Forage seed yield response to N and P fertilizers and soil nutrients in northeastern Saskatchewan

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Loeppky, H. A., Horton, P. R., Bittman, S., Townley-Smith, L., Wright, T. and Nuttall, W. F. 1999. **Forage seed yield response to N and P fertilizers and soil nutrients in northeastern Saskatchewan.** Can. J. Soil Sci. **79**: 265–271. There is no information on the effect, in northeastern Saskatchewan, of N and P fertilizers on forage seed production as influenced by these nutrients in the soil. Therefore, experiments were conducted at eight sites from 1988 to 1991 to determine the effect of N and P fertilizers and soil nutrients on seed yields of alfalfa (*Medicago media* Pers.), smooth bromegrass (*Bromus inermis* Leyss.), crested wheatgrass (*Agropyron cristatum* L.), intermediate wheatgrass (*Agropyron intermedium* [Host.] Beauv.) and timothy (*Phleum pratense* L.). Nitrogen fertilizer (urea) was applied on grasses annually at 0, 50, 100 and 150 kg N ha^{-1} in factorial combination with 0, 9 and 18 kg P ha^{-1} (monoammonium phosphate and triple superphosphate) and on alfalfa at 0 and 50 kg N ha^{-1} in combination with 0, 9, 18, 26 and 53 kg P ha^{-1}. Nitrogen significantly increased forage seed yields of all species except alfalfa. Phosphorus increased yields of forage seed for all crops except intermediate wheatgrass. The site, N, P and year and their interactions influenced seed yields. Seed yields ranged from a low of 0.29 t ha^{-1} for smooth bromegrass in 1990, a dry year, to a high of 1.24 t ha^{-1} in 1989 a cool, moist year. The yield response to N and P fertilizers was affected by available soil N and P. Relative to control, the percentage increase in grass seed yield from applied N and P fertilizers was highly related to the available soil N and P ($R^2 = 0.93$). The estimated smooth bromegrass seed yield response to 50N–9P kg ha^{-1} was 0.54 t ha^{-1} when the soil had intermediate amounts of available N and P (2 mg N ha^{-1} and 8 mg P ha^{-1}, 0- to 60-cm and 0- to 15-cm depths, respectively). On a soil that tested high in available N and P, there was no response to fertilizer. Regression equations were developed that can be used to estimate forage seed yield response of different species in relation to available soil nutrients. These results are useful for estimating the most economical return on fertilizer investment for forage seed production in Saskatchewan.

Key words: Forage, seed, N, P, fertilizer, soil tests, correlation

Loeppky, H. A., Horton, P. R., Bittman, S., Townley-Smith, L., Wright, T. et Nuttall, W. F. 1999. **Effets de la fumure N et P et de la biodisponibilité de ces éléments dans le sol sur le rendement de semences fourragères dans le nord-est de la Saskatchewan.** Can. J. Soil Sc. **79**: 265–271. Dans le nord-est de la Saskatchewan, on ne dispose d'aucune information sur l'effet de la fumure N et P sur la production de semences fourragères en fonction des quantités disponibles de ces éléments dans le sol. Des expériences ont été conduites de 1988 à 1991 à 8 emplacements pour déterminer l'effet des engrais N et P, ainsi que des disponibilités de ces éléments dans le sol, sur le rendement semencier de la luzerne (*Medicago media* Pers.), du brome inerme (*Bromus inermis* Leyss.), de l'agropyre à crête (*Agropyron cristatum* L.), de l'agropyre intermédiaire (*Agropyron intermedium* [Host.] (Beauv.) et de la fléole des prés (*Phleum pratense* L.). L'azote sous forme d'urée était apporté aux graminées tous les ans aux doses de 0, 50, 100 et 150 kg N ha^{-1} en combinaison factorielle avec 0, 9 et 18 kg P ha^{-1} sous forme de phosphate monoammonique et de superphosphate double. Sur la luzerne, deux doses de N: 0 et 50 kg N ha^{-1} étaient utilisées en combinaison avec 0, 9, 18, 26 et 53 kg P ha^{-1}. L'azote a causé un accroissement de rendement semencier chez toutes les espèces sauf la luzerne, et le phosphore chez toutes sauf l'agropyre intermédiaire. En plus de ces facteurs, on notait aussi l'influence de l'emplacement et de l'année et des interactions entre tous ces facteurs. Les rendements semenciers allaient d'aussi peu que de 0,29 t ha^{-1} pour le brome inerme en 1990, année particulièrement sèche, à un sommet de 1,24 t ha^{-1} en 1989, année fraîche et bien arrosée. Par rapport aux témoins, le pourcentage d'augmentation du rendement semencier résultant de la fumure N et P était fortement relié aux quantités déjà disponibles de ces éléments dans le sol ($R^2 = 0{,}93$). L'accroissement calculé du rendement semencier du brome inerme en présence d'un apport de 50 kg N–9 kg P ha^{-1} était de 0,54 t ha^{-1} lorsque le sol contenait des quantités moyennes de N et de P assimilables, soit 2 mg N et 8 mg P ha^{-1}, respectivement, dans les tranches de profondeur de 0 à 60 cm et de 0 à 15 cm. Dans un sol bien pourvu en N et P assimilable, la fumure n'avait pas d'effet sur le rendement. Des équations de régression on permis de calculer le comportement du rendement semencier de diverses espèces fourragères en fonction des quantités biodisponibles de ces éléments déjà présentes dans le sol. Nos observations peuvent servir à calculer le taux de rémunération le plus économique des frais de fumure dans la production de semences fourragères dans la province de Saskatchewan.

