INTERPRETIVE SUMMARY - 1990

Project: MB-3 **Leader: C. Grant**

P-K Placement in Established Alfalfa

Banding fertilizer into established alfalfa does not appear to be more advantageous than broadcast applications in Manitoba. Results from this study, now in its second year, shows little difference between broadcast and banded fertilizer treatments. Alfalfa responded well to applied P and K using both application methods, but the highest yields occurred when both P and K were applied as a broadcast. Studies like this will have a positive impact on alfalfa production because only 15% of the alfalfa grown on the Canadian prairies are fertilized annually, and that with only low rates of P.

ALFALFA RESEARCH: Quantitative and Qualitative Response of Established Alfalfa Forage to Methods of Application of Phosphorus and Potassium Fertilizers

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BACKGROUND:

Although alfalfa is the predominant forage grown on the Canadian prairies, management of fertilizer applications to produce the optimum yield and quality is often neglected. Only about 15% of the alfalfa grown on the prairies is fertilized annually, and that is generally with low rates of P. Therefore, P and K may often be inadequate to produce the most economic yield. Since these two nutrients are relatively immobile in the soil, their availability to the plant may be strongly influenced by the method of placement. The P and K applied to alfalfa in the prairies are generally applied as broadcast applications, which may not be readily available to the plant under dry conditions. This study was undertaken to evaluate the effect of broadcast and banded applications of P and K on the yield and quality of established alfalfa stands.

OBJECTIVE:

To evaluate application techniques that may increase the availability of P and K fertilizer to alfalfa, thus resulting in increased forage yield and improved protein and mineral composition.

METHODOLOGY:

Two research sites were selected in 1989. The first was a Marringhurst sandy loam soil near Brandon and the second a Newdale clay loam soil, near Newdale, MB. Each site had been sown to Algonquin alfalfa three years previously and had been cut for two years. Neither had been fertilized in the previous year. Uniform areas were selected for the experimental site. In 1989, fertilizer was applied to the Marringhurst sandy loam on May 30 and harvests were taken on June 21, July 27 and September 27. Fertilizer was applied to the Newdale clay loam soil on May 26 and harvests were taken on June 27, August 1 and September 27. In 1990, fertilizer was applied in the first week of May on both sites. Harvests were taken on the Marringhurst soil on June 21, July 27 to August 2 and September 27. On the Newdale soil, harvests were taken on June 19-20 and July 24-26. No third harvest was taken on the Newdale soil in 1990, due to insufficient regrowth. Plant samples were dried, ground and submitted to the laboratory for analysis for N, P and K. Statistical analysis was conducted using the GLM procedure of SAS (SAS Institute 1982).

RESULTS AND DISCUSSION:

1989 Crop Year

Sandy Loam Soil

Alfalfa yield on the sandy loam soil was extremely high (Table 1). The site was located in a depressional area and received ample moisture. The stand was thick, lush and productive. Dry matter yield at the first harvest was reduced by the banding operation. By the second harvest, differences due to placement were no longer significant. Total dry weight production over the season was

lower with banded rather than broadcast fertilizer application. Dry matter yield at the first and third harvests were not significantly influenced by fertilizer application. However, yield at the second harvest was increased with application of K. Fertilizer P and K tended to increase yield at the final harvest. Total dry weight production over the season was increased by application of K.

Clay Loam Soil

Yield on the clay loam soil was low, due to dry conditions throughout the growing season. The banding operation did not depress yield as strongly as it did in the sandy soil. Dry matter yield at the first and second harvests were not significantly influenced by fertilization (Tables 3 and 4). By the third harvest, yield was increased with application of P at 20 kg ha^{-1} and increased further with the application of 40 or 80 kg P ha^{-1}. Total dry matter yield through the season increased with increasing P. The highest total yields were obtained when both P and K were applied at moderate to high levels.

