Influence of Long-Term Applications of N and S Fertilizers (1980-2005) on Dry Matter Yield of Grass and Soil Properties in a Dark Gray Chernozem in North-Central Saskatchewan

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Background

- In the Prairie Provinces of Canada, most soils are deficient in plant-available N.
- In the Parkland region, many soils also contain insufficient amounts of plant-available S for high crop yields.
- When soils are lacking in one or more nutrients, plant growth is reduced, resulting in low crop yields. So, application of fertilizers is essential to obtain high sustainable yield.
- Application of N, S and other fertilizers to soils lacking in these nutrients can increase forage dry matter yield and improve soil quality.

Objective

To determine the effects of long-term annual applications of N, S and K fertilizers to grass from 1980 to 2005 on forage dry matter yield (DMY), and soil pH, total organic C (TOC), total N (TN), light fraction organic C (LFOC) and light fraction organic N (LFN).

Materials and Methods

- Field experiment was conducted on a Dark Gray Chernozem (Boralfic Haploboroll) loam soil at Canwood in north-central Saskatchewan (mean annual precipitation 425 mm).
- The site had been cultivated for several years in 1920's or early 1930's, and then allowed to revert to grassland.
- The dominant grasses on the experimental site were bromegrass (*Bromus inermis* Leyss), Kentucky bluegrass (*Poa pratensis* L.) and rough hair grass (*Agrostic scabra* Wild).
- Experiment was established in 1980 with annual applications of:
  - no fertilizer (Nil);
  - Ammonium nitrate at 112 kg N ha^{-1} (N);
  - 112 kg N + sodium sulphate to supply 11 kg S ha^{-1} (NS); and
  - 112 kg N + 11 kg S + potassium chloride to supply 40 kg K ha^{-1} (NSK).
- Fertilizers were broadcast on the surface every year in May from 1980 to 2005.
- There was one strip (0.91 m wide x 62 m long) for each treatment, and each strip was divided into 10 replications (6.2 m long x 0.91 m wide).

- The strips were separated by 1 m wide x 62 m long pathways.
- Grass was usually harvested once in each growing season for DMY.
- Soil samples in Nil, N, NS and NSK treatments were obtained from the 0-5, 5-10 and 10-15 cm depths in spring 2007.
- Soil samples after air-drying and grinding were analyzed for pH, TOC, TN, LFOC and LFN.
- In 1994, grass species composition in cut 1 and cut 2, and ground cover were estimated.

Summary of Results

- There was no increase in DMY with N alone application compared to the unfertilized control. Forage DMY increased considerably when both N and S fertilizers were applied together (i.e., NS treatment), and DMY further improved when K fertilizer was also applied in combination with NS (i.e., NSK treatment).
- Composition of plant species changed markedly in various treatments after long-term fertilization. In Nil treatment, land was covered with bromegrass, fine grasses and herbs (dogwood). In N only treatment, there was virtually no bromegrass in the stands. In treatments with combined applications of NS or NSK, vegetation was predominantly bromegrass, which is a high yielding grass species.
- Root mass (0-15 cm) usually maximized when N, S or K fertilizers were applied together. Root mass in the Nil, N, NS and NSK treatments was 19.5, 17.6, 32.8 and 41.2 Mg ha^{-1}, respectively.
- Soil pH declined with annual applications of N and S fertilizers mainly in the 0-5 cm and 5-10 layers.
- TOC and N increased with NS application mainly in the 0-5 cm soil layer, while LFOC and LFN also increased in the 5-10 cm soil layer.
- There is a close relationship between DMY improvement and increase in C sequestration in soil from proper fertilization.

Conclusion

- The findings suggest that application of balanced fertilization by alleviating all nutrient deficiencies is an appropriate strategy for sustaining high forage yield, while also improving soil quality by increasing organic C and N storage in soil**.**

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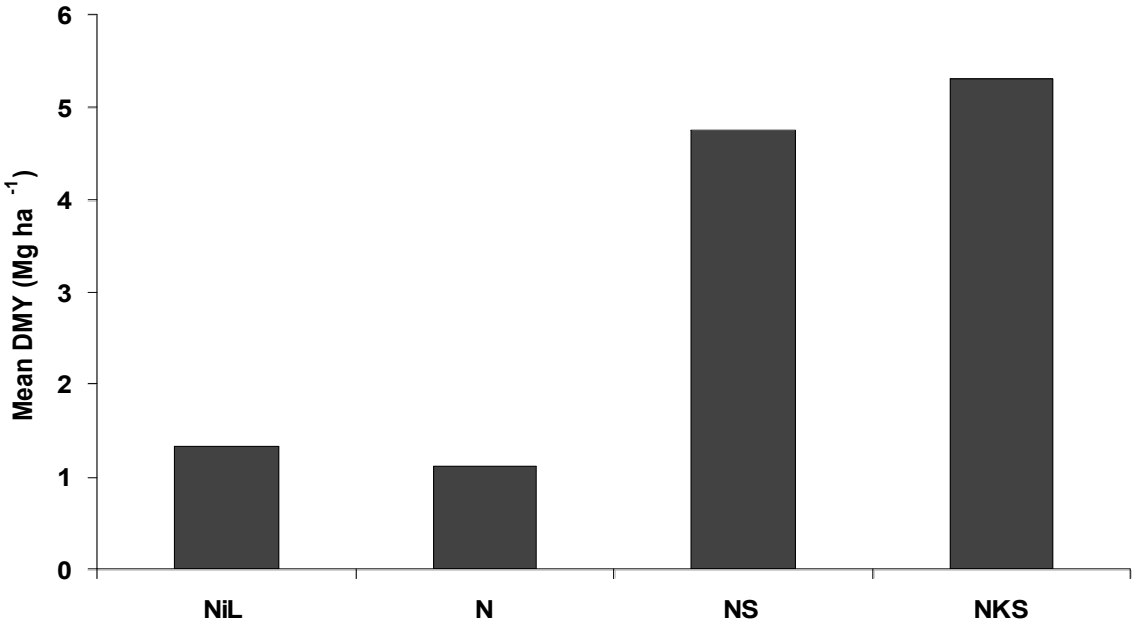