Mots clés: Culture fourragère, semence, N, P, engrais chimique, analyse du sol, corrélation

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No studies have been conducted to determine forage seed yield response to N and P fertilizers as affected by the availability of these elements in northeastern Saskatchewan soils. Experiments on the production of forage seed crops have been conducted in southern Saskatchewan at Swift Current (Buglass 1964; Lawrence and Kilcher 1964), central Saskatchewan under irrigation (Crowle 1966), northern Alberta (Fairey 1993) and Manitoba (Entz et al. 1994). However, in these studies, response of grasses to N and P fertilizer was not related to available N and P in the soil. Because there are many forage species, a large number of experiments would be required to test, in detail, fertilizer effects on each crop. At least 18 site-years would be required to make an acceptable estimate of yield response to N and P fertilizers in relation to available nutrients in the soil as measured by soil tests for a single crop (Steel and Torie 1960; Nuttall 1973). The number of experiments required could be reduced by selecting a few species planted on each of several different sites with a wide range of fertilizer rates. For example, three of five species planted and equally distributed over 10 sites would amount to 30 sites per year and 90 site-years over a 3-yr period. However, if five species were planted at the 10 sites over the 3-yr period, the number of sites would become unmanageable for the project. Measurements of plant-available nutrients in soil samples taken at each site could be used to relate the forage seed yield response to fertilizer on a percentage basis. The premise would be that all forage species respond proportionally to nutrients from the soil or from applied fertilizer. Soper (1971) and McCartney et al. (1998) used this method for annual seed crops and forage herbage crops, respectively, in order to reduce variability among sites because of variable environmental weather factors. Accordingly, experiments were conducted with N and P fertilizer applied to several forage species at several sites in northeastern Saskatchewan. Objectives were to determine the seed yield response of forage species to N and P fertilizers and to relate this response to available N and P nutrients in the soil.

MATERIALS AND METHODS

Response to N and P fertilizer was assessed at eight sites (Table 1) on five forage crop species (Table 2) over the period from 1988 to 1991. The experimental design was a randomized complete block with four replicates. Treatments consisted of a factorial combination of 0, 50, 100 and 150 kg N ha^{-1} as urea with 0, 9 and 18 kg P ha^{-1} as monoammonium phosphate and triple superphosphate applied in April of each year including year of seeding. Treatments on alfalfa consisted of 0 and 50 kg N ha^{-1} in combination with 0, 9, 18, 26 and 53 kg P ha^{-1}. The trials were seeded in June and seed crops were harvested the following years in August (Table 2.). Alfalfa was harvested in October. Trials were conducted on previously established fields of crested wheatgrass, intermediate wheatgrass and timothy as indicated in Table 2. Other trials were seeded to a depth of approximately 3 cm with a seven row planter equipped with cone seed dispensers and double disc openers spaced at 30 cm. Each plot was 2.1 m wide and 6.1 m long. Leaf cutting bees (*Megachile rotundatas* Fabricius) were placed in the vicinity of the alfalfa trials to facilitate pollination.

