ALBERTA

Soil Testing Methods Calibrated to Phosphate Fertilizer Trials

By R. H. McKenzie and Len Kryzanowski

Extensive P fertilizer calibration trials were conducted in Alberta in response to concern about the accuracy of P soil test methods. Replicated trials with wheat, barley and canola were conducted on major soil types across Alberta from 1991 to 1993. Response data were collected from 427 sites. Based on a minimum two bushel yield difference between the control and the P treatments, 81 percent of wheat sites, 90 percent of barley sites and 72 percent of canola sites responded to P fertilization.

A recent study has clearly demonstrated the need for phosphorus (P) fertilizer in Alberta, suggesting 50 to 80 percent of the soils in the province are marginally to severely deficient in P. It has also provided valuable calibration information for several P soil tests which are in use across Western Canada.

The purpose of our study was to improve P fertilizer recommendations in the province and other areas of the prairies. Several P soil test methods currently in use in western Canada were evaluated for their ability to predict wheat and barley response to seed-placed P and canola response to seed-placed and banded P. Some of these are listed in **Table 1**. The Miller-Axley was the standard method used in Alberta and the Olsen test was routinely used in Saskatchewan and Manitoba. The Kelowna and modifications of this method (i.e. Norwest and Saskatchewan) were developed in recent years because the Miller-Axley and Olsen tests did not appear to work effectively across a wide range of soils.

Several mathematical models were tested to correlate relative yield (control yield divided by the highest yielding P treatment) with extractable P based on the different soil test methods. **Figure 1** gives an example of the model that proved the most successful using wheat data versus the Kelowna P test. Curves were fitted for each crop, each soil zone and for each soil test method.

TABLE 1. Soil test P methods evaluated in P calibration trials in Alberta.

Method	Extractant
Miller and Axley	ammonium fluoride and sulfuric acid (0.03N NH_4F + 0.03N H_2SO_4)
Olsen	sodium bicarbonate (0.5M $NaHCO_3$)
Kelowna	acetic acid and ammonium fluoride (0.25N HOAc + 0.015N NH_4F)
Norwest	acetic acid, ammonium fluoride and ammonium acetate (0.5N HOAc + 0.015N NH_4F + 1.0N NH_4Oac)
Saskatchewan	acetic acid, ammonium fluoride and ammonium acetate (0.25N HOAc + 0.015N NH_4F + 0.25N NH_4Oac)

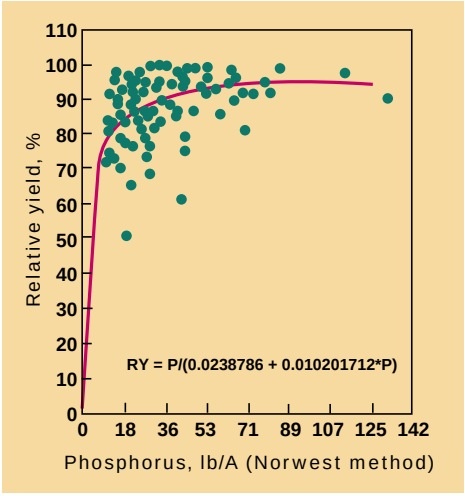

FIGURE 1. Correlation of relative wheat yield with soil test P using the Norwest method. (Alberta)

Figure 1 shows the relative yield for wheat did not reach 100 percent (i.e. no difference between the control and maximum yield) until the soil test P level was about 27 lb/A. However, even at that level, 90 percent of the sites still responded to applied P. Whenever soil test P was 18 lb/A or less, almost all sites had relative yields less than 100 percent. As soil test P levels increased, the frequency of 100 percent relative yield also increased. However, even at soil test levels greater than 53 lb/A there were still sites that did not reach 100 percent relative yield and were still responsive to added P fertilizer.

The frequency of P response in wheat at all sites and its relationship to soil test P by the various methods are illustrated in **Figure 2**. The methods differed in their ability to predict P response, most notably at the lowest soil test level. The three methods which use ammonium fluoride and acetic acid in their extracting solutions successfully predicted 100 percent P response when soil P was between 0 and 9 lb/A. The other two methods did not perform as well. They correctly predicted a response in only 40 to 60 percent of the sites at this lowest soil test level. This is not surprising as soil characteristics (e.g. pH and carbonates) can vary widely over the province, which would limit the effectiveness of some extraction methods.

