Nutrients Affecting Crop Production in northeastern Saskatchewan

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Introduction

Extensive studies on the nutrient effects of N, P, and S on crops have been studied over the past 35 years by scientists at the Melfort Research Station. Later work was devoted to micronutrients such as boron applied to canola. In the past 10 years, work with the micronutrients boron (B), copper (Cu), and zinc (Zn) on forage seed production has been undertaken. Soil test correlation, placement studies, fertilizer sources and timing of application of the macronutrients on several crops have been investigated over the years. Fertility work with forage crops on pasture and for seed production is presented here .

Results and Discussion

The yield increase of pasture herbage over the control from the'application of S fertilizer in relation to the available sulphate-S in the soil is shown in Fig. 1. The response is a logarithmic function and is averaged over 10 years. By averaging over years the variability in response is reduced and results in a much better correlation. The soil test values should be multiplied by 8 to give the units in kg ha^{-1} which would correspond to the units used by local commercial soil test laboratories. Response to S appeared to be quite significant up to approximately 80 kg S ha^{-1} in the soil. The pastures were mixtures of grasses and legumes. A bromegrass and alfalfa mixture response is designated in Fig. 1 by a “z” The other pastures contained mixtures of smooth bromegrass, bluegrass, creeping red fescue, alfalfa and clover as well as other miscellaneous species. The yield response of these herbage mixtures to N, P and S fertilizer compared to purer stands of grasses such as smooth bromegrass and alfalfa mixtures was not known. These experiments provided us with the information to show that the response was similar.

Estimates of forage herbage yield response to N fertilizer in most cases were not significantly related to soil tests for N. Forage grasses have a great capacity to absorb N in their tissues and when a soil test is made the form in the soil roots or biomass is not extracted and therefore, is excluded from the analyses. In most cases the ammonium- and nitrate- N in the soil is low, and there is always a response to N fertilizer.