Prior to applying fertilizer to the plot areas, 20 soil cores were taken in a grid at five per replicate from the experimental area and air dried. The sampling depths were 0–15, 15–30 and 30–60 cm. Soil samples were analyzed for nitrate-N and sodium bicarbonate soluble P by methods of Gentry and Willis (1988) and Hamm et al. (1970), respectively, (Table 1).

When forage seed matured, a 0.9 m × 6.1 m cut was harvested from each plot with a sickle bar mower set at a height of 5 cm. Plant material not harvested was removed by cutting to a height of 5 cm. Plant samples were dried overnight at 70°C, weighed for whole plant yield, and threshed for seed yield. The experimental results were analysed statistically with SAS (SAS Institute, Inc. 1989) by combining the experiments over years for each species with procedures of ANOVA, GLM and REG. The relationship between forage seed yield response to N and P (yield expressed as percentage of control) and available soil nutrients was determined by regression analyses (REG).

RESULTS

Forage Yield Response to N and P Fertilizers

Analyses of variance indicated that differences in seed yields among sites were significant for all species except alfalfa (Table 3). Nitrogen fertilizer significantly increased seed yields for the grasses, but not for alfalfa. Phosphorus, also, increased grass seed yields, except for intermediate wheatgrass and increased alfalfa seed yield significantly at

Table 1. Site, soil type, soil classification, location and initial soil tests for forage seed fertilizer field experiments in northeastern Saskatchewan

Site no. and name	Soil type	Classification	Location: Long.	Lat.	Elev. (m)	Soil tests: N 0–60 cm (mg kg^{-1})	P 0–15 cm (mg kg^{-1})
1. Baxter	Blaine Lake sil	Orthic Black Chernozem	103° 49′	53° 16′	335	0.5	13
2. Drury	Melfort sic	Orthic Black Chernozem	104° 47′	52° 44′	495	6.5	19
3. Eggerman	Yorkton sil	Orthic Black Chernozem	104° 32′	52° 10′	556	4.6	11
4. Hornseth	Whitefox fl	Orthic Dark Gray Chernozem	103° 56′	53° 25′	357	0.6	27
6. Newfield	Whitefox fl	Orthic Dark Gray Chernozem	104° 3′	53° 25′	381	–	–
7. Smelland	Weirdale sil	Calcareous Dk. Gray Chernozem	104° 14′	53° 24′	419	4.4	4
8. Staffen	Whitefox fl	Orthic Dark Gray Chernozem	103° 55′	53° 22′	360	4.3	11
10. Youzwa	Whitefox fl	Orthic Dark Gray Chernozem	103° 56′	53° 23′	351	2.1	19

Table 2. Forage crop species, seeding rates and sites in northeastern Saskatchewan where N and P fertilizer trials were conducted for forage seed production

Forage crop	Scientific name	Site no. and name	Years of trial[z]	Seeding rates ($kg\ ha^{-1}$)
Alfalfa	*Medicago media* Pers.	3. Eggerman	1989–1990	8
		6. Newfield	1990–1991	
		10. Youzwa	1989–1991	
Smooth bromegrass	*Bromus inermus* Leyss.	3. Eggerman	1989–1991	8
		6. Newfield		
		8. Staffen		
Crested wheatgrass	*Agropyron cristatum* L.	2. Drury	1989–1991	7
		3. Eggerman		
		6. Newfield		
		4. Hornseth[y]	1988–1990	
Intermediate wheatgrass	*Agropyron intermedium* Host.	3. Eggerman	1989–1991	11
		7. Smelland[y]	1988–1991	
Timothy	*Phleum pratense* L.	1. Baxter[y]	1988–1991	
		6. Newfield	1989–1991	7

[z]Indicates years seed was harvested.
[y]Established stands with fertilizer applied in each year seed yields were taken.

