay
Fertilizer applied – Early/Late flooding sets: N-55: P-25 (lbs/acre)
Control set: N-43: P-15 (lbs/acre)
Pesticides applied – Axial @ 0.5lit/acre + Buctril @ 0.4lit/acre
(only late flooding & control sets on June 30)
Coragen @ 50ml/acre for grasshoppers on July 17
Coragen @100ml/acre for grasshoppers on Aug 11 (only control set)
Seeding/Harvesting date – June 02/ Sep 11