Effect of Grazing and Re-Establishment of Native Species on Soil Organic Matter Sequestration for the Semiarid Central Grasslands of Canada

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Introduction The native mixed grass prairie in North America is estimated to have been reduced to 20 to 30% of its former extent, due to agriculture expansion and urbanization. Aside from the importance that native grasslands play as a repository for biodiversity, wildlife habitat and a grazing resource, the restoration and maintenance of native grasslands can provide an important opportunity to mitigate greenhouse gas concerns through soil organic carbon (SOC) sequestration. Native grasses have more extensive rooting system than tame species, and higher specie richness can result in higher SOC potential (Wedin and Tilman 1996). Objective of this research was to evaluate the impact that grazing and non-grazing treatments and different native mixtures have on SOC sequestration potential in newly established native pastures.

Materials and methods Sixteen pastures (2 ha ea) were randomly set up in a 2×2 factorial design with four replicates: two native mixtures [7 species simple (S) or 14 species complex (C)] and two grazing utilization levels [low (40-50%) and high (60-70%)]. Seeding occurred in the spring of 2001 using a double disk air seeder. Seeding rate for the S and C mixes were 9.5 kg ha^{-1} [25 pure live seeds (PLS) per 0.30 m^2] and 9 kg ha^{-1} (33 PLS per 0.30 m^2), respectively. Cattle grazing were from the end of June to September and in 2002, 2003 and 2004. In each pasture a permanent enclosure (3.6×3.6 m) was used as the non-grazing treatment. In all pastures, SOC samples were taken in the fall of 2000 and 2004. Prior to soil sampling all surface residues in the area were cut and the soil surface flattened. In 2000, soil samples were taken from five different location sites, while in 2004 only three different location sites were used. At each location site, core samples were taken at six micro-sites and at 0-15, 15-30, 30-45 and 45-60 cm. Determination of soil bulk density and sieving the soil sample through a 2-mm wire sieve were done. Representative sub-samples were ground and analyzed for SOC (McConkey et al. 2003). Data was analyzed using the MIXED procedure from SAS Institute, Inc. (2000).

Results and discussion Average annual C sequestration rate on the newly established native pasture was 530 kg ha^{-1} yr^{-1}. In support, a study by Mensah et al. (2003) on dark Brown and Black soils in Saskatchewan compared favourably to our results. Favourable moisture conditions and forage productivity generally occurred for our study, which contributed to the excellent C sequestration potential. A seed mixture x pasture utilization ($P < 0.05$) interaction was observed and orthogonal contrasts were used. The simple+high (S+H) treatment gave the highest ($P < 0.05$) SOC level compared to complex + low (C+L), S+L and C+H and the SOC changes were 3.59, 2.03, 1.47 and 0.94 ± 0.68 Mg C ha^{-1}, respectively. Higher SOC associated with the S+H may be due to more livestock hoof action breaking down and incorporating the standing dead and litter into the soil and enhancing decomposition and reducing loss through oxidation (Schuman et al. 1999). Highest pasture forage production was observed for the S native mix, thus higher SOC levels were not unexpected.

Conclusion Excellent C sequestration rates can be achieved on newly established native pastures on brown soil land previously annually cropped. Pasture forage production and animal stocking rates can affect C sequestration levels.

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