Table 3. Analyses of variance for effects of fertilizer, sites and years on forage seed production in northeastern Saskatchewan

Source of variation	Alfalfa		Grass species: Smooth bromegrass		Crested wheatgrass		Intermediate wheatgrass		Timothy	
	df	Pr > F	df	Pr > F	df	Pr > F	df	Pr > F	df	Pr > F
Site (S)	2	NS	2	0.01	3	0.01	1	0.01	1	0.02
Rep (R)	3	NS	3	NS	3	NS	3	NS	3	NS
Error (a) S × R										
Nitrogen (N)	1	NS	3	0.01	3	0.01	3	0.01	3	0.01
Phosphorus (P)	5	0.10	2	0.01	2	0.05	2	NS	2	0.01
N × P	5	NS	6	NS	6	NS	6	NS	6	NS
S × N	2	NS	6	0.01	9	NS	3	0.01	3	0.01
S × P	10	0.03	4	NS	6	NS	2	NS	2	NS
S × N × P	10	NS	12	NS	18	NS	6	NS	6	NS
Error (b) S × R × N × P										
Year	2	0.01	2	0.01	3	0.01	3	0.01	3	0.01
S × Yr	2	0.01	4	0.01	4	0.01	2	0.01	1	NS
N × Yr	2	NS	6	0.01	9	0.01	6	0.01	9	0.01
P × Yr	10	NS	4	NS	6	NS	4	NS	6	0.03
Error (c) S × R × N × P × Yr										

$P = 0.10$. The response of alfalfa seed to P was significant on the Eggerman site (Site 3, Fig. 1), but not on the other two sites, resulting in a significant site × P interaction. Site × N interactions were significant for seed yields of bromegrass, intermediate wheatgrass and timothy (Table 3). For example, at sites 3 and 6, addition of 50 kg N ha^{-1} resulted in over 30% increase in bromegrass seed yield, while at site 8 the corresponding response was only 5% (not significant) (Table 4).

Year effects were significant among all forage species; site × year effects were significant for all crops except timothy; and N × year effects were significant for all crops except alfalfa. For example, bromegrass seed yield did not respond to N fertilizer in 1989 (Table 5); however, in 1991, even though yields were much lower, the response to N was positive. Further, in 1990, though 50 kg N ha^{-1} increased seed yields, greater rates of N suppressed yields. Yields of forage seed were as low as 0.28 t ha^{-1} for smooth bromegrass in 1990, a dry year, and as high as 1.24 t ha^{-1} in 1989, a cool moist year.

The year 1988, which was very dry, was included in estimating the response of timothy seed yields to P and would account for a significant year × P interaction for this species only (data not included in tables).

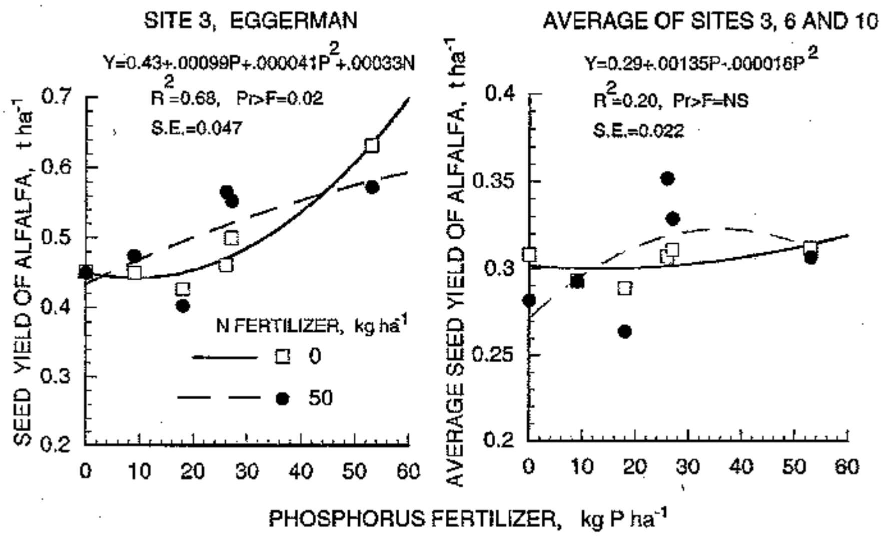

Fig. 1. The relationship of alfalfa seed yield to applied P and N fertilizers in northeastern Saskatchewan averaged over sites and years, 1989 to 1991.

