



University of Kentucky  
UKnowledge

---

International Grassland Congress Proceedings

XXI International Grassland Congress / VIII  
International Rangeland Congress

---

## How Has Converting Native Grassland to Introduced Monocultures Altered Soil C, N, and P in the Semiarid Region of the Northern Great Plains?

Xiying Hao

*Agriculture and Agri-Food Canada, Canada*

Walter D. Willms

*Agriculture and Agri-Food Canada, Canada*

Follow this and additional works at: <https://uknowledge.uky.edu/igc>



Part of the [Plant Sciences Commons](#), and the [Soil Science Commons](#)

This document is available at <https://uknowledge.uky.edu/igc/21/18-1/19>

The XXI International Grassland Congress / VIII 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

---

This Event is brought to you for free and open access by the Plant and Soil Sciences at UKnowledge. It has been accepted for inclusion in International Grassland Congress Proceedings by an authorized administrator of UKnowledge. For more information, please contact [UKnowledge@lsv.uky.edu](mailto:UKnowledge@lsv.uky.edu).

## How has converting native grassland to introduced monocultures altered soil C, N, and P in the semiarid region of the Northern Great Plains ?

Xiying Hao\* and Walter Willms

Agriculture and Agri-Food Canada, Lethbridge Research Centre, 5403 1<sup>st</sup> Ave. S. Lethbridge, AB. T1J 4B1 Canada

\* Corresponding author, E-mail: haoxy@agr.gc.ca.

**Key word :** soil quality, *Stipa-Bouteloua* community, crested wheatgrass, Russian Wildrye grass, wheat production

**Introduction** With world population increases, marginal native grassland are being converted for food production. This study investigated how converting native grassland to introduced monocultures has altered soil C, N, and P.

**Materials and methods** We examined the effects of seven common practices of land disturbance and management (treatments) in a randomized complete block with four replications at the Agriculture and Agri-Food Canada substation at Onefour (49°07'N, 110°29'W) in southern Alberta, Canada, on a *Stipa-Bouteloua* community of the Mixed Prairie. The treatments, established in plots (3 x 10 m) on previously undisturbed native grassland, were: (1) cultivated and then abandoned, leaving the plot to re-establish thorough succession from residual germplasm with no harvesting (ABA), (2 and 3) cultivated and seeded to monocultures of either crested wheatgrass (CWG, *Agropyron cristatum* (L.) Gaertn. or (3) Russian wildrye (RWR, *Psathyrostachys juncea* (Fisch.) Nevski), (4 and 5) cultivated and seeded to wheat (*Triticum aestivum* L.) annually (WHA) or biannually (summerfallow, WHF), (6) a native community that was harvested (NAT1) and (7) a native community that was left undisturbed as a control (NAT2). The two perennial grasses and NAT1 were harvested annually at 10 cm height while the wheat was harvested at 15 cm height. The treatments were established in spring 1994 by cultivating and seeding or abandoning according to plan. The native treatment was left intact during plot preparation. The abandoned plot was cultivated several times during the first summer and plants that emerged from live tillers were removed. All seeding was made with 15-cm row spacing. The site was enclosed with a 4-strand barbed-wire fence that excluded livestock. Soil samples were taken in fall 2006 and analyzed for organic C (OC), total nitrogen (TN),  $\delta^{15}\text{N}$  total phosphorus (TP), KCl-extractable  $\text{NH}_4^+$  and  $\text{NO}_3^-$  and available P (AP) contents. Two set of soil samples (0 to 90 cm) were collected, one from in-between plants and one from over the crown of plants. The data were analyzed with the MIXED procedure (SAS Institute Inc. 2005) as a split-split-plot design to examine the main fixed effects (treatment, position, depth) and their interactions. Depth was treated as a repeated measure to account for potential correlations and different variances among the depths. Various types of variance-covariance matrices were fitted and the one with the lowest AIC value was used for the final analysis. The UNIVARIATE procedure was used to check the residuals for normality and for potential outliers. When an outlier was detected, it was removed before the final analysis was performed. Means of significant treatment effects were separated using LSD test.

**Results and discussion** Soil OC and TN contents were lowest and  $\text{NO}_3^-$  and AP highest from both wheat treatments while the OC and TN contents were generally highest and  $\text{NO}_3^-$  and AP lowest from the NAT2 treatment.  $\text{NO}_3^-$ -N was affected by treatment at all soil depths. The OC, TN,  $\text{NH}_4^+$ -N and AP were higher and the  $\delta^{15}\text{N}$  values were lower for soil that was found beneath plant crowns than on bare ground between plants. The effect of sampling position was only significant in the surface soil (0-15cm). The treatments effect was also most pronounced near the surface and diminished as soil sampling depth increases. Soil TP concentration was only affected by the sampling depth with the highest concentration near the surface. The effect of sampling depth on TP was not influenced by the treatment. On the other hand, soil OC, TN, and AP concentrations were also affected by soil depth, which were influenced by the treatment.

The decreases in soil OC and TN contents when native grassland was converted to annual crop production was mainly due to the removal of biomass when the crop is harvested. Similarly, when native grassland or the seeded perennial grass treatments were harvested, the soil OC and TN were reduced as resulted of biomass removal. Although ABA treatment was never harvested, re-establishment thorough succession from residual germplasm takes time thus the low OC and TN content compared with the non-harvested native grassland. The higher soil available N and P content in the wheat treatment might be due to the soil microbial community and the transformation of soil nutrients resulting from cultivation and the conversion of the plant community from native grassland.

**Conclusion** Converting native grassland to introduced monocultures of perennial or annual species altered soil C and N, and to a lesser degrees the P dynamics in the semiarid region of the Northern Great Plains.

### Reference

SAS Institute Inc. 2005. SAS OnlineDoc® 9.1.3. Cary, NC: SAS Institute Inc.