The Norwest method is the most commonly used in Alberta. About 88 percent of all wheat (128 of 144 sites), barley (140 of 159 sites) and canola (110 of 125) sites tested less than 53 lb/A (0 - 6 inch) using this method. And, a significant number of sites testing high in available P (i.e. > 53 lb/A) had a relative yield less than 100

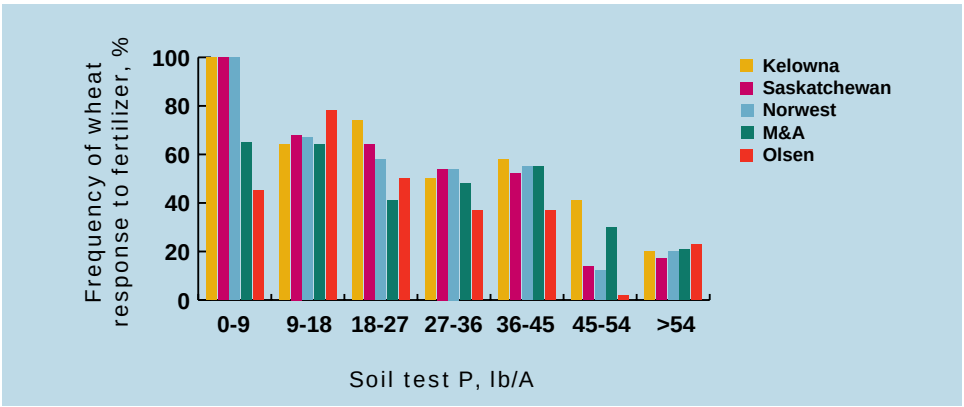

FIGURE 2. Frequency of wheat response to P fertilizer at various soil test levels as determined by several methods. (Alberta)

TABLE 2. Phosphorus fertilizer recommendations for spring wheat on a medium to fine textured soil with a neutral pH based on the Kelowna method.

Soil test P, lb/A 0 to 6 inches	P_2O_5 recommended, lb/A					
	Brown Soil Zone			Black Soil Zone		
	D	M	W	D	M	W
0 - 9	27	31	36	36	40	45
9 - 18	22	27	31	31	36	40
18 - 27	18	22	27	27	31	36
27 - 36	13	18	22	22	27	31
36 - 45	13	13	18	22	22	27
45 - 54	13	13	18	18	18	27
54 - 62	13	13	13	13	13	22
62 - 71	0	13	13	0	13	18
71 - 80	0	0	13	0	0	13
> 80	0	0	0	0	0	0

Seedbed moisture conditions at planting: dry (D) = 25%, medium (M) = 50% and wet (W) = 75% of field capacity.

percent, indicating that response to added P had occurred. In fact, 60 percent of the wheat and canola sites, and 70 percent of the barley sites indicated some response to applied P when the soil test method was greater than 53 lb/A. This was based on a two bushel yield increase above the control. However, based on a statistical response ($P>0.05$), only 20 percent of wheat sites, 30 percent of barley sites and 15 percent of canola responded to P fertilization at this high soil test level.

We also evaluated the effects of soil pH, organic matter and soil texture on the various extraction methods. In some cases there was a clear separation of responsive sites for acidic, neutral and alkaline soils, particularly for the Miller-Axley P test. Soil pH was not a factor for the Kelowna or modified Kelowna methods. Characterizing the data by soil texture and organic matter had slight effect, but not as great as that found for pH.

This calibration study enabled us to revise the P fertilizer recommendation for the province based on: major soil zone (i.e. Brown, Dark Brown, Thin Black, Black, Gray Wooded and Irrigated), soil texture (medium to fine and coarse), pH (acidic, neutral and alkaline) and seedbed moisture at the time of planting (dry, moist and wet). **Table 2** gives an example of the P recommendations for wheat grown in the Brown and Black soil zones based on the Kelowna P method.

Characterizing these new recommendations by soil zone, pH, texture and seedbed moisture helps make them applicable to Saskatchewan, Manitoba and other areas of the Northern Great Plains with similar type soils. More detailed tables have been provided to soil test laboratories working in the region which include recommendations for each P soil test method. BC

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