WHEAT

MANITOBA CROP ALLIANCE

MAXIMIZING SPRING WHEAT PRODUCTIVITY: GRAIN NITROGEN, GRAIN PROTEIN AND NITROGEN USE

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KEY POINTS

- Split nitrogen (N) application increased grain protein content compared to N applied entirely at planting.
- To reduce risk of low N uptake post-flowering due to dry conditions, farmers may consider management practices that promote early season N uptake, but they should be mindful of the risk of N loss associated with applying high rates of N fertilizer as urea prior to or at planting.
- In the black soil zone of Manitoba, a larger portion of N was taken up post-flowering compared to other dryland spring wheat areas of the Canadian Prairies.

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BACKGROUND

- Large amounts of N fertilizer are required to meet the milling market protein standards in spring wheat.
- To maximize N uptake and utilization, it is important to understand the patterns of crop N uptake and N use in high-yielding cultivars.
- The objective of this research was to study how agronomic management practices influence grain N, grain protein and N use in spring wheat, as well as the influence of N uptake and remobilization patterns on these traits.

TERMS TO KNOW

Grain nitrogen use efficiency: the amount of N available to the crop that is used to produce grain N. Grain N use efficiency is the product of nitrogen uptake efficiency (per cent of N available to the crop from the soil and fertilizer that was taken up by the plant) and nitrogen utilization efficiency (per cent of N taken up by the plant that is used for grain N).

Nitrogen remobilization: the movement of N from vegetative tissue to the developing grain to support grain N production during the post-flowering period. Measured by the difference between N content in vegetative parts of the plant at flowering compared to at maturity.

Nitrogen remobilization efficiency: a measure of the amount of N that has been remobilized from vegetative tissue to the developing grain during the post-flowering period, relative to the total amount of N that was in the vegetative tissue at flowering. This represents the ability of the plant to "re-use" N from vegetative parts of the plant.

MATERIALS AND METHODS

- Field experiments were carried out in Carman and Manitou, MB, in 2018 and 2019.
- Evaluated three spring wheat cultivars, five N management strategies and the application of a plant growth regulator (PGR) (Table 1).

Cultivar			
	Wheat Class†	*Lodging Rating*	
AAC Brandon	CWRS	VG	
AAC Cameron	CWRS	G	
Prosper	CNHR	G	
N Management			
	Total N Rate	*App. Timing*	*N Source*
Check	0		
Reduced Rate	70 lb N acre^{-1}	Seeding	Urea
Standard	140 lb N acre^{-1}	Seeding	Urea
ESN Blend	100 + 40 lb N acre^{-1}	Seeding	ESN + Urea
Split App.	70 + 70 lb N acre^{-1}	Seeding + Flag Leaf	Urea + SuperU™
PGR			
	Product	*App. Timing*	*Rate*
Untreated			
Treated	Manipulator™	Stem Elongation§	0.7 acre^{-1}

† Canadian wheat classification. CWRS: Canadian Western Red Spring, CNHR: Canadian Northern Hard Red.
§ Zadoks growth stage 31, first node detectable and one cm above tillering node.

Table 1. List of treatments included in split-split plot experiment with a main plot of cultivar, sub-plot of nitrogen (N) management and sub-sub plot of the application of the plant growth regulator (PGR) Manipulator™ (chlormequat chloride).

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RESULTS

- Split N application significantly increased grain protein content and post-flowering N uptake, but only when late-season precipitation occurred (Figure 1, Figure 2).
- When high rates of N were applied (standard, ESN blend or split application), only 60 per cent of the N available to the crop was used for grain N production (Figure 3).
- 80 per cent of leaf tissue N and 70 per cent of stem tissue N that had accumulated by flowering was remobilized to the grain during grain fill.
- 21-36 per cent of total growing season N was taken up after flowering, but was highly dependent on environmental conditions.

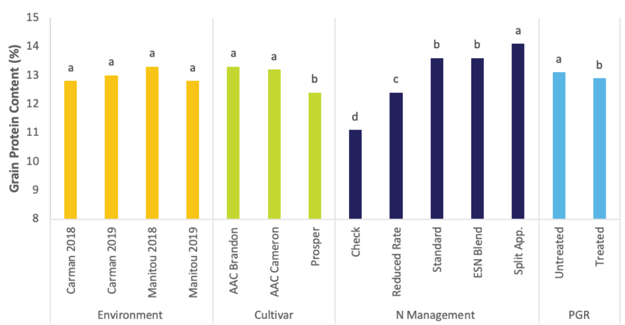

Figure 1: Mean grain protein content across environments, cultivars, N management strategies (Check = 0 lb N/ac, Reduced rate = 70 lb N/ac urea, Standard = 140 lb N/ac urea, ESN blend = 100 lb N/ac ESN with 40 lb N/ac urea, Split app = 70 lb N/ac urea with 70 lb N/ac SuperU™) and application of the PGR chlormequat chloride (Manipulator™). Means with the same letter are not significantly different.

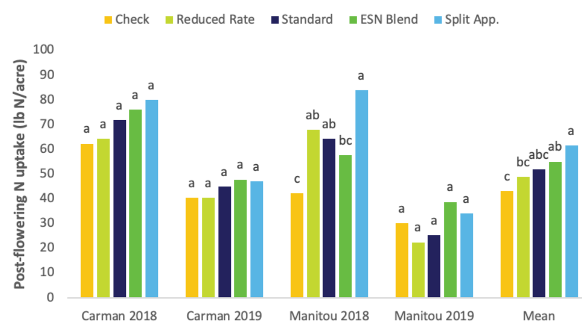

Figure 2: N uptake after flowering across site years, as influenced by nitrogen management (Check = 0 lb N/ac, Reduced rate = 70 lb N/ac urea, Standard = 140 lb N/ac urea, ESN blend = 100 lb N/ac ESN with 40 lb N/ac urea, Split app = 70 lb N/ac urea with 70 lb N/ac SuperU™). Within site years, means with the same letter are not significantly different. (Note: dry conditions were present during this study. Only the Manitou site in 2018 received consistent precipitation during the grain fill period).

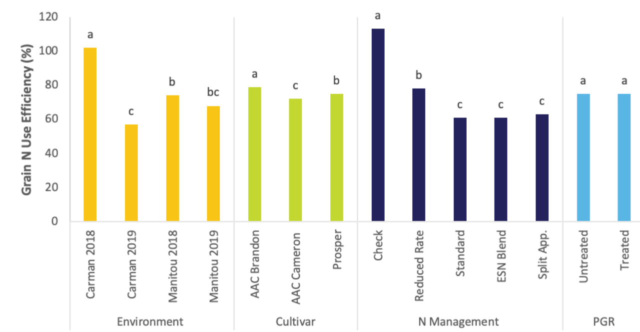

Figure 3: Mean grain N use efficiency for environments, cultivars, N management strategies (Check = 0 lb N/ac, Reduced rate = 70 lb N/ac urea, Standard = 140 lb N/ac urea, ESN blend = 100 lb N/ac ESN with 40 lb N/ac urea, Split app = 70 lb N/ac urea with 70 lb N/ac SuperU™) and application of the PGR chlormequat chloride (Manipulator™). Means with the same letter are not significantly different..

LEARN MORE

This project also studied yield and lodging risk. For more information, view our factsheet titled "Maximizing spring wheat productivity: Yield, yield components and lodging risk."

This research has been published in a peer-reviewed journal, available here:

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