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Chunli Li
Agriculture and Agri-Food Canada, Canada

Walter D. Willms
Agriculture and Agri-Food Canada, Canada

Xiying Hao
Agriculture and Agri-Food Canada, Canada

Ben Ellert
Agriculture and Agri-Food Canada, Canada

Mengli Zhao
Inner Mongolia Agricultural University, China

See next page for additional authors

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The 21st International Grassland Congress / 8th International Rangeland Congress took place in Hohhot, China from June 29 through July 5, 2008.

Proceedings edited by Organizing Committee of 2008 IGC/IRC Conference

Published by Guangdong People's Publishing House

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Chunli Li, Walter D. Willms, Xiying Hao, Ben Ellert, Mengli Zhao, and Guodong Han

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Long-term cattle grazing effects on soil chemistry in the Rough Fescue grassland

Chunli Li[1,2], Walter D. Willms[1], Xiying Hao[1], Ben Ellert[1], Mengli Zhao[2], Guodong Han[2]*
[1]Agriculture and Agri-Food Canada, Lethbridge Research Centre. P.O. Box 3000, Lethbridge, Alberta, Canada, T1J 4B1. [2]Department of Grassland Science, College of Ecological and Environmental Science, Inner Mongolia Agricultural University. 306 Zhao Wu Da Road. Hohhot, Inner Mongolia, P.R. China. 010018. [*] Corresponding author's E-mail: willmsw@agr.gc.ca

Key word: Rough Fescue grassland, soil OC, soil nitrogen, soil phosphorus, soil pH, soil soluble ions

Introduction The Rough Fescue grasslands in western Canada are highly productive but sensitive to summer grazing. This can lead to overgrazing and subsequently soil degradation, which includes increased soil crusting, reduced soil infiltration, and enhanced soil erosion susceptibility (Manzano and Návar, 2000), which results in the loss of soil nutrients. Therefore, an experiment was conducted to investigate the effects of 58-yr of cattle grazing on soil properties in a Rough Fescue grassland.

Materials and methods The study site was at the Department of Agriculture Research Substation, Stavely, Alberta Canada with a semiarid climate. Annual mean precipitation was 494mm (from 1997 to 2007). The vegetation is classified as the Fescue Grassland (*Festuca campestris* (Rydb.) Association. Soil is Orthic Black Chernozemic and has a clay-loam to loam texture. Three treatments were established in 1949 consisting of fields representing a (i) non-grazed exclosue (CK), (ii) moderate grazing (MG), and (iii) heavy grazing (HG). The fields (MG and HG) were grazing by cattle from about May 15 to November 15 at 2.4 and 4.8 animal unit month ha^{-1}, respectively. In May 2007, Soil C, N, P, pH, electrical conductivity (EC) and water soluble ions were determined to the 60 cm depth for each treatment. The MIXED procedure from SAS (SAS Institute Inc. 2005) was used to analyze the data as a randomized complete block design with grazing effects. Tukey's test was used for all mean comparisons.

Results Soil organic carbon (OC), total P (TP) concentrations and Cl^- at all depths were higher ($p<0.05$) in the CK than in the grazing treatments whereas the total N (TN) concentration at all depths was lower ($p<0.05$) in the CK than in the grazing treatments (Tables 1and 2). Soil soluble K^+ at all depths was higher ($p<0.05$) in HG treatment than CK and LG treatments, Soil pH values were higher ($p<0.05$) in grazing treatments than in the CK (Table 1). There was no grazing effect ($p>0.05$) on soil EC, available N (NO_3-N and NH_4-N) and available P (AP) concentrations, soluble Mg^{2+}, Na^+ and SO_4^{2-} at all depths (Tables 1 and 2).

Table 1 *The effect of long-term cattle grazing on soil pH, EC, C, N and P concentrations in the Rough Fescue grassland.*

Indicators	P	CK	MG	HG
pH	0.00	6.45b[1]	7.10a	7.30a
EC(dS m^{-1})	0.20	0.12a	0.17a	0.19a
OC(%)	0.01	5.57a	4.58b	4.29b
TN(%)	0.04	0.52b	0.60a	0.59a
TP(g kg^{-1})	0.10	0.85a	0.74b	0.77ab
NO_3-N (mg kg^{-1})	0.22	3.62a	5.47a	5.86a
NH_4-N (mg kg^{-1})	0.52	7.85a	8.61a	8.30a
AP(mg kg^{-1})	0.44	3.08a	4.19a	3.73a

Table 2 *The effect of long-term cattle grazing on soil soluble ions (mg kg^{-1}) in the Rough Fescue grassland.*

Indicators	P	CK	MG	HG
Ca^{2+}	0.10	28.26a[2]	82.93a	59.26a
Mg^{2+}	0.29	5.69a	9.31a	8.42a
Na^+	0.13	19.31a	12.27a	12.95a
K^+	0.02	21.98b	25.23b	38.71a
Cl^-	0.02	27.25a	19.53b	16.79b
SO_4^{2-}	0.34	13.23a	9.77a	11.04a

[1,2] Means within row having different lower case letters are different at $P<0.05$ probability levels.

Conclusions Fifty-eight years of cattle grazing had a major impact on the concentration of soil nutrients in the Rough Fescue grassland. Soil C and P significantly decreased ($p<0.05$) both in the MG and HG treatments compare to CK. Loss of C and P in soil is indicative of soil deterioration and suggests that HG is not sustainable.

References

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