

HOW TO GET THE **MOST OF P FERTILIZER IN ALFALFA STANDS**

S.S. Malhi and K. Heier

Agriculture and Agri-Food Canada, Lacombe, Alberta, Canada T4L 1 W1

ABSTRACT

Phosphorus (P) is relatively immobile in soil. Our previous research has shown that the majority of fertilizer P recovered in soil as extractable P remains in the top 5 cm layer, even after long-term annual applications of P to grass or alfalfa. This suggests that P fertilizer would be less effective when surface-broadcast. For this reason, placement of P fertilizer is very critical; that is, it must be located where roots can intercept it. A field experiment was initiated in 1992 on the existing alfalfa stands on a P-deficient Black Chernozem (Typic Boroll) soil at Ponoka, Alberta, Canada to compare the effects of surface-broadcasting versus subsurface banding (using a special disc drill) of annual and one-time initial applications of P on dry matter yield (DMY). The alfalfa was harvested for dry matter yield two times during growing seasons in 1992 to 1995. There was a marked increase in DMY from P applications in all the four years. Disc-banding at 15 cm spacing produced greater forage yield than surface-broadcasting, regardless whether P was applied annually (by **828** kg DMY/ha) or as single initial applications (by 565 kg DMY/ha). The P-use efficiency (averaged across P rates over a 4-year period) was greater with subsurface banding as compared to surface-broadcasting by 50 kg DMY/kg P/ha for annual applications and by 21 kg DMY/kg P/ha for single initial applications.

INTRODUCTION

Alfalfa is an important forage crop in Alberta and other Prairie Provinces. Many soils in Alberta contain insufficient amounts of plant-available P to obtain optimum crop production. Field experiments on alfalfa have shown increases in hay yield from P fertilization, depending on the extractable P level in soil

(Malhi et al. 1992a). Surface-broadcasting is the most convenient way to apply fertilizers to established forage stands. Because P is relatively immobile, surface-applied P fertilizer would remain near the surface (Malhi et al. 1992b). The objective of this study was to find if effectiveness of P fertilizer on forage yield of alfalfa can be increased by subsurface banding as compared to surface-broadcasting.

MATERIALS AND METHODS

A field experiment was initiated in 1992 on the existing alfalfa stands near Ponoka in central Alberta. The soil was a Black Chernozem, containing 1 mg extractable P/kg (Miller-Axley) and sandy loam texture. The experimental design was 4 x 2 x 2 factorial in a randomized complete block with four applications. There were two modes of application (annual and one-time initial), four rates of P (10, 20, 30 and 40 kg P/ha for annual, and 50, 100, 150 and 200 kg P/ha for one-time initial applications) and two methods of placements (surface-broadcast and subsurface banding). In addition, there was a check treatment without P fertilizer. The P fertilizer (triple superphosphate) was applied in early spring. In the "banding" application, the fertilizer was banded in rows 15 cm apart at about 5 cm depth, using a special disc drill. Each plot received a blanket application of K and S fertilizers. The plots were harvested for dry matter yield (DMY) two times during the growing seasons in 1992, 1993, 1994 and 1995 (i.e. early July and mid September).

RESULTS AND DISCUSSION

There was a substantial increase in DMY from P applications (Tables 1 and 2). The soil in the present experiment was very deficient in plant-available P, which resulted in marked yield response to applied P. Averaged across P rates, disc-banding had more DMY than surface-broadcasting in all four years for both annual and single initial P applications (Table 1). On the average, the DMY differences between the two methods of placement were much greater at lower P rates than at high P rates (Table 2). For single initial P applications,

there was no improvement in DMY from subsurface banding over surface-broadcasting at the 200 kg P/ha rate.

Research has shown that when P fertilizer is applied to the surface in established forage stands, it remains near the surface soil (Malhi et al. 1992b) and may not become fully available to roots for effective use. On the other hand, P fertilizer placed below the surface has been found more effective in increasing crop yield than surface-applied P for annual crops (Randall and Hoeft 1988) and on alfalfa (Sheard et al. **1971**; I Goos et al. 1984). In addition, subsurface banding reduces the contact between the P fertilizer and the soil, which could reduce the potential for conversion of fertilizer P to less soluble P compounds and/or P fixation in soil (Racz and Soper 1967), thus leaving more fertilizer P for crop uptake. Due to these reasons, it is possible that in the present study disc-banding produced greater forage yield than broadcast application, irrespective whether P was applied annually or as single initial applications.

In a field study in south-western Saskatchewan, Leyshon (1982) found reduction in forage yield from banding of granular P fertilizer in established alfalfa stands. He attributed this yield reduction to stand damage caused by the application process, because in his study a “hoe drill” type implement was used. In the present study, the P fertilizer was banded with a special coulter-type disc drill which apparently does not cause much disturbance to soil and plant roots, and also the study was conducted in a higher rainfall area than the study area of Leyshon (1982).

In other research by R.G. Simons, C.A. Grant and L.D. Bailey (unpublished results), there was no forage yield difference between band and broadcast applications of P fertilizer to established alfalfa stands on two Black Chernozem soils in western Manitoba. In that study, band application using a “double disc drill” reduced forage yield slightly compared to broadcast application on one soil. They attributed this to the banding operation causing damage to the superficial roots of alfalfa. In the Manitoba study, the forage yield increase from applied P was also relatively small.

CONCLUSIONS

Forage productivity can be increased by improving effectiveness of P fertilizer using a special disc-banding technique on alfalfa stands. The other implication of this research, in addition to improving DMY, is that subsurface banding may reduce the potential for P loss due to surface runoff and will be safer for the environment.

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Table 1. Influence of method of placement on dry matter yield increase (DMYI) of alfalfa from annual and single initial P applications (averaged across P rates)

Year+	DMY I (kg/ha)					
	Annual applications			Single applications		
	Broadcast	Disc-band	LSD _{0.05}	Broadcast	Disc-band	LSD _{0.05}
1992	3160	3782	473	5011	4738	ns
1993	5069	5748	510	6056	7221	622
1994	3690	4821	835	3680	4639	726
1995	3116	3994	399	2392	2802	ns

[†]The DMYs in the zero-P treatment for 1992, 1993, 1994 and 1995, respectively, were 2928, 1026, 1429 and 2407 kg/ha.

Table 2. Influence of method of placement on dry matter yield increase (DMYI) of alfalfa from annual and single initial P applications at different rates (averaged across 4 years)

Rate of P (kg P/ha)	DMYI (kg/ha) [†]				
	Annual applications		Rate of P (kg P/ha)	Single applications	
	Broadcast	Disc-band		Broadcast	Disc-band
10	1783	2983	50	2536	3586
20	3488	4589	100	4282	4856
30	4770	4995	1 5 0	4556	5366
40	4995	5729	200	5764	5591

[†]Average DMY in the zero-P treatment was 1947 kg/ha. The LSD (P = 0.05) values for rate and method of P placement, respectively, were 468 and 331 for annual applications, and were 543 and 384 for single initial applications.