Pasture Management Strategies for Sequestering Soil Carbon

Agricultural Research Service

Alan J. Franzluebbers
1420 Experiment Station Road, Watkinsville GA 30677
afranz@arches.uga.edu

Objectives

Determine rate and magnitude of soil organic C (SOC) sequestration, depth distribution of SOC, and biochemical quality of SOC.

Elucidate the biological and/or environmental controls that might contribute to greater SOC sequestration in endophyte-infected tall fescue.

Hypotheses

High endophyte–low alkaloid plant material (i.e., Newly available genotype) will lead to SOC sequestration equal or greater than high endophyte –high alkaloid plant material and significantly greater than endophyte-free plant material.

SOC sequestration will be rapid during establishment (i.e., first 5 years) of tall fescue because of surface litter accumulation and senescent root deposition. Rate and magnitude of SOC sequestration in tall fescue (adaptable, cool-season perennial forage with major growth in spring and variable growth in fall and summer) will be more rapid than in hybrid bermudagrass (warm-season perennial forage with growth only in summer).

Poultry litter application will enhance the rate of SOC sequestration in endophyte-infected tall fescue more than in endophyte-free tall fescue.

Poultry litter application will enhance SOC sequestration compared with inorganic fertilizer.

Cattle grazing will increase SOC sequestration compared with hay removal.

Approach

A 20-ha parcel of land located near Watkinsville GA (33° 62' N, 83° 25' W, 230 m above mean sea level) was divided into 14, 1-ha experimental paddocks. Long-term mean precipitation is 1250 mm and temperature is 16.5 °C. Soil at the site is Cecil sandy loam (80%), Pacolet sandy clay loam (12%), and Appling sandy loam (8%) (fine, kaolinitic, thermic Typic Kanhapludults). Treatments include 3 tall fescue genetic sources factorially arranged with 2 fertilizer sources and replicated twice. 2 additional paddocks will be ungrazed.

Review of relevant results

SOC under tall fescue with high endophyte infection was 18% greater at a depth of 0-2.5 cm than under tall fescue with low endophyte infection.

Soil properties (0-15 cm depth) under tall fescue as affected by endophyte infection level (data from Franzluebbers et al., 1999).

Soil property	Endophyte level High		Low
Total organic C ($Mg \cdot ha^{-1}$)	31.2	**	29.1
Potentially mineralizable C ($kg \cdot ha^{-1} \cdot d^{-1}$)	48.5	*	53.9
Ratio of mineralizable-to-total	1.56	**	1.87

* and ** are significant at $P \leq 0.1$ and $P \leq 0.01$, respectively.

In addition to differences in the quantity of SOC, particulate organic C and N (i.e., macroorganic matter >0.25 mm, which is indicative of plant root residues below the surface layer) were 12 and 21% greater, respectively, with high than with low endophyte infection (Franzluebbers et al., 2002).

On-going analyses indicate that soil microbial activity may indeed be adversely affected by the endophyte.

Significance

To a depth of 15 cm, SOC under tall fescue with high endophyte infection was an average of 1.8 $Mg \cdot ha^{-1}$ greater than with low endophyte infection. This difference in SOC storage between two very desirable soil conservation and animal production strategies even approaches the increase in SOC upon conversion of management in the same region from conventional-tillage crop production (i.e., a typically degraded situation) to no-tillage crop production (i.e., an often-reported improved situation).

References

Franzluebbers AJ, Nazih N, Stuedemann JA, Fuhrmann JJ, Schomberg HH, Hartel PG. 1999. Soil carbon and nitrogen pools under low- and high-endophyte-infected tall fescue. *Soil Science Society of America Journal* 63:1687-1694.

Franzluebbers AJ, Stuedemann JA. 2002. Particulate and non-particulate fractions of soil organic carbon under pastures in the Southern Piedmont USA. *Environmental Pollution* (in press).