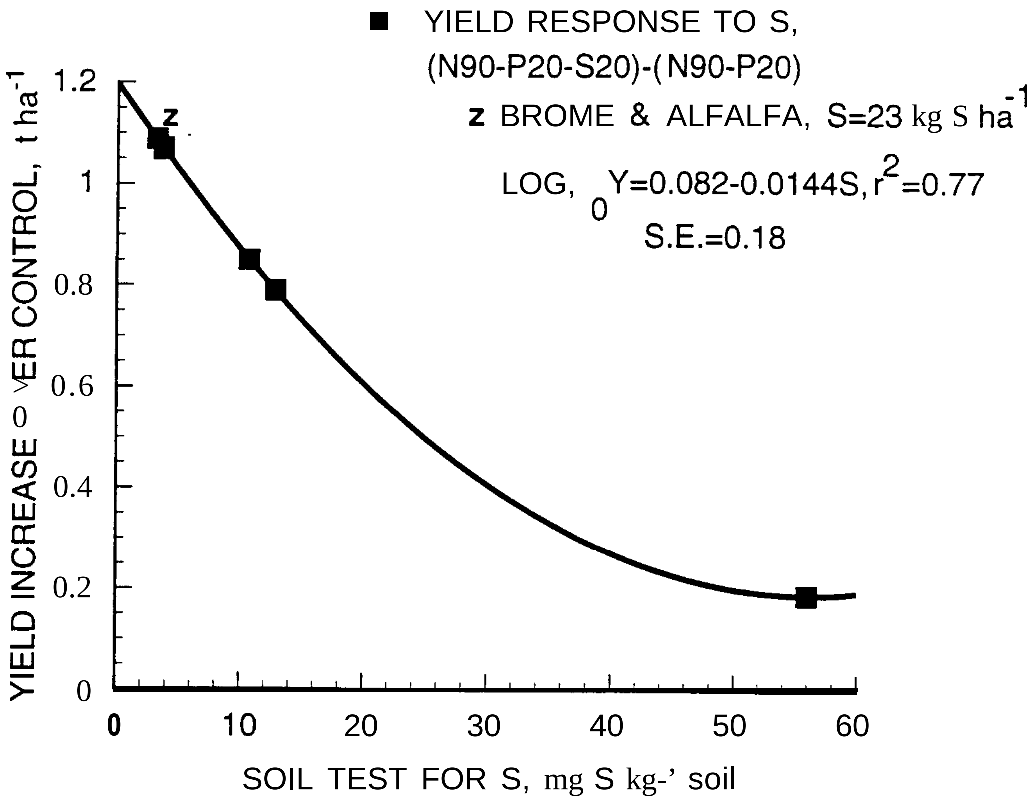

Fig. 1. The effect of available soil sulphate -S on mean of 10 year yield response of forage herbage over control on Pathlow and Pleasantdale pastures.

In Table 1, estimates of herbage yield response of forage mixtures to N, P and S fertilizer as affected by soil tests are shown. The soil tests for measuring available N and P were not significant in affecting % herbage yield response over control for these elements, but the soil test for S was. This could be accounted for by an available soil S x N and P fertilizer interaction. The % herbage yield response to S over the control was negatively related by a quadratic response to the soil tests for sulphur. The available ammonium- and -nitrate-N, and sodium bicarbonate soluble P significantly affected the % yield response of herbage to S fertilizer over control Because other work has shown that these nutrient factors all interact, then one can expect available soil nutrient x fertilizer nutrient interactions. Usually N and P nutrients will enhance the response to S, but in this case the nitrate-N coefficient was negative, indicating that with increased amounts of this source of N in the soil response to S fertilizer would be reduced.

Table 1. Estimates of herbage yield response to N, P and S fertilizers in relation to soil tests by multiple regression equations

Estimate yield response[z]	units yr^{-1}	$S_{y.x}$[y]	a[w]	Coefficients of Soil Tests NH_4-N	NO_3-N	$NaHCO_3$-P	$CaCl_2$-S	$CaCl_2$-S^2	R2	P>F
NP-C	t ha^{-1}	1.1	2.6	-0.188	0.232	-0.12			0.10	ns
NP/C x 100	%	72.	320.	-18.4	21.62	-12.1			0.21/	ns
NP/C x 100	%	65.	220.	31.6	5.88	-5.0	-22.8*	0.080*	0.42	0.06
NPS-NP	t ha^{-1}	0.42	-3.7	1.042	-0.442	0.23*	-.188	0.00064	0.41	ns
NPS/NP x 100	%	11.	-77.	44.0**	-20.8**	11.3**	-7.32*	0.0248~	0.77	0.01

[z]Estimates are absolute fertilizer yield increases over control treatments or percentage of fertilizer over control yields.

*Standard error of estimate.

[w]Intercept.

Symbols for NP. NPS and C fertilizer treatments are: N=90 kg N ha^{-1}, P=20 kg P ha^{-1}, S=20 kg S ha^{-1} and C=control without fertilizer. Note: S=23 kg S ha^{-1} on Bromegrass and alfalfa site 3 at Pathlow.

**,*,τ F test significant at 1%. 5% and 10% probability levels, respectively.

A more accurate estimate of the response of several species of forage seed to N and P fertilizers *was* obtained by relating % response to available soil N and P (Table 2). Amounts of these available soil elements can be very low or very high. Because the forage seed yield of several species has been related to available soil N and P, tables of expected yield response to fertilizer can be generated (Table 3). The potential grass seed yield for bromegrass was estimated at 1.000 t ha^{-1}. With soil tests of I mg N kg^{-1}(8 kg ha^{-1}) and 8 mg P kg^{-1}(16 kg ha^{-1}) an expected increase in yield over the control with fertilizer applied at 50N-9P kg ha^{-1} is 282%. The control yield is set at 100% and the percentage left (282-100) 182 is used to calculate the yield response. The yield response was calculated to be (182/282*1 .O) 0.0.645 t ha^{-1} and the control yield (1 .OOO-0.645) 0.355 t ha^{-1}. Care must be taken to choose a proper potential yield for the grass which is within the range of the expected yield response. Also, the range of available nutrients in the soil in making up the table should comply reasonably with actual measurements. The equations from Table 2 can be used to make a much larger "family" of yield response tables for forage seed response to N and P fertilizers than that shown in Table 3