The average response of grass seed to N and P fertilizers is shown in Fig. 2 and Tables 6 and 7. An overall regression equation of yield vs. N and P is shown. In general, there was a quadratic response to N and a linear response to P. However, there was no response of intermediate wheatgrass to P. The analyses of variance (Table 3) indicated a significant response of bromegrass seed to P fertilizer, but this was not shown to be significant in the multiple regression equation (Table 7). The equations (Fig. 1 to Fig. 2, Table 7) give a general indication of the response of forage seed to applied fertilizer.

Soil Test Correlation

A more accurate estimation of the response of seed yield of the forage grass species to N and P fertilizers was obtained by relating this response to the soil tests for N and P (Table 8). Because the forage seed yield of several species was shown to be related to N and P soil tests, we used the equations in Table 8 to generate tables of expected yield response to fertilizer (Table 9). For example, if the potential grass seed yield for bromegrass was estimated to be 1.0 t ha^{-1}, then with soil tests of 2 mg N kg^{-1} and 8 mg P kg^{-1}, an expected increase in yield over the control with fertilizer applied at 50N–9P kg ha^{-1} would be 215%. This was derived by setting the control yield at 100%, thus, the percentage left (215–100) 115 is used to calculate the yield response. The yield response was calculated to be (115/215 × 1.000) 0.536 t ha^{-1} and the control yield would be 0.464 t ha^{-1}.

Temperature and Precipitation Effects

Temperature and precipitation over the 3 yr in which the experiments were conducted and the 30 yr average for Melfort (a median site under which the experiments were conducted) show that the seasonal precipitation (May, June, July and August) for 1989–1991 (209 mm) was lower than the 30-yr average, 1960–1989 (225 mm). The lower seasonal rainfall was accompanied by higher than normal temperatures compared to the 30-yr average. The higher temperatures over 1989–1991 would produce higher evapotranspiration rates resulting in lower water use efficiency and lower seed yields. Less precipitation and higher temperatures over the 1989–1991 period were estimated to lower average forage herbage yields by 15.6% when compared with the 30-yr average based on a weather model (Nuttall et al. 1991). Smooth bromegrass seed yield averaged 0.525 t ha^{-1} (1989–1991) and, based on this weather model, would have been 0.095 t ha^{-1} less than the estimated 30-yr average.

DISCUSSION

Forage Yield Response to N and P Fertilizers

Response to N and P fertilizers indicated that the nutrition of the forage plant was important for seed production. There is no published information on seed production in northeastern Saskatchewan, but there have been many studies on forage herbage response to fertilizers (Lutwick and Smith 1977; Ukrainetz et al. 1988; MacKay and Wewala 1990; Nuttall et al. 1991; Malhi et al. 1992) that indicate that forage seed yields could be increased with N, P and S fertilizers. Earlier studies in southern Saskatchewan have not shown P to be important for increasing forage seed yield, perhaps because most of the sites tested were high in available soil P (Buglass 1964). Soil tests for P did not come into common use until 1967 and many of the experiments on which recommendations were based were conducted before that time. The experiments in this study covering the conditions in northeastern Saskatchewan showed great variability in the response of forage crops to P fertilizer. This variable response reflected the variability in the P status of the soils. Year (weather) effects were also great as expected. Crowle (1966) showed consistent seed yield response to rates of N fertilizer for nine forage species grown under irrigation in central Saskatchewan.

Seed yields of forage crops have been markedly affected by row spacing, which is believed to influence soil moisture

Table 4. Seed yield of smooth bromegrass as affected by N fertilizer on three sites in northeastern Saskatchewan averaged across P fertilizer rates, 1989 to 1991

Site[z]	N fertilizer[z] ($kg\ ha^{-1}$) 0	50	100	150
	(seed yield $t\ ha^{-1}$)			
3. Eggerman	0.394	0.522	0.453	0.427
6. Newfield	0.446	0.592	0.548	0.473
8. Thompson	0.626	0.656	0.610	0.558

[z]Standard error for comparing values within the table is 0.018.