Figure 1. Effect of long-term applications of N, S and K fertilizers (from 1980 to 2005 - 26 annual applications) to grass on dry matter yield (DMY - averaged over 26 years) on a Dark Gray Chernozem soil at Canwood, Saskatchewan (Experiment 1).

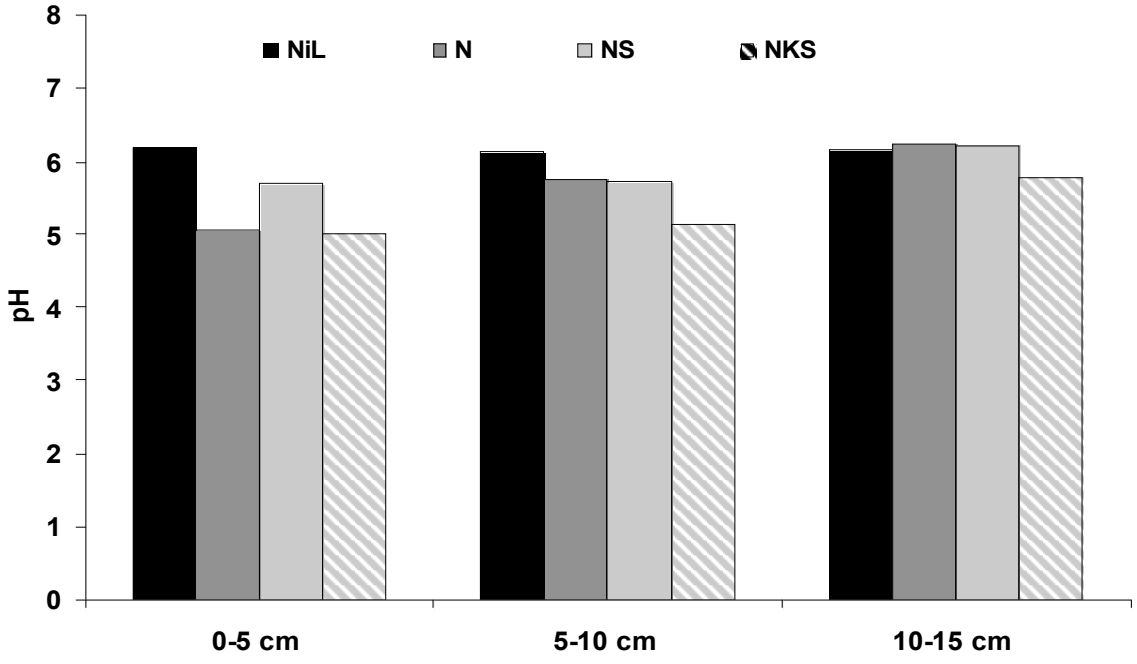

Figure 2. Effect of long-term applications of N, S and K fertilizers (from 1980 to 2005 - 26 annual applications) to grass on soil pH in a Dark Gray Chernozem soil at Canwood, Saskatchewan (Experiment 1).