Micronutrient interaction effects were found to be significant in affecting response of alfalfa and smooth bromegrass to the elements shown in Table 4, but the response to these elements was not great (Table 5). Because the Cu and Zn fertilizers contained some sulphate-S, some effect of the fertilizer could be due to the small amount of available S in the fertilizer. The significant three factor interactions shows the dependence of nutrients on one another in affecting forage seed yields. Some of these effects appeared to be negative as the N0-Cu0.55-Zn3.3 treatment produced the lowest alfalfa seed yield (0.417 t ha^{-1}). However, the N0-Cu0.55-Zn0.0 fertilizer treatment produced the highest alfalfa seed yield (0.486).

In conclusion, measurement of available nutrients in the soil and relating these amounts to fertilizer response has been a major undertaking at the Melfort Research Station. The practical use of the information in soil testing laboratories to make more precise fertilizer recommendations to farmers and thus, a greater return on fertilizer invested has a dramatic effect on the farm economy. When fertilizer is applied where it is needed then there is less likelihood of putting on too much fertilizer which could result in pollution of streams and rivers by runoff or erosion. High concentrations of nutrients in soils could result in infiltration of the nutrient elements into underground aquifers. The use of soil testing by farmers has been in the range of 5 to 10% in the past. We should endeavor to increase the use of soil testing and it is important that we as agrologists promote and understand how available nutrients in the soil relate to practical recommendations.

Acknowledgments

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Table 2. Percentage forage seed yield response to N and P fertilizers over controls as affected by soil tests for these elements

Estimate of yield response[y]	Units yr^{-1}	$S_{y.x}$[z]	Intercept	Soil Tests: NO_3-N	NO_3-N^2	$NaHCO_3$-P	$NaHCO_3$-P^2	R2	P>F
				coefficients of sod					
$\frac{N50}{C}$ x100	%	39.9	265.	-45.2	3.83			0.66	0.07
$\frac{N50P9}{C}$ x 100	%	29.2	546.	-104.*	12.6τ	-27.3*	0.72*	0.93	0.04
$\frac{N100P18}{C}$ x 100	%	36.3	671.	-130.*	16.9τ	-39.0*	0.98*	0.91	0.06

[z]Standard error of estimate.
[y]C=control; N50 and N100 = 50 and 100 kg N ha^{-1}; P9 and P18 = 9 and 18 kg P ha^{-1}.
*,τ F test significant at 5 % and 10 % probability levels, respectively.

Table 3. Estimates of yield response of bromegrass seed to N and P fertilizer as affected by soil tests for these elements

% yield over cntrl	yield' response	control yield	Soil Nitrate-N 0-60 cm	Soil $NaHCO_3$ -P O-15 cm
%	-------t ha^{-1}---------		----------kg ha-l	
282	0.645	0.355	8	16
135	0.258	0.742	16	32

^{z}50 kg N ha^{-1} and 9 kg P ha^{-1} applied.

Table 4. Significant macro and micronutrient effects on forage seed yields

Alfalfa3		Bromegrass8	
Effect	Pr>F	Effect	Pr>F
B	0.03	P*S	0.05
		N*P*S	0.04
		N*S*Zn	0.01
N*Cu*Zn	0.03	N*Cu*Zn	0.05
		Cu*Zn*B	0.03

Table 5. Yields of alfalfa seed affected by applied macro- and micronutrients

N	Copper (Cu)	Zinc (Zn), kg ha" 0.0	3.3
	kg ha^{-1}----------	------------seed yield, t ha^{-1}--------	
0	0.0	0.45 1	0.453
0	0.55	0.486	0.417
50	0.00	0.452	0.423
50	0.55	0.440	0.467
Control		0.435	
L.S.D. (0.05)		0.020	