Nitrogen and Phosphorus Fertilizer Management of No-Till Flax

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Flax was grown on 1.7 million acres in Canada in 2001, of which 97% was in the western Prairie Provinces. A major shift in seeding practices is also occurring in Canada. In 2001, 59% of the total land prepared for seeding used either a no-till seeding system or a seeding system where most of the crop residues were left on the soil surface. Flax has been shown to respond well agronomically and economically to these new conservation tillage seeding systems over a wide range of growing conditions.

> Flax response to fertilizer phosphorus (P) additions are highly variable, supporting the importance of maintaining medium to high soil P levels to optimize flax yields. Combined nitrogen (N) and P fertilizer placement as a side band when seeding flax was found to be a viable option.

The response of flax to N has been well established, as has the sensitivity of crop emergence and seed yield to seed-placed N. Flax is less sensitive to seed placed monoammonium phosphate (MAP) than N fertilizer and the recommendation of 18 lb P_2O_5/A has been established for a double disc opener on 6 in. row spacing. These allowable rates would meet the P requirements of flax in the majority of cases and at the same time not jeopardize crop emergence.

Maintaining soil P in the medium to optimum range is the best way to assure adequate supply for high yields of flax.

An important issue concerning flax and P fertilizer is the general lack of response to seed-placed applications and the improved response when fertilizer is placed either directly below the seed or below and to the side of the seed in a band. This response of flax to P placement has been reported when the soil is very low in P. Absence of fertilizer P responses on soils with higher P levels suggests that flax benefits from management practices that maintain medium to high soil test P levels.

The objective of this study was to determine the combination of N fertilizer form, and N and P fertilizer placement methods, that maximize flax P uptake, establishment, and yield using a no-till production system. The study was conducted over three years at four locations (12 site-years) across the thin-Black and Black soil zone (Haploborolls) of the western Canadian prairies. Except for the no P control, MAP was applied either seed-placed (Sp), side-banded (Sb) or preplant (Pp) banded using a uniform rate of 18 lb P_2O_5/A for all treatments. Seed was placed at a depth of 1 in. or less, and fertilizer placement depth was approximately 2 to 3 in. for the Pp band and Sb treatments. Three forms of N were evaluated: urea, ammonium nitrate (AN), and ammonium sulfate

TABLE 1. Effect of N and P fertilizer management on crop establishment, plant P uptake, and yield of flax (mean of three years at four locations).

Treatment N	Treatment P	Seedling stand, plants/yd²	P uptake, lb P/A 14 days	P uptake, lb P/A 28 days	P uptake, lb P/A Flowering	Grain yield, bu/A
Urea Pp[1]	Check	350	0.48	2.14	5.54	27.6
Urea Pp	Pp	359	0.51	2.20	6.06	28.2
Urea Pp	Sp	325	0.54	2.23	5.91	27.8
Urea Pp	Sb	343	0.58	2.32	6.27	28.1
Urea Sb	Sb	308	0.49	2.45	6.18	28.3
Urea (NBPT) Sb	Sb	322	0.57	2.49	6.47	28.8
AN Sb	Sb	362	0.61	2.65	6.35	28.8
AS Sb	Sb	356	0.64	2.63	6.53	28.5
AS Pp	Sb	352	0.56	2.47	6.24	28.0
	$LSD_{0.05}$	54	0.15	0.71	1.34	2.2

[1]Pp – preplant banded in the spring; Sb – side-banded at seeding; Sp – seed-placed; AN – ammonium nitrate; AS – ammonium sulfate; rates = 62 lb N/A, 18 lb P_2O_5/A.

(AS), each applied at a uniform rate of 62 lb N/A. The N was applied either as a Pp band or at seeding time in a Sb position. Urea treated with a urease inhibitor (NBPT) was also included as a treatment. Norlin, an early maturing, high yielding flax cultivar adapted to all areas of the study, was grown.

Flax emergence is very sensitive to seed-placed N and P fertilizer, and in this study some injury was observed with urea, even when it was in a Sb position (**Table 1**). Relative to the Pp placement, Sb placement resulted in an 11% reduction in flax establishment. The addition of NBPT to slow down the conversion of urea to ammonia did not improve plant stand when urea was Sb. The effects of AN and AS on crop establishment were less than for urea, but the lack of a N treatment response prevents us from determining if AN and AS reduced plant populations. The effect of Sb urea on crop establishment has also been observed by the authors on canola and spring wheat.