Table 5. Seed yield of smooth bromegrass as affected by N fertilizer over 3 yr in northeastern Saskatchewan averaged across P fertilizer rates and sites 3, 6 and 8

Year[z]	N fertilizer[z] ($kg\ ha^{-1}$) 0	50	100	150
	(seed yield $t\ ha^{-1}$)			
1989	0.870	0.921	0.917	0.919
1990	0.422	0.489	0.360	0.282
1991	0.173	0.361	0.335	0.256

[z]Standard error for comparing values within the table is 0.032.

use efficiency and nutrient status (Austenson and Peabody 1964; Black and Reitz 1969; Buglass 1964). Wider row spacing resulted in increased moisture use efficiency, particularly in dry years. Response to N fertilizer was greater in solid stand or closed row seeding than spaced rows, indicating N deficiency was not as great in the widely spaced rows. Also, post-harvest residue management may have an overall effect on forage seed yields (Entz et al. 1994).

This study had solid stand (established stands) and 30-cm row spacing establishment, which could cause greater variation in seed yield among these sites.

Sometimes, there is difficulty in determining what nutrients are limiting yield if the fertility status of the soil is not

Table 6. Grass species seed yield response to N and P fertilizers averaged over years and sites in northeastern Saskatchewan

Fertilizer rates applied N ($kg\ ha^{-1}\ yr^{-1}$)	P	Bromegrass	Intermediate wheatgrass	Timothy
		(grass seed, $t\ ha^{-1}$)[z]		
0	0	0.467	0.269	0.116
0	9	0.484	0.279	0.125
0	18	0.513	0.272	0.153
50	0	0.585	0.356	0.225
50	9	0.563	0.377	0.256
50	18	0.621	0.390	0.266
100	0	0.559	0.436	0.245
100	9	0.521	0.419	0.258
100	18	0.533	0.422	0.273
150	0	0.490	0.442	0.251
150	9	0.520	0.436	0.271
150	18	0.448	0.401	0.299

[z]Standard errors of estimate are shown in Table 7.

known. The relationship of soil nutrient availability indexes to yield response to fertilizers is important because the soil test correlation with yield response has to be proven significant if predictable and useful fertilizer recommendations are to be made.

Soil Test Correlation

The high correlations of the percentage yield response to N and P relative to the controls was not expected. However, the response at each site was averaged over the years the trials were conducted, and the averaging would reduce the variability in response because of weather variables such as temperature and precipitation (McCartney et al. 1998). Because the correlations were based on different crop species, the premise was that each species responded to fertilizer proportionately to their controls and the response was correlated to available soil N and P. Absolute yield esti-

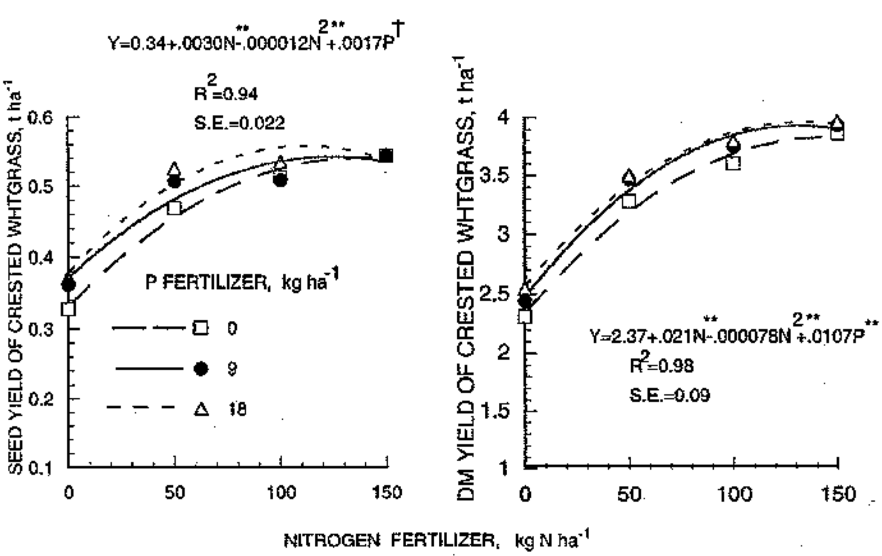

Fig. 2. The relationship of crested wheatgrass seed and dry matter yields to applied N and P fertilizers in northeastern Saskatchewan averaged over sites and years, 1989 to 1991.

