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A COMPARISON OF PRODUCTION AND SOILS IN A MODIFIED MIXED PRAIRIE COMMUNITY

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ABSTRACT
This study examined the effects of reseeding a *Stipa-Agropyron-Bouteloua* community to monocultures of crested wheatgrass (*Agropyron cristatum* (L.) Geartn.), Russian wild rye grass (*Elymus junceus Fisch*.), and wheat (*Triticum aestivum* L.) on above and below ground biomass and indicators of soil quality. Summer fallowed wheat produced 10817 kg ha^{-1} and 4090 kg ha^{-1} of above ground below ground biomass respectively whereas the native community produced 3191 kg ha^{-1} above ground and 13013 kg ha^{-1} of below ground biomass. However wheat, crested wheatgrass and Russian wildrye grass generally showed a lower biological index, phosphatase and dehydrogenase activity.

KEYWORDS
Mixed prairie, standing crop, root production, soil

INTRODUCTION
The production goals of agriculture have resulted in tremendous changes to land-use on the prairies. A century ago the Northern Great plains in Canada were used primarily for grazing but today over 70% have been dedicated to the production of cereal and forage crops. The cropping of these lands may lead to reduced soil quality and eventually reduce profitability. A comparison between production of native species and agronomic systems and their effect on the soil have not been well documented. An insufficient number of studies, inadequate methods of study, and flawed experimental designs have contributed to a lack of understanding. Negative effects of converting native prairie to a monoculture might be expected if native grasslands communities have evolved for optimal exploitation of the environment. Any change would then be considered retrogressive. However, conclusions cannot be made since evidence is lacking.

The effect of converting native grasslands to agronomic monocultures are expected to show differences in production and soil quality over time. It is hypothesized that the above ground production of seeded forages and cereals will be greater than that of the *Stipa-Bouteloua -Agropyron* community in the first few years. During that time the quality of the soil will deteriorate and ultimately result in a decrease in the production of the forages and cereals. The purpose of this research is to compare the short term effects between seeded monocultures and a native grass community.

MATERIALS AND METHODS
SITE DESCRIPTION
The research was conducted on a *Stipa-Agropyron-Bouteloua* community in the mixed prairie near Lethbridge, Alberta (lat. 49o 43íN, long. 112o58í W). The average annual precipitation is 42 cm with a peak occurring in May and June. The bedrock consists of sandy shales, sandstone and coals overlain with glacial tills. The soils are classified as Orthic Dark Brown Chernozems. (Typic Haploboroll). The *Stipa- Agropyron-Bouteloua* faciation of the mixed prairie was described by Coupland (1961). The major grasses are needle and thread (*Stipa comata* Trin. & Rupr.), blue grama grass (*Bouteloua gracilis* (H.B.K.) lag. Ex Steud), western wheatgrass (*Agropyron smithii* Rydb.), June grass (*Koelaria macrantha* (Ledeb.), and green needle grass (*S. viridula* Trin.). Other graminoids are thread leaved sedge (*Carex filifolia* Nutt.) and low sedge (*C. stenophylla* Wahleng.) while pasture sage (*Artemisia frigida* Willd.) is an important forb.

DESIGN AND ANALYSIS
The different agronomic systems compared were wheat (*Agropyron aestivum* L.) - continuously cropped (WhCo), wheat summerfallowed (WhFa)), crested wheatgrass (*A. cristatum* (L.) Gaertn.), and Russian wildrye (*Elymus junceus* Fisch.). These were compared to the native community within a randomized complete block design having four replicates. The study was established in 1993 and sampled in 1995.

The above ground biomass was estimated in early August by harvesting 2 - 0.5 x 0.5 m subplots. The herbage was separated into current years growth and standing litter. The roots were sampled before growth was initiated in early April and when growth was terminated in the fall. Three, 2-cm. cores were taken from each treatment. Treatment effects were tested using an ANOVA. Paired treatment means were compared using a single degree of freedom (Steel and Torrie, 1980).

The Ah soil horizon was sampled in early April and October and analyzed for phosphatase, dehydrogenase and biological index of available soil nitrogen. (Keeney, 1982).

