

Secrets of great soil

Beautiful flowers and bountiful vegetables start with the rich earth



Sift a double handful of garden soil and you're holding a largely unknown universe of microbes. Their mysterious interactions determine fertility. They give life to soil. Without them, it dies. With them, it breathes, lives, and becomes ever richer.

A gardener's real job involves working with those microbes, keeping them in balance, urging them to help pull together to produce bountiful crops and beautiful flowers.

Scientists understand only a small part of this unusual underground world. They do, however, know microbes fit several categories. Grazers are arthropods, like spring-tails, that feed on fungi and release nutrients which plants use. Herbivores, on the other hand, may damage plants by feeding on roots.

Bacteria and certain fungi can form symbiotic relationships with roots and supply nutrients to them. They give healthy soil its distinct smell. Protozoa both stimulate and control activity of bacterial populations.

Nematodes come in many types, and may be either good or bad, from a plant survival standpoint. Predators are the hunters of the soil world. Shredders help make the organic matter so necessary for healthy soil. Earthworms may be the ultimate shredder, spreading plant litter and improving soil structure.

Researchers can't even begin to pinpoint the number of microbes working in the soil or just what they all do. "There can be millions and millions in one gram of soil," says Mike Hubbs, national agronomist with USDA's Natural Resources Conservation Service in Washington, D.C.

Big numbers, big impact. "The number is big and we don't know exactly what all of them are or what they do," says Bonnie Ownley, University of Tennessee plant pathologist studying soil-borne pathogens.

She recommends that gardeners keep the microbe population balanced so that no single harmful pathogen spins out of control. "Take a holistic approach, using the right cultural practices, resistant plants, and rotation. If the soil microbes get out of balance, we create conditions favorable to pathogens," she says.

Doing that balancing act should involve several steps, Hubbs says. First, feed the soil. Add organic matter in the form of grass clippings, leaves, compost, or old crop material.

Next, seed a cover crop. Legumes like crimson clover or hairy vetch may produce as much as 60 pounds of nitrogen per acre. Rye or wheat can work well by taking up excess nitrogen. It's good to have organic matter on the soil when preparing for spring planting.

Leave some of that residue on the soil surface. If you conventionally till, consider putting wheat straw on the soil to reduce erosion, choke weeds, and hold water during drought. As the residue decays, it feeds soil microbes and improves tilth and adds organic matter.

If you use no-till or reduced tillage, simply cut a slit into the dead cover crop and allow it to decay naturally. Some growers now push a cover crop, like rye, in one direction, making planting and weed control easier.

"A friend of mine got remarkable soil quality improvements in a garden by putting grass clippings on it all summer. There was good earthworm activity and the soil had excellent tilth," Hubbs says.

"Earthworms get a lot of the credit for helping create good soil. If you go out in the garden and find earthworm casts and burrows, that's good. They'll take residue into the burrows, which helps organic matter."

Rotation helps. You'll do a better job of keeping that balance in the soil if you rotate crops from one year to the next. That means not growing the same type plants in the same place in the garden year after year.

"Disease builds up, otherwise. Rotation breaks the cycle so some disease and fungal communities starve out," Hubbs says.

Understanding how plant pathogens work can help you fight them, as well. "Be aware of what pathogen it is and how long it remains present in the soil," Ownley says.

In many states, including Tennessee, where Ownley works, the Extension service runs disease diagnostic tests to help nail down a sometimes baffling array of plant pathogens.

"If you have a disease problem, after the season is over, pull those plants out of the ground and take the dead leaves away. You want to destroy the food base for those pathogens and get that plant material to break down quickly," she says.

A complex system. Scientists may not know exactly what's happening in that double handful of soil out in the garden. They do see it as a complex, interacting food web. It's a world of heterotrophs that break down organic compounds, phototrophs that live on light, and chemotrophs that oxidize inorganic compounds like nitrite, sulfur, and ammonium.

A million one-celled bacteria may fit in a teaspoon but they're all key in stimulating root growth and nutrient uptake. Teeming with activity, that root zone is a dynamic system of life, change, struggle, and death.

"Soil breathes," Hubbs says. It's alive, and it may need a little help. ■

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By Charles Johnson

ILLUSTRATION: PAUL LANGE



Top: A wide range of microbes work together to produce healthy, fertile soil. **Above:** Any garden benefits from well-balanced soil where no single soil organism dominates the system.