Ranchers Taught How to Increase Fungi Capable of Improving Soil Structure and Agricultural Economy

Llewellyn L. Manske PhD
North Dakota State University
Dickinson Research Extension Center

North Dakota State University Extension Service and NDSU Dickinson Research Extension Center sponsored grazing schools to teach beef producers grazing management techniques that stimulate activity of recently discovered beneficial fungi. These fungi can improve soil structure and can lead to enhanced quality of natural resources and improved profit margins.

The previously unknown group of ectomycorrhizal fungi was discovered during a recent study conducted by Lee Manske, of NDSU Dickinson Research Extension Center, and TheCan Caesar-TonThat, of USDA Agricultural Research Service at Sidney, Montana. The fungi were found in association with roots of grass plants managed with the twice-over rotation grazing system and are part of the rhizosphere, the narrow zone of soil surrounding the roots of perennial plants. The discovery of these organisms is scientifically important because they are the only ectomycorrhizal fungi to have been found in association with herbaceous plant roots in the mixed grass prairie. Ectomycorrhizal fungi are slow growing and were previously thought to occur almost exclusively in associations with woody plants such as spruce trees, whose root systems are long lived.

An enzyme-linked immunosorbent assay (ELISA) technique developed by Caesar-TonThat identified the newly discovered rhizosphere organisms as ectomycorrhizal fungi belonging to the Homobasidiomycete class and the Russuloid clade. Ectomycorrhizal fungi are unlike the common endomycorrhizal fungi, vesicular-arbuscular mycorrhizae, whose structures enter the tissues of the plant with which the fungi exist in a mutually beneficial relationship: the hyphae of the ectomycorrhizal fungi do not enter the tissue of the plant but develop a sheath around its roots.

The activity levels of rhizosphere organisms are greater on pastures managed with the twice-over rotation system than on pastures under other grazing management. The reason for this increased activity is the twice-over rotation system's coordination of grazing with grass growth stages. Defoliation of grasses at some plant growth stages stimulates soil organism activity by promoting 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 ecosystems.

The ability of ectomycorrhizal fungi to improve soil quality results from their excretion of large amounts of insoluble polysaccharides with adhesive qualities. These substances stabilize soil particles and bind them into water-stable aggregates. An increase in water-stable aggregates increases soil pore size and distribution. The changes in soil quality improve soil oxygenation, water infiltration, and root distribution and decrease erodibility. The rooting depth of rangeland soils at the location where ectomycorrhizal fungi were first discovered increased from 2-3 inches to 18-24 inches after seven years of management with the twice-over rotation system.

Ongoing research efforts are exploring the fungi's potential to enhance the sustainability of agricultural use of natural resources, to increase productivity of rangeland and cropland soils in the Northern Plains, and to substantially enhance the region's agricultural economy. Caesar-TonThat is investigating the possibility of inoculating worn-out cropland soils with culture-grown ectomycorrhizal fungi to restore the soil structure and increase the productivity levels of the region's agricultural lands. Manske is investigating the enhancement of productivity of rangeland soils and continues to conduct grazing schools to teach regional livestock producers the grazing management techniques that stimulate soil fungal activity.

Acknowledgment

I am grateful to Amy M. Kraus for assistance in preparation of this manuscript. I am grateful to Sheri Schneider for assistance in production of this manuscript.