1990 Crop Year

Sandy Loam Soil

In 1990, alfalfa yield on the sandy loam soil although high, was slightly lower than in 1989. Yield of the first harvest was reduced by band placement of fertilizer (Tables 5 and 6). At the later harvests, and for total yield, there was no effect of fertilizer placement on alfalfa yield. Potassium application increased the first harvest yield but only when the fertilizer was broadcast. On the second harvest, there was no effect of fertilizer application or

placement method on alfalfa yield, while at the third harvest, yield increased with application of 50 or 100 kg K ha-1, banded or broadcast.

Clay Loam Soil

In 1990, on the clay loam soil, yield was similar to that in 1989. Adequate early season moisture led to moderate yields at the first and second harvests, but drought during the midsummer reduced regrowth and no third harvest was taken. Yield at the first harvest was increased by P application to 40 kg P ha^{-1}. The increase was greater when the fertilizer was broadcast than banded. At the second harvest, yield was again increased with P application to 40 kg P ha^{-1}, but the yields were higher with banded rather than broadcast fertilization. Presumably, by the second harvest, drying of the soil surface and reaction of the phosphate with the soil to form less soluble reaction products was restricting uptake of the surface broadcast P and availability of the banded P was superior. Final total yield was increased by application of P to 40 kg ha^{-1}, but was not influenced by fertilizer placement. There was a P by K interaction, with the greatest response to P application occurring where 25 kg K ha^{-1} was applied.

CONCLUSIONS:

In both 1989 and 1990, banding fertilizer disrupted the alfalfa stand in the sandy loam soil, which generally reduced yield in banded compared to broadcast fertilizer treatments at the first harvest. By the third harvest, differences were not significant. However, the total dry matter production over the season was still lower in the banded as compared to the broadcast treatments in 1989.

In 1990, the difference between placements was not significant, but K fertilizer response was greater where the K was broadcast rather than banded ($p<0.0557$). In the clay loam soil, differences between banding and broadcast treatments were less than in the sandy loam soil and banded applications showed a slight advantage at the second harvest, which was significant in 1990.

The sandy loam soil showed increased total dry matter yield with application of K, but not with application of P. Conversely, the clay loam soil showed increased yield with application of P, but not with application of K. However, on the clay loam soil, yield was highest when both K and P were applied and a significant P by K interaction occurred.

Table 1: Yield of alfalfa on the Marringhurst sandy loam soil as influenced by method and rate of P and K fertilization (1989).

P	K	Placement	Harvest 1	Harvest 2	Harvest 3	Total
-kg ha^{-1}-			---------- t ha^{-1} ----------			
0	0	Broadcast	5.4	4.8	2.3	12.6
0	0	Banded	4.7	4.6	2.4	11.7
0	50	Broadcast	5.1	4.9	2.5	12.5
0	50	Banded	4.9	5.0	2.2	12.2
0	100	Broadcast	6.0	5.4	2.4	13.7
0	100	Banded	4.6	4.9	2.6	12.1
20	0	Broadcast	4.5	4.2	2.2	10.8
20	0	Banded	4.0	4.7	2.6	11.3
20	50	Broadcast	6.2	5.0	2.2	13.4
20	50	Banded	4.6	5.7	2.6	12.9
20	100	Broadcast	5.5	4.8	2.5	12.8
20	100	Banded	4.8	5.0	2.4	12.2
40	0	Broadcast	4.9	4.7	2.1	11.6
40	0	Banded	4.7	4.6	2.6	11.9
40	50	Broadcast	5.5	5.1	2.4	13.0
40	50	Banded	4.2	4.4	2.2	10.8
40	100	Broadcast	5.8	4.7	2.6	13.1
40	100	Banded	4.8	4.9	2.3	11.9
80	0	Broadcast	5.4	4.5	2.5	12.3
80	0	Banded	4.9	5.0	2.5	12.4
80	50	Broadcast	5.6	5.1	2.3	13.0
80	50	Banded	5.0	5.2	2.7	13.0
80	100	Broadcast	5.4	4.9	2.2	12.6
80	100	Banded	4.5	4.8	2.6	12.0

Table 2: Analysis of Variance of yield on Marringhurst sandy loam (1989).