Table 7. Forage grass seed yield response to N and P fertilizers by regression analyses over years and sites

Grass seed yield ($t\ ha^{-1}\ yr^{-1}$)	$S_{y,x}$[z]	Intercept	Fertilizers N	N^2	P	R^2	$P > F$
			Coefficients of fertilizer rates				
Bromegrass	0.035	0.49	0.0022**	–0.000015**	0.00021	0.65	0.01
Intermediate wheatgrass	0.015	0.27	0.0025**	–0.0000099**	0.0025	0.96	0.01
Timothy	0.017	0.118	0.0024**	–0.000010**	0.0022**	0.98	0.01

[z]Standard error of estimate.
***F* test significant at 1% probability level.

Table 8. Forage grass seed yield response to N and P fertilizers expressed as a percentage of the control in relation to available soil N and P over 10 experimental sites in northeastern Saskatchewan[z]

Estimate of yield response[x] (% yr^{-1})	$S_{y,x}$[y]	Intercept	Soil Tests NO_3-N	NO_3-N^2	$NaHCO_3$-P	$NaHCO_3$-P^2	R^2	$P > F$
			Coefficients of soil tests					
N50/C × 100	39.9	265.	–45.2	3.83			0.66	0.07
N50P9/C × 100	29.2	546.	–104.*	12.6[t]	–27.3*	0.72*	0.93	0.04
N100P18/C × 100	36.3	671.	–130.*	16.9[t]	–39.0*	0.98*	0.91	0.06

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

Table 9. Estimated seed yield response of smooth bromegrass to N and P fertilizer in relation to soil tests when 50 kg N and 9 kg P ha^{-1} are applied

Percentage yield increase over control[z]	Yield response ($t\ ha^{-1}$)	Control yield ($t\ ha^{-1}$)	Soil tests: Nitrate-N 0–60 cm ($mg\ kg^{-1}$)	Soil tests: $NaHCO_3$-P 0–15 cm ($mg\ kg^{-1}$)
215	0.536	0.464	2	8
163	0.389	0.611	2	12
135	0.258	0.742	2	16
233	0.571	0.429	4	4
159	0.369	0.631	4	8
107	0.063	0.937	4	12
77	–0.285	1.285	4	16

[z]Estimates of yield response from equation in Table 8 listed under N50P9/C × 100.

mates of crop response in relation to soil test were obtained when a potential yield was estimated for the desired seed crop. The potential yield could be obtained from either an average or a maximum yield obtained in the fertilizer trials. The procedure for calculating the seed yield responses and control yields are shown in the Results section. A "family" of equations could be obtained to make tables of yield response to N and P fertilizer relative to soil tests for N and P. These tables would be useful to soil testing laboratories in making fertilizer recommendations.

Temperature and Precipitation Effects

The temperatures in this study were higher and precipitation lower than the 30-yr average; thus, yields of forage seed were lower than would generally be expected in this region of Saskatchewan. In 1989, however, the maximum yield of bromegrass at Site 8 was 1.26 t ha^{-1}, a yield higher than any found in the literature. Other sites had yields in the order of 0.90 t ha^{-1} in 1989. The fertility status of the soils played a part in maximizing yields when weather conditions were optimum for grass seed production. Expected yield response to fertilizer can be increased or decreased depending upon the potential yield.

CONCLUSIONS

The results of this study show that N and P fertilizers and the initial nutrient status of the soil have very significant effects on seed production of forage crops. Our soil test correlation results have established the significance of the nutrient status of the soil in making more precise fertilizer recommendations. Although the dry weather conditions under which the trials were conducted produced lower than average yields, one year (1989) in particular produced high forage seed yields. To simulate higher moisture conditions, a higher potential yield can be used in the soil test correlation equations to indicate expected yield response to fertilizers under the better moisture conditions.

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