In only one instance, at 14 days after emergence, did adding P fertilizer significantly increase plant P uptake (**Table 1**). When AS and fertilizer P were blended together in a Sb position, P uptake was greater than for urea at the 14 day sampling time. Acidification of alkaline soils can release soil P, allowing for more P uptake by plants. When AS was Pp banded and the P Sb, early season P uptake was less than when AS and P were placed together in a Sb. However, no treatment effects were observed on P uptake by day 28 or at flowering. The lack of treatment differences is possibly due to dissipation, conversion, and overall greater root and plant growth, the end result being that the root system was capable of exploiting soil P. In this study, we found no difference in P uptake whether the P was Sp or Sb, except when N was present in the band with P, with the response varying with N form. The reason for the discrepancy is possibly due to the somewhat high recorded soil P levels in the soils in the study, possibly minimizing the differences between placement methods.

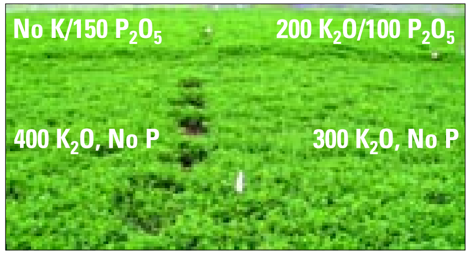
Although the soil residual P levels were relatively high for most site years, there was nonetheless a small seed yield response ($p = 0.062$) to fertilizer P addition. Yield increases were not necessarily related to low soil P, as the three sites where increases resulted tested 11, 23, and 15 parts per million (ppm) P (method: 0.03 M ammonium fluoride + 0.03 M sulfuric acid mixture). Variability in early season P uptake observed for various treatments did not translate into higher seed yields. These results support past research which has shown that unlike cereals, flax does not proliferate roots very well in a fertilizer P band. From emergence through to maturity, the crop tends to take up more P from the soil than from added fertilizer P. When the treatment effect

(continued on page 11)

ed K. Applying half the specified amount of K to meet the specific yield goals after the first harvest, and the remainder after the last harvest in the fall, will increase K fertilizer use efficiency.

Seasonal changes in alfalfa response to K application and soil K status also have implications for timing of soil sampling and interpretation of soil test values. Soil samples taken in spring may provide inflated estimates of soil test K concentrations. This could alter fertility management decisions by reducing K applications and subsequently placing the crop at risk of K-deficiency later in the growing season. Also, when comparing soil tests results obtained over a series of years, time of soil sampling must be considered. The most valid comparisons are those tests where the soil sampling is done the same month of each year. This practice would avoid season-induced changes in soil test K values that could be misleading, and provide a clearer indication of how management practices are influencing soil test K concentrations.

By using information on yield and K removal, we can arrive at the following fertilizer recommendations for alfalfa when soil test



Yield increases in May were primarily due to addition of P, whereas additional K supplied without P failed to promote greater alfalfa yield.

P and K are in the maintenance range: 14 lb P_2O_5/ton of dry hay removed/A and 60 lb K_2O/ton of hay removed/A (based on 0% hay moisture). By following these application guidelines, producers can replenish the amount of P and K removed from the soil. To increase soil test P and K levels, greater P or K applications would be required.

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Management of No-Till Flax...

(continued from page 7)

was determined for each site-year, we observed treatment differences in three of the 12 trials. In two of those years the treatments where N and P were placed in a Sb position gave the highest seed yields. When all sites are included, the trend was for better seed yields when N and P were placed in Sb position, although the differences were small in absolute terms (**Table 1**). The absence of a flax response to P fertilizer, when the crop takes up more than twice the P per unit of yield than spring wheat, is difficult to explain. It appears that the flax crop is capable of using residual soil P to meet growth and development requirements.

Based on the results of this study, we conclude that no-till flax growers have many N and P management options available. The current trend of adding all the crop's fertilizer requirements during the seeding operation, a one-pass seeding and fertilizing no-till system, may in some cases actually improve seed yields with no apparent negative effects on flax nutrient uptake or seed yield. Limited response of flax to fertilizer P applied at seeding supports the recommendation that maintaining soil P in the medium to optimum range provides the best means of ensuring adequate P supply for high yielding flax production.

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