Stimulation of Ecosystem Biogeochemical Processes with Grazing

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- The renewable forage plant nutrients produced on the land are the primary unit of production in the beef industry.
- Forage nutrient production, capture, and conversion to a saleable product can be increased from a land base through biologically effective pasture-forage management practices.
- In grassland ecosystems, the nutrients are cycled by biogeochemical processes in conjunction with a symbiotic relationship among grass plants, rhizosphere organisms, and grazing animals.
- The nitrogen biogeochemical cycle provides protein.
- The carbon biogeochemical cycle provides energy.

Symbiotic Biogeochemical Cycles

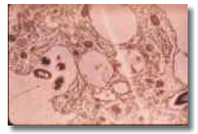
- Grassland soils contain 5 to 8 tons of organic nitrogen per acre, which is the form of nitrogen not usable by grass plants.
- Rhizosphere organisms convert the organic nitrogen in soil organic matter into mineral nitrogen, which is the form of nitrogen usable by grass plants.
- During photosynthesis, plants fix carbon and oxygen from atmospheric carbon dioxide with hydrogen from soil water, forming carbohydrates (CH_2O) (carbon compounds with stored chemical energy) and giving off oxygen.
- Grass plants that are between the three and a half new leaf stage and the flowering stage release some of the carbon compounds through the roots and into the rhizosphere when grazing animals remove 25% to 33% of the leaf tissue from the plants.
- Activity of rhizosphere organisms increases with the increase in available carbon compounds.
- Elevated microorganism activity in the rhizosphere results in an increase in mineral nitrogen available for grass plant use.
- Increases in plant-available mineral nitrogen enable grasses to increase growth and produce greater quantities of herbage crude protein; increased growth causes increased photosynthetic activity, which produces greater quantities of carbon compounds.
- Greater quantities of protein and energy nutrients produced per acre result in greater weight of saleable beef produced per acre.

Microfauna

Protozoa - are single-celled microorganisms classified into three groups based on shape: Amoebae, which are large and move by means of a temporary foot, are the most common protozoa in grassland soils; Flagellates, which are the smallest and move by whip-like flagella, are present in grassland soils; Ciliates, which are the largest and move by means of hair-like cilia, are rare in grassland soils. Protozoa feed primarily on bacteria, which contain more nitrogen than protozoa need. Protozoa excrete the excess nitrogen as ammonium (NH_4).

Photo from J.P. Martin

Amoeba ingesting bacteria.



Nematodes - are small nonsegmented worms. Nematodes are a diverse group: most feed primarily on bacteria or fungi, some feed on protozoa, and some eat other nematodes. Most nematodes are beneficial; some cause disease. Bacteria and fungi contain more nitrogen than nematodes need. Nematodes excrete the excess nitrogen as ammonium (NH_4).

Photo from H. Garrett

Beneficial nematode.

Microarthropods

Springtails (Collembola) - are minute insects about 0.25 inches long. They are the most abundant arthropod in grassland soils. Springtails escape predators by releasing the tail (furcula) that is clasped under their abdomen and propelling themselves 3 to 4 inches. Springtails ingest considerable quantities of soil organic matter in order to eat fungi and bacteria, which contain more nitrogen than springtails need. Springtails excrete the excess nitrogen as ammonium (NH_4).

Photo from A.R. Moldenke

Blind fungal-feeding springtail.

Photo from G. Eisenbeis and W. Wichard

Springtail with furcula released.

Mites (Acarina) - are small eight-legged arachnids. Mites feed primarily on fungi and nematodes; some eat springtails and other mites. Mites help distribute fungus spores and bacteria through the soil by carrying them on their exoskeleton.

Photo from G. Eisenbeis and W. Wichard

Predatory mite.

Microflora

Bacteria - are microscopic single-celled organisms. An acre of grassland may contain bacterial biomass equal to two cows. Bacteria consume soil organic matter and the simple carbon compounds exuded from plant roots. The quantity of plant exudates regulates bacteria populations. Bacteria contain a high concentration of nitrogen.

Photo from M.T. Holmes

Bacteria are 4/100,000 of an inch (1 μ m) wide.

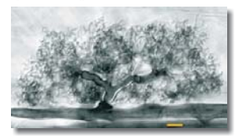
Endomycorrhizal fungi (Phycomycetes) - form symbiotic relationships with grassland plants. The vesicles, arbuscules, and hyphae of the vesicular-arbuscular mycorrhizal fungi enter the cells and tissue of the host plant. Endomycorrhizal fungi move phosphorus, other mineral nutrients, and water to the plant for absorption. The symbiotic function of the mycorrhizal fungi is to convert ammonium (NH_4) into nitrate (NO_3), which is the form of mineral nitrogen usable by plants. Mycorrhizal fungi excrete adhesive polysaccharides that help to bind soil into aggregates and to bond soil particles around plant roots and form the rhizosphere.

Photo from R. Campbell

Fungal hyphae strands with bacteria on the surface.

Photo from M. Brundrett

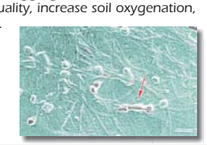
Arbuscules and vesicles of a mycorrhizal fungus within root tissue.



Ectomycorrhizal fungi (Homobasidiomycetes) - form symbiotic relationships with grassland plants. The hyphae develop a sheath around the root and do not enter the tissue of the host plant. Ectomycorrhizal fungi excrete large amounts of adhesive polysaccharides that form water-stable aggregates in soil. Increases in water-stable soil aggregates, which are water permeable but not water soluble, improve soil quality, increase soil oxygenation, increase water infiltration, and decrease erodibility.

Photo from T.C. Caesar-TonThat

Ectomycorrhizal fungus with extracellular polysaccharides.



Rhizosphere - is the narrow zone of soil surrounding living roots of perennial grass plants; here the symbiotic soil organisms (microflora, microfauna, and microarthropods) interact as a complex trophic web that is critical for energy and nutrient flow in grassland ecosystems. Rhizosphere organisms trade nitrogen to grass plants for carbon, and grass plants trade carbon to microorganisms for nitrogen.

Photo from J. Barrows

Rhizosphere with soil particles bound to plant roots by polysaccharides secreted by mycorrhizal fungi.

More Information on Biologically Effective Management of Graziinglands is available on the web at: **www.GrazingHandbook.com**

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