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Nitrogen management strategies for spring wheat

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Under relatively dry conditions of this study, grain yield was not influenced by rate, source or timing. Split application of N resulted in higher grain protein. The application of a PGR increased grain yield but resulted in lower grain protein. When high N rates were applied, average N use efficiency, for grain N production, was 60%.

New, high yielding spring wheat varieties require nitrogen (N) fertility programs that can deliver upwards of 200 lbs N/ac (224 kg/ha) to ensure yield is maximized and high protein levels are achieved on the eastern Prairies. Understanding crop N uptake and N use efficiency under intensive management practices can help to guide agronomic management.

The first objective of this study was to determine N uptake, accumulation, and remobilization patterns in spring wheat, and how these patterns are influenced by agronomic practices such as N management and PGR application. The second was to measure the N use efficiencies for grain N production and potential for improvement through agronomic management.

Field trials were conducted at the University of Manitoba Ian N. Morrison Research Farm in Carman, MB, and in a commercial field near Manitou, Manitoba in 2018 and 2019 for a total of 4 site years.

AAC Brandon (CWRS), AAC Cameron (CWRS), and Prosper (CNHR) were compared. AAC Brandon has high yield potential, high protein and very good lodging resistance. AAC Cameron is a tall variety with good lodging resistance and high yield and protein. Prosper has high yield but lower protein content and lodging resistance rated as good.

Soil was sampled at 0-6, 6-24, and 24-48 inches (0-to-15-, 15-to-60-, and 60-to-120-cm) depths for residual soil nutrient analysis in the spring before planting.

Seed-placed phosphorus (P) was applied as mono-ammonium phosphate (11–52–0) at a rate of 40 lbs P_2O_5/ac (45 kg P_2O_5/ha) for all plots. Herbicides and fungicides were applied as necessary.

In addition to the check plot with 0 N fertilizer application, a standard rate of 140 lbs N/ac (156 kg N/ha) and a reduced rate of 70 lbs N/ac (78 kg N/ha) were applied as conventional urea, midrow banded at planting. A blend of ESN, a polymer-coated urea and conventional urea at rates of 100 lbs N/ac as ESN plus 40 lbs N/ac as urea (112 kg N/ha:44 kg N/ha) was applied through midrow banders at planting to evaluate N source. To evaluate application timing, a split application of 70 lbs N/ac was applied as conventional urea through midrow banders at planting with the remaining 70 lbs N/ac applied broadcast on the soil surface as SuperU at flag leaf.

All combinations of varieties and N treatments were compared with and without a PGR, Manipulator 620 (chlormequat chloride), applied at the onset of stem elongation (GS 31).

Dry conditions influenced protein and yield responses

Nitrogen management strategies of rate, source and timing did not differ statistically, and yields were roughly around 75 bu/ac (5000 kg/ha). The 0 N check was statistically lower at 60 bu/ac (4032 kg/ha). Yields during the two years were lower than normal due to dry conditions with precipitation at 68 to 78% of the long term average. This may explain why the reduced N rate was statistically similar to the standard N rate applications, especially since spring nitrate-N values ranged from 63 to 80 lbs/ac (71 to 90 kg/ha) in the 0-48 inch soil profile.

There were differences in grain protein content as influenced by N treatments. The statistically highest average grain protein content was with the split application at 14.1%. The standard and ESN blend treatments were statistically similar at 13.6%, and were statistically higher than the reduced rate of 12.4%, which was statistically higher than the check at 11.1%.

The application of a PGR significantly increased grain yield from 71 to 72 bu/ac (4746 kg/ha to 4837 kg/ha), although, agronomically, this small increase would be insignificant. This increase in yield, however, resulted in a significant decrease in grain protein content from 13.1% in the untreated to 12.9% with a PGR application.

Environment influenced N uptake, efficiency and remobilization

At standard high rates of N, the average N uptake efficiency was 80% and the N use efficiency was also 80%. This resulted in the final grain N use efficiency of approximately 60%.

Under the conditions of this trial, this shows that only 60% of the N available to the crop (excluding mineralized N) is being used for grain N production during the growing season. Most of the remaining N was probably left in the crop residues and soils.

Nitrogen uptake post anthesis was 21–36% of the total growing season N taken up, but this post anthesis uptake was highly dependent on environmental conditions.

Remobilization of N from leaf and stem tissue into grain fill was 80% from leaf and 70% from stem tissue. However, when high levels of N were taken up post anthesis by the plant, N remobilization from stem tissue was reduced.

There were differences in N uptake between varieties. AAC Brandon took up more total N after anthesis. Prosper accumulated more early-season N, and had a higher N remobilization from stem and tissue during grain fill. This difference provides an opportunity for plant breeders to target N uptake patterns suited to different growing areas of the Prairies.

Overall, N management and PGR applications had little impact on N remobilization during grain fill. As a result, pre-seed or side-band application of N fertilizer at seeding remain the most efficient methods to manage N fertility in the Black soil zone of the eastern Prairies, and producers should focus on management practices that promote early season N uptake. Even though post anthesis N uptake can be high under good environmental conditions, ensuring adequate early season N fertility will help to ensure adequate N remobilization can occur to produce adequate grain N during drier years.

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