RESULTS AND DISCUSSION
Above ground biomass of summer fallowed wheat production (10817 kg ha^{-1}) was significantly greater than all of the other treatments while Russian wildrye grass (1209 kg ha^{-1}) and native range (3191 Kg ha^{-1}) possess the least standing crop. Crested wheatgrass (4104 kg ha^{-1}) and continuous seeded wheat (6096 kg ha^{-1})did not differ significantly in standing crop. This supports the hypothesis that differences between above ground biomass of native grasslands and cultivated forages and cereal crops occur during early establishment and data presented by Porter *et al*. (1995). The productivity of the Russian wildrye grass may not have been complete since growth may have occurred after the August harvest. High above ground in wheat and crested wheatgrass were generally associated with reduced activities of phosphatase, hydrogenase, and a smaller biological index (Table 1). This possibly indicates reduced quantities of exudates as compared with the native grass (Biondini *et al*., 1988)

The production of roots of the *Stipa-Bouteloua-Bouteloua* community (15820 kg ha^{-1}) and Russian wildrye grass (15620 kg ha^{-1})were significantly greater than that all other treatments. The two wheat treatments (fallow and continuously cropped) had significantly lower root production than perennial grass communities (Crested wheatgrass and Russian wildrye). (Fig.1). The lower root growth of the wheat reflects movement of the available resources from the root into stem and seed. In Russian wildrye extensive root production may be indicative of its ability to resist senescence in late summer.

The flux of CO_2 from the soil is the net effect of respiration in the soil. The higher CO_2 flux in perennial forages and native grasses remain higher throughout the year and may be related to higher soil temperatures and prolonged growth period exhibited by the perennial species.

This research shows that in the short term introduced cereal and forage crops show greatest above ground production. The annual cereals show the smallest root to shoot ratio while the native grass community shows the greatest root to shoot ratio. Research is

continuing in order to consolidate the observations and determine the sustainability of these practices.

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Figure 1
Comparison of standing crop and root production of modified communities in a Stipa-Agropyron-Bouteloua community. Symbols : Native - Stipa-Agropyron-Bouteloua community, CWG -Crested wheatgrass, RWR - Russian wildrye, WhFa -Summer fallowed wheat and WhCo - Wheat continuously cropped.

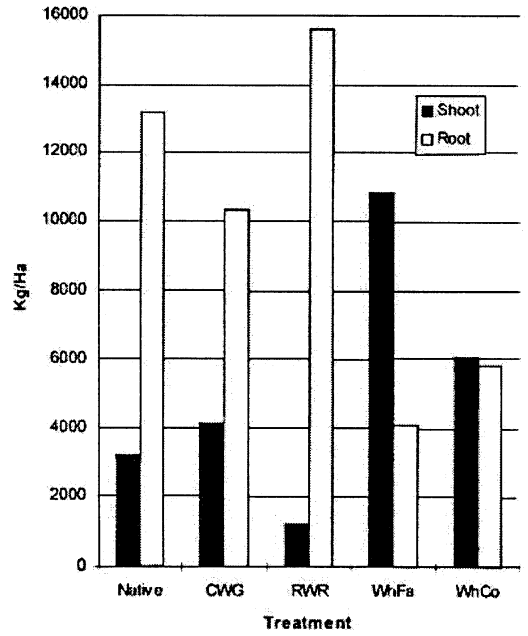

Table 1
Effects of converting native prairie to agronomic communities

Variable	Native prairie	Crested wheat-grass	Russian wild rye grass	Wheat (fallow)	Wheat (cont.)
CO_2 Flux	*u*mole m^2 s^{-1}				
Spring	2.379	2.957	2.672	1.778	1.565
Summer	5.347	4.864	5.214	4.150	3.333
Fall	1.303	1.050	0.536	0.484	0.697
Soil Temperature	^{0}C.@2.5 cm				
Spring	14.160	22.319	20.389	23.400	23.068
Summer	25.423	31.044	29.116	23.820	25.602
October	17.925	22.377	22.085	19.024	19.907
Phosphatase[1]					
April	963.53	595.02	556.12	546.93	531.00
October	590.66	482.69	442.41	494.51	420.66
Dehydrogenase[2]					
April	158.32	135.31	118.03	93.37	98.50
October	97.46	129.68	110.91	131.56	109.71
Biological Index[3]					
April	86.12	79.43	74.19	49.64	63.49
October	80.47	79.55	84.59	70.60	63.90
% Moisture[4]					
April	24.95	9.67	9.16	11.13	14.74
October	24.54	20.68	19.28	21.3	19.14

[1] *u*g PNP g^{-1} dry soil h^{-1}
[2] nm Formazan g^{-1} dry soil h^{-1}
[3] *u*g NH_4 + N g^{-1}soil
[4]% dry weight