

Soil Food Web

C. Nivetha¹, N. Gobikashri² and S. Punithkumar³

¹Assistant Professor, Department of Agronomy, Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal - 609603, India

²Ph.D. Research Scholar, Department of Agronomy, Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal - 609603, India

³PG Research Scholar, Department of Agronomy, Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal - 609603, India

Corresponding Author: sandippatra47@gmail.com

Introduction

Soil food web is a natural network of consumer resource interactions among different functional groups of soil organisms which occur in the soil ecosystem. Soil is a complex, unconsolidated mixture of inorganic, organic, and living material that is found on the immediate surface of the earth that supports many important functions for plants, animals, and humans. The soil food web is very dynamic, complex and interchanging depending on its ecosystem. The interactions found in the food web are soil organisms living all or part of their lives in the soil while producing energy and working together with plants to survive.

The organisms found in the soil food web carry out a large number of microbial processes such as decomposition, mineralization, immobilization, respiration, and fixation along with many others. These processes help to support above and below-ground plant growth and their processes make nourishment for plants.

The soil food web consists of bacteria, fungi, including protozoa, nematodes, micro arthropods and a range of above ground predators, from earthworms to spiders, mice, birds etc. These food web varies with soil types (mineral composition, depth of horizons, structure, texture, etc) organic food resources present, prevailing temperatures, climate, etc. Food webs are used to know different energy interactions in a given ecosystem.

Soil Food Web - Definitions

- ❖ "An assemblage of populations of plants, animals, bacteria and fungi that live in an environment and interact with one another, forming together a distinctive living system with its own composition, structure, environmental relations, development and function" -- R. Whittaker (1975).

- ❖ "A collection of organisms in an environment" J. Emlen (1977).
- ❖ "Organisms that interact in a given area" P. Price (1984).
- ❖ "Associations of plants and animals that are spatially delimited and that are dominated by one or more prominent species or by a physical characteristic" R. Ricklefs (1990).
- ❖ "The species that occur together in space and time" Begon, Harper, and Townsend (1996).

Characteristics of Healthy Soil Food Web in Per Gram Soil

- ❖ 600 million bacterial individuals.
- ❖ 15,000 to 20,000 bacterial species.
- ❖ 150 to 300 meters of fungal biomass.
- ❖ 5,000 to 10,000 fungal species.
- ❖ 20,000 protozoa.
- ❖ 20 to 30 beneficial nematodes.
- ❖ 200,000 arthropods.

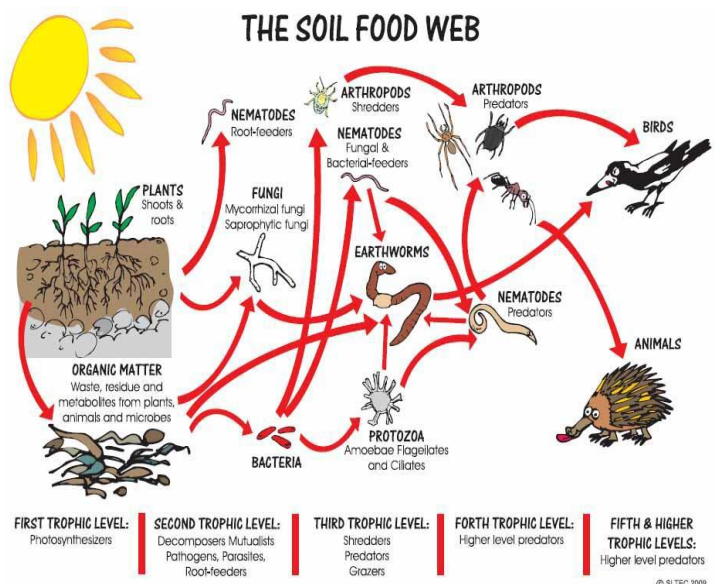


Fig 1. Soil organisms and their interactions in soil food web

Typical Numbers of Soil Organisms in Healthy Ecosystems

	Agricultural Soils	Prairie Soils	Forest soils
Bacteria	100 million to 1 billion	100 million to 1 billion	100 million to 1 billion
Fungi	Several yards (Dominated by VAM fungi)	Ten to hundreds of yards. (Dominated by VAM fungi)	Several hundred yards in deciduous forests. One to forty miles in coniferous forests
Protozoa	Several thousand flagellates and amoebae, one hundred to several hundred ciliates	Several thousand flagellates and amoebae, one hundred to several hundred ciliates	Several hundred thousand amoebae, fewer flagellates
Nematodes	Ten to twenty bacterial feeders. A few fungal feeders. Few predatory nematodes	Ten to several hundred	Several hundred bacterial and fungal feeders. Many predatory nematodes
Arthropods	Up to one hundred	Five hundred to two thousand	Ten to twenty-five thousand. Many more species than in agricultural soils
Earthworms	Five to thirty. More in soils with high organic matter	Ten to fifty. Arid or semi-arid areas may have none	Ten to fifty in deciduous woodlands. Very few in coniferous forests