Source	DF	Probability Harvest 1	Harvest 2	Harvest 3	Total
P	3	ns	ns	ns	ns
K	2	ns	0.0305	ns	0.0443
P*K	6	ns	ns	ns	ns
Place	1	0.0001	ns	ns	0.0275
P*Place	3	ns	ns	ns	ns
K*Place	2	ns	ns	ns	ns
P*K*Place	6	ns	ns	ns	ns
Rep	3	0.0001	ns	ns	0.0038
MSE	69				

Table 3: Yield of alfalfa on the Newdale clay loam soil as influenced by method and rate of P and K fertilization (1989).

P	K	Placement	Harvest 1	Harvest 2	Harvest 3	Total
-kg ha^{-1}-			---------- t ha^{-1} ----------			
0	0	Broadcast	1.2	1.4	0.9	3.5
0	0	Banded	1.0	1.3	0.7	3.0
0	25	Broadcast	1.0	1.0	0.5	2.5
0	25	Banded	1.2	1.3	0.9	3.4
0	50	Broadcast	1.3	1.4	0.9	3.6
0	50	Banded	1.1	1.1	0.8	3.1
20	0	Broadcast	1.2	1.2	0.9	3.3
20	0	Banded	1.0	1.4	1.0	3.4
20	25	Broadcast	1.2	0.9	1.1	3.2
20	25	Banded	0.9	1.1	0.8	2.8
20	50	Broadcast	0.9	1.4	0.9	3.1
20	50	Banded	1.3	1.6	1.2	4.1
40	0	Broadcast	1.2	1.4	1.0	3.5
40	0	Banded	1.1	1.3	1.2	3.6
40	25	Broadcast	1.5	1.2	1.3	4.0
40	25	Banded	1.4	1.3	1.2	3.9
40	50	Broadcast	1.1	1.4	1.2	3.7
40	50	Banded	1.0	1.3	1.0	3.3
0	0	Broadcast	0.9	1.2	1.0	3.1
80	0	Banded	1.0	1.3	1.2	3.4
80	25	Broadcast	1.2	1.5	1.4	4.1
80	25	Banded	1.2	1.6	1.3	4.1
80	50	Broadcast	1.4	1.7	1.5	4.6
80	50	Banded	1.0	1.6	1.3	3.9

Table 4: Analysis of variance of yield on Newdale clay loam soil (1989).

Source	DF	Probability			
		Harvest 1	Harvest 2	Harvest 3	Total
P	3	ns	ns	0.0001	0.0096
K	2	ns	ns	ns	ns
P*K	6	ns	ns	ns	ns
Place	1	0.0942	ns	ns	ns
P*Place	3	ns	ns	ns	ns
K*Place	2	ns	ns	ns	ns
P*K*Place	6	0.0508	ns	0.0746	ns
Rep	3	0.0001	0.0761	0.0001	0.0001
MSE	69	238254	166068	73828	579449

Table 5: Yield of alfalfa on the Marringhurst sandy loam soil as influenced by method and rate of P and K fertilization (1990).

