Fertilizer BMPs for the Northern Great Plains — How Do You Measure Up?

By Adrian Johnston

Farmers in the Northern Great Plains have implemented soil conservation practices to a degree that exceeds any other resource conservation activity in North America. Erosion has been reduced and moisture conservation and soils improved, increasing yields and whole farm economics. Now fertilizer best management practices (BMPs) need evaluation.

The main science-based tool we have to make estimates of soil nutrient supply on agricultural lands in the Northern Great Plains is soil testing. The soil testing process is based on soil samples being taken from representative areas in a field, analyzed using a chemical extraction appropriate for the soils in the region, and either correlated with plant nutrient uptake or calibrated with crop yield (Karamanos, 2003). Resulting fertilizer recommendations would be based on how a particular crop responded to a nutrient, using the average response from a multi-year and multi-site data set.

In semiarid agriculture, water is one of the major driving variables in crop yields. Nutrients also play an important role in improving the use of water by crops by increasing the amount of yield per unit of water used (Zentner et al., 2002). As a result, a field-specific yield goal is determined based on available soil moisture at seeding, precipitation probabilities for the region, crop water use, and soil residual nutrient levels. For nitrogen (N) specifically, the result is a minimum fertilizer recommendation followed by in-season crop monitoring at critical growth stages based on plant density, tiller formation, and spikelets per head. If yield estimates indicate a larger yield than fertilized for originally, additional N can be top-dressed before the crop becomes too advanced.

For phosphorus (P) and potassium (K), the year-to-year variation in plant-available soil supply is minor, and annual application based on a balance between soil test levels and crop requirements can avoid depletion or over-application.

Soil testing and use of crop nutrient uptake and removal information are important guides to ensuring that balance among soil-available nutrients plus applied fertilizer prevents nutrient deficiencies from limiting crop yields or some nutrients from being used inefficiently. An example of proper nutrient balance is illustrated in a winter wheat study conducted in Manitoba (**Table 1**). Soil testing indicated a deficiency of both N and P at this site. The P fertilizer was seed row-applied at planting, and the N spring broadcast as ammonium nitrate (NH_4NO_3) immediately prior to crop growth and N uptake. While application of N alone increased yields more than P alone, it was the balance of N + P that optimized the crop response. To maximize yields using the highest rate of N, the highest rate of P was also required. Similar examples

Table 1. Winter wheat response to fertilizer N and P application in Manitoba.

P_2O_5 rate, lb/A	N rate, lb/A		
	0	110	N efficiency
	-- Grain yield, bu/A --		lb grain/lb N
0	15	48	26.2
20	17	55	30.0
40	20	65	35.5

Source: Grant et al. 1985. Can. J. Soil Sci. 65: 621-628.

Table 2. Barley yield response to tillage and fertilizer urea placement.

	Conventional tillage	Zero tillage
	--- Grain yield, bu/A ---	
Broadcast, 65 lb N/A	62	45
Band, 65 lb N/A	64	65

Source: Malhi and Nyborg. 1992. Soil Tillage Res. 23: 193-197.

can be shown with N and sulfur (S) on canola.

Deep banding of fertilizer N is a very important BMP, widely used in the region. It has been shown to reduce per-unit production costs by increasing fertilizer efficiency. Seeding system also plays an important role on the impact of fertilizer placement. When incorporated with tillage, barley showed a similar response to broadcast and in-soil band application (**Table 2**). However, when the broadcast urea was applied on the residue-covered surface of a zero tillage field and not incorporated, grain yield was reduced by 31% relative to an in-soil band.

A project on heavy clay soils in Manitoba found that fall N application timing had less of an impact on crop yield response in upland landscape positions than lowland areas. Even though all of the urea N treatments were banded in this study, delaying the N application timing improved the crop response with the wetter soil conditions in the lowland areas of the field.

Crops grown with proper nutrition are also playing a major role in building soil organic matter. Increased crop residue production leads to increased residue incorporation to build soil organic matter levels. In long-term rotation studies across the semiarid region of western Canada, moderate applications of N and P fertilizer have been shown to increase surface soil organic matter content (**Table 3**).

In many instances where no-till field management has been adopted, soil erosion and water runoff have been significantly reduced. In Quebec, an on-farm program using forage buffer strips adjacent to surface water bodies found that total runoff of water was reduced by 48%, soil particles in the water were reduced by 90%, and nutrient losses were reduced by 69% for total N and 86% for total P.

Table 3. Influence of fertilization on the average organic C and total N concentration in surface soils from long-term continuous wheat rotations on the Canadian Prairies.

Location	Fertilizer	Organic C, %	Total N, %
Swift Current (Brown soils)	P	1.78	0.197
	N + P	2.15	0.226
Lethbridge (Dark Brown soils)	None	1.62	0.149
	N + P	1.88	0.171
Indian Head (Black soils)	None	2.48	0.198
	N + P	2.59	0.223

Sources: Biederbeck et al. 1984. Can. J. Soil Sci. 64: 355-367.
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Many farmers in the Northern Great Plains have demonstrated a rapid adoption of fertilizer BMPs. Soil testing, realistic yield goals based on available water, balanced fertilizer application, in-soil banding of fertilizer at seeding, and use of no-till seeding systems all demonstrate excellent progress. Continued evaluation of new fertilizer management practices is critical. BC

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To view a chart listing fertilizer BMPs for this region, plus additional information and references, visit the PPI website: ***>www.ppi-ppic.org<.***

References

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