Twice-Over Grazing System Improves Soil Quality

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Grazing native rangeland in rotational periods that are coordinated with grass growth stages stimulates fungus activity that improves soil structure, says a North Dakota State University range scientist.

In a recent study, Lee Manske, of the NDSU Dickinson Research Extension Center, and TheCan Caesar-TonThat, of USDA Agricultural Research Service at Sidney, Montana, discovered a beneficial group of fungi associated with roots of grass plants managed with the twice-over rotation grazing system. A technique developed by Caesar-TonThat detected and quantified the previously unknown organisms.

"The fungi are part of the rhizosphere, the narrow zone of soil surrounding the roots of perennial plants," Manske explains. "The discovery of these organisms is important because they are the only ectomycorrhizal fungi that have been found in association with herbaceous plant roots in the mixed grass prairie. Ectomycorrhizal fungi are fungi that do not invade the tissue of the host plant with which they exist in a mutually beneficial relationship. The action of the ectomycorrhizal fungi improves the quality of the soil, making the organisms extremely beneficial to the grassland ecosystem."

The ability of the fungi to enhance soil quality stems from the organisms' excretion of large amounts of adhesive substances that stabilize soil particles and bind them into water-stable aggregates. An increase in water-stable aggregates increases soil pore size and distribution. Further, because the aggregates do not break down when the soil is wetted, their presence helps prevent pores from becoming blocked by dispersed soil particles. The changes result in increased soil oxygenation, water infiltration, and root distribution and in decreased erodibility. These improvements in soil quality are advantageous for increased herbage production.

The rhizosphere contains organisms whose complex system of interactions developed in conjunction with the coevolution of grasses and grazing mammals, Manske explains. The activity of these rhizosphere organisms in association with grass roots is beneficial to both grass plants and rhizosphere organisms. The activity is also critical for grassland ecosystem functions and for energy and nutrient flow through the ecosystem.

Activity levels of rhizosphere organisms are greater on pastures managed with the twice-over rotation system than on pastures under seasonlong grazing. The factor believed to be responsible for the increase is the twice-over rotation system's coordination of grazing with grass growth stages, which stimulates the active passage of greater quantities of carbon compounds such as simple sugars through the grass plant roots. The carbon compounds exuded into the zone of soil around the grass plant roots accelerate rhizosphere organism activity and the biogeochemical cycles of the grassland ecosystem.

"Grasslands are complex ecosystems whose above- and below-ground components interact by stimulation, response, and feedback processes," Manske says. "When all of the interrelated components are functioning properly, the ecosystem is healthy and productive. The key factor in sustaining grassland ecosystem performance at potential levels is properly timed grazing by large herbivores. This action stimulates ecological processes and produces conditions that meet the biological requirements of the components of the ecosystem."

"The capacity of the twice-over rotation grazing management system to enhance the activity levels of rhizosphere fungi that can improve the soil quality in grasslands is a significant finding," Manske says. "The grazing system's potential for improving and sustaining grassland ecosystem health is of considerable importance for the development of ecologically sound management strategies."