P	K	Placement	Harvest 1	Harvest 2	Harvest 3	Total
-kg ha^{-1}-			----------kg ha^{-1}----------			
0	0	Broadcast	5.0	3.3	1.6	9.9
0	0	Banded	5.2	3.9	1.2	10.2
0	50	Broadcast	5.3	3.5	1.9	10.7
0	50	Banded	4.6	3.2	1.9	9.7
0	100	Broadcast	5.2	3.1	1.5	9.9
0	100	Banded	4.9	3.5	1.8	10.2
20	0	Broadcast	4.8	2.8	1.4	9.0
20	0	Banded	4.9	3.2	1.7	9.9
20	50	Broadcast	5.6	3.5	2.0	10.6
20	50	Banded	5.1	3.4	1.5	10.0
20	100	Broadcast	5.0	3.6	1.9	10.5
20	100	Banded	4.7	3.3	2.2	10.1
40	0	Broadcast	4.7	3.4	1.5	9.6
40	0	Banded	5.0	3.3	1.5	9.8
40	50	Broadcast	5.2	3.4	2.3	10.9
40	50	Banded	4.5	3.0	1.6	9.1
40	100	Broadcast	4.9	3.5	1.7	10.0
40	100	Banded	4.8	3.4	1.6	9.9
80	0	Broadcast	5.3	3.3	1.7	10.3
80	0	Banded	5.1	3.6	1.5	10.1
80	50	Broadcast	5.3	3.4	1.9	10.7
80	50	Banded	4.9	3.6	1.9	10.3
80	100	Broadcast	5.3	3.3	1.9	10.4
80	100	Banded	4.7	3.5	1.9	10.1

Table 6: Analysis of variance of yield on Marringhurst sandy loam (1990).

Source	DF	Probability			
		Harvest 1	Harvest 2	Harvest 3	Total
P	3	ns	ns	ns	ns
K	2	ns	ns	0.0124	ns
P*K	6	ns	ns	ns	ns
Place	1	0.0078	ns	ns	ns
P*Place	3	ns	ns	ns	ns
K*Place	2	0.0308	ns	ns	0.0557
P*K*Place	6	ns	ns	ns	ns
Rep	3	ns	ns	ns	ns
MSE	69	186101	241249	273317	985612

Table 7: Yield of alfalfa on the Newdale clay loam soil as influenced by method and rate of P and K fertilization (1990).

P	K	Placement	Harvest 1	Harvest 2	Harvest 3	Total
-kg ha^{-1}-			----------kg ha^{-1}----------			
0	0	Broadcast	2.4	1.4	.	3.8
0	0	Banded	2.1	1.5	.	3.6
0	25	Broadcast	1.6	1.0	.	2.6
0	25	Banded	2.3	1.5	.	3.7
0	50	Broadcast	2.3	1.3	.	3.6
0	50	Banded	2.3	1.6	.	3.9
20	0	Broadcast	2.4	1.6	.	4.1
20	0	Banded	2.6	2.1	.	4.8
20	25	Broadcast	2.5	2.0	.	4.4
20	25	Banded	2.5	2.0	.	4.5
20	50	Broadcast	2.6	1.8	.	4.4
20	50	Banded	2.9	2.1	.	5.1
40	0	Broadcast	3.2	2.2	.	5.3
40	0	Banded	2.7	2.2	.	4.7
40	25	Broadcast	3.6	2.4	.	6.1
40	25	Banded	3.1	2.3	.	5.4
40	50	Broadcast	3.2	2.2	.	5.4
40	50	Banded	2.5	2.0	.	4.5
80	0	Broadcast	2.8	1.9	.	4.8
80	0	Banded	2.9	2.3	.	5.2
80	25	Broadcast	3.5	2.2	.	5.7
80	25	Banded	3.5	2.7	.	6.2
80	50	Broadcast	3.6	2.4	.	6.0
80	50	Banded	3.1	2.3	.	5.4

Table 8: Analysis of variance of yield on Newdale clay loam soil (1990).

Source	DF	Probability Harvest 1	Harvest 2	Harvest 3	Total
P	3	0.0001	0.0001	.	0.0001
K	2	ns	ns	.	ns
P*K	6	0.0127	0.0507	.	0.0107
Place	1	ns	0.0028	.	ns
P*Place	3	0.0126	0.0267	.	0.0079
K*Place	2	ns	ns	.	ns
P*K*Place	6	ns	ns	.	ns
Rep	3	0.0001	0.0001	.	0.0001
MSE	69	169369	67999	.	378760