A healthy food web occurs when

1. **Present & Accounted For:** All the organisms the plant requires are present and functioning. These include mycorrhizal fungi, beneficial bacteria, protozoa, nematodes and microarthropods.
2. **Take Up of Nutrients:** Nutrients in the soil are in the proper forms for the plant to take-up. It is one of the functions of a healthy food web to hold nutrients in non-leachable forms so they remain in soil, until the plant requires the nutrients. Then the plant “turns-on” the right biology to convert the nutrients into forms the plant can take-up. These nutrients are typically very leachable.
3. **Ratio Levels are correct:** The correct ratio of fungi to bacteria is present, and ratio of predator to prey is present, so soil pH, soil structure, and nutrient cycling occur at the rates and produce the right forms of plant nutrients.

Functions of Soil food web

- ❖ Nutrients are cycled into the right forms at the right rates for the plant. The correct ratio of fungi to bacteria is needed for this to happen, as well as a balanced level of natural predator activity.
- ❖ Building the soil structure, so that the oxygen, water and other nutrients can easily absorb

into the soil thus permitting plants to develop a deep, well-structured root system. When the biology is functioning properly, water use is reduced, the need for fertilizers is reduced, and plant growth is increased.

- ❖ Retention of nutrients so they do not leach or pass off as vapour from the soil.
- ❖ Suppression of disease-causing organisms via competition with beneficial, by setting up the soil and foliar conditions so as to assist the beneficially as opposed to diseases.
- ❖ Protection of plant surfaces, above or below ground, this is achieved by making certain the foods created by the plant surfaces release into the soil and are used by beneficial, not disease organisms, thereby ensuring that infection sites on plant surfaces are occupied by beneficial, and not disease-causing organisms.
- ❖ Retaining the natural nutrients means a decrease in the need for fertilizer usage.
- ❖ Production of plant-growth-promoting hormones and chemicals that assist in plants developing larger stronger root systems.
- ❖ Control of toxic compounds through the breakdown or decay of these organic materials.

Enhancement of Soil Food Web

- Vermicompost (worm farming)
- Using of Organic matter
- Plant ferments such as comfrey tea or nettle tea
- Mycorrhizal inoculants (fungi)
- Chop and drop of tree and biomass plants
- Application of biofertilizer and minimum/no use of chemical fertilizer
- Rotational grazing and animal integration
- Growth of plant in multi-layered
- Biodiverse plantings and Azolla planting
- Hot compost
- Teas and extracts derived from compost sources
- Rhizobium Inoculants (nitrogen fixing bacteria)
- Earthworm, which stabilize soil system
- Humanure

Maintenance of Soil Food Web

Bacterial dominance is maintained by mixing plant material into the soil. Plant material needs to be mixed in enough to maintain bacterial dominance, but too much mixing results in soil degradation. But the bacteria and fungi eat this material at an incredibly rapid speed. Fungi can be maintained by letting litter accumulate on the soil's surface.

Larger soil organisms like millipedes, centipedes, earthworms, and ants mix plant material into soil and open-air channels, especially important in wet periods in heavy clay soils. It's important to remember that grassland, garden and forest soils represent a gradient from bacterial to fungal dominance. Gardens require equal amounts of bacteria and fungi, while trees require fungi.

A healthy food web ensures that nutrient cycling speeds along giving the plants exactly what they need and through symbiosis the plant is

providing the soil food web the food resources and overall niche for their proliferation. By breaking down carbon structures and rebuilding new ones or storing the carbon into their own biomass, soil biota plays the most important role in nutrient cycling processes.

Conclusion

Soil food web is a natural network of consumer resource interactions among different functional groups of soil organisms which are occur in the soil ecosystem. There are diverse group of organisms contribute in this food web. Nematodes, which have a great number and live freely in the soil food web in decomposing soil organic matter and mineralizing nutrients. Bacterial- feeding nematodes and fungal nematodes have more important role of decomposing and mineralizing than other types of nematodes, and plant-feeding nematodes give negative effect on plant growth. Liquid composts will also give great benefits, as long as the organisms are present and functioning in the liquid compost, or aerated compost tea. Therefore, the beneficial predator prey interaction produces plant available nutrients which create conditions for optimal photosynthesis to occur. When the food web is strong, the plant is strong, which help with pest and disease resistance and provide food for diverse group heterotrophs or no photosynthetic organisms by means of photosynthesis process. (Rajeev Ranjan *et al.*, 2015).

References

- Howard Ferris. Contribution of Nematodes to the Structure and Function of the Soil Food Web, *Journal of Nematology* 42(1): 63-67. 2010.
- Ingham ER. Benefits of the soil food web. *Soil microbiology*, 2005, 6-8.
- Rajeev Ranjan, M. Divya and M. Bavitha. The importance of soil food web for healthy environment and sustainable development, *IJAR* 2015; 1(3): 15-20.