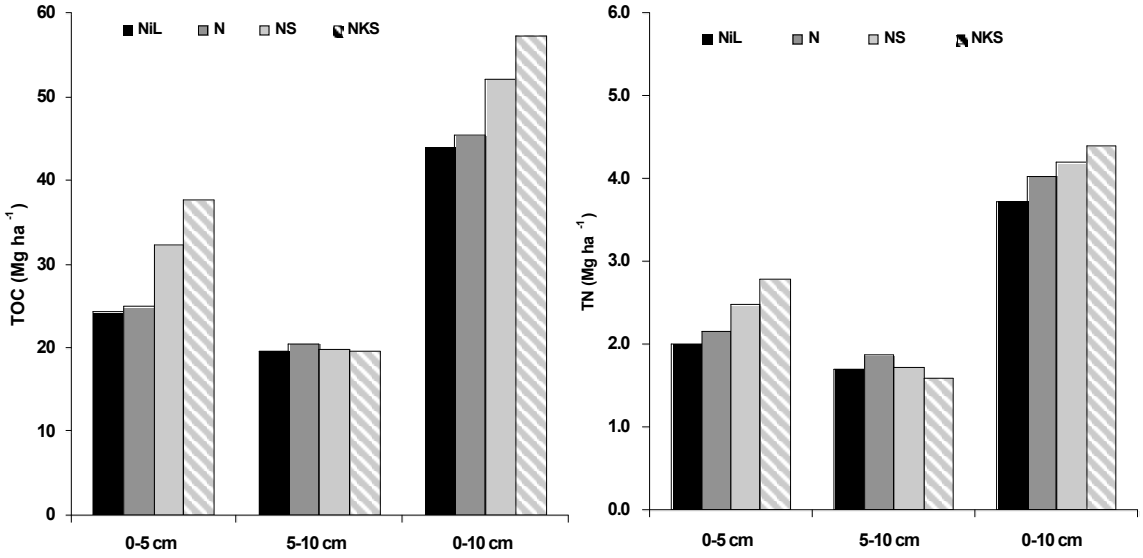

Figure 3. Effect of long-term applications of N, S and K fertilizers (from 1980 to 2005 - 26 annual applications) to grass on soil total organic C (TOC) and total N (TN) in a Dark Gray Chernozem soil at Canwood, Saskatchewan, Canada (Experiment 1).

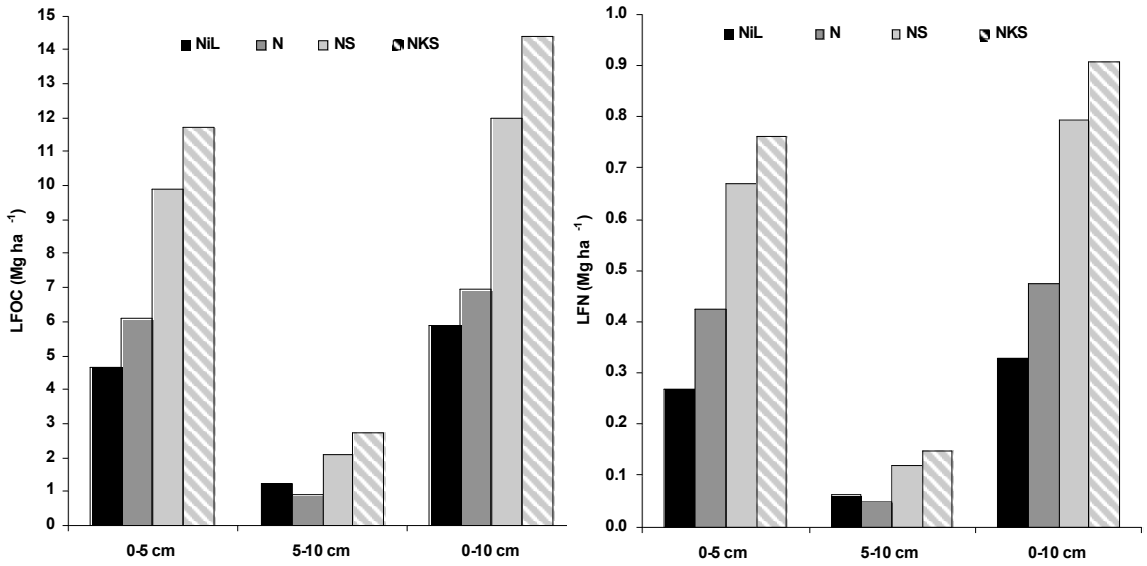

Figure 4. Effect of long-term applications of N, S and K fertilizers (from 1980 to 2005 - 26 annual applications) to grass on soil light fraction organic C (LFOC) and N (LFN) in a Dark Gray Chernozem soil at Canwood, Saskatchewan, Canada (Experiment 1).

Table 1. Effect of long-term annual applications of N, S and K fertilizers on vegetation composition in cut 1 and cut 2 in 1994, and estimated ground cover of various grass species on a Dark Gray Chernozem soil at Canwood, Saskatchewan, unlimed plots (Experiment 1 – established in 1980)

Treatment	Nil	N	NS	NSK	[a]$LSD_{0.05}$
			Vegetation composition in cut 1 (%)		
Bromegrass	29	2	92	92	11***
Vetch	2	0	0	0	2**
Fine grasses	12	70	7	6	10***
Herbs	57	28	1	2	13***
			Vegetation composition in cut 2 (%)		
Bromegrass	43	5	83	89	15***
Vetch	0	0	0	0	0^{ns}
Fine grasses	19	88	16	7	12***
Herbs	38	7	1	2	11***
			Estimated ground cover (%)		
Bromegrass	33	2	72	75	10***
Vetch	14	4	5	3	4***
Fine grasses	19	55	12	15	11***
Herbs	22	23	11	7	6***
Bluegrass	12	16	0	0	3***

[a]ns indicates that the difference between the treatments is not significant;
, and * indicate that the difference is significant at $P \leq 0.01$ and $P \leq 0.001$, respectively.