NSW DPI
Soil biology basics
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Fumigation, inoculation and disease suppression

In every teaspoon of healthy soil there are billions of organisms representing hundreds of thousands of species. Most of these organisms are beneficial and perform many essential roles, including keeping harmful organisms in check.

Populations of microbes can boom or bust in the space of a few days in response to changes in soil moisture, soil temperature or carbon substrate. To gain advantage in this process, many microbes release antibiotic substances to suppress particular competitors.

Overall, a balance is achieved but it changes continually according to the seasons, climate and crops grown.

Fumigation and sterilisation

Soil fumigation and sterilisation are techniques used to suppress weeds and harmful organisms. Another technique is the use of plastic mulching, known as solarisation. The use of double layers of clear plastic can produce high soil temperatures to a depth of 20cm. Care should be taken not to damage roots in vineyards and orchards.

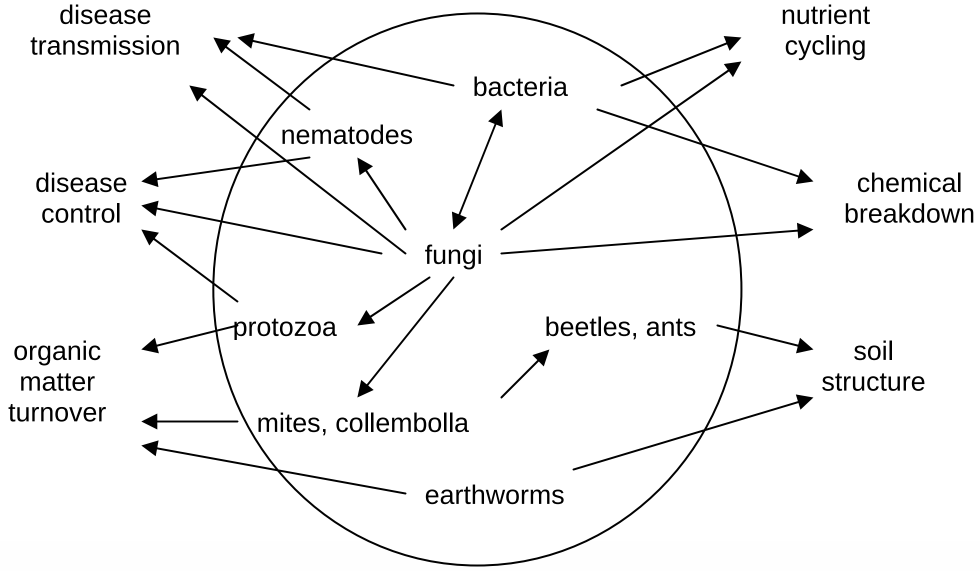
These techniques can boost productivity initially, but they destroy many beneficial organisms and their effect is short-lived because bacteria are quick to rebuild. Beneficial fungi and earthworms are slower to recolonise, which means sterilisation unbalances the soil ecosystem. Maintaining sterilised soil is similar to maintaining bare ground where opportunistic weeds soon return and dominate.

Soil fumigation and sterilisation by chemicals, steam or plastic mulch are severe measures. Repeat applications are likely to be required at continually shortening intervals unless a more integrated plan of disease control is adopted.

It is possible to develop naturally disease-suppressive soil. This requires management that encourages diversity in soil life and may take several years to become effective. While disease control strategies should not be abandoned, it is important to review why disease has become a problem. Is the crop vulnerable due to influences such as poor drainage? Are some field practices helping to spread the disease? Would a break crop, pasture fallow or green manure crop help reduce disease incidence?

Some green manure crops are also useful as biofumigants. Indian mustard (*Brassica juncea*) has been shown to help in the control of potato nematodes and to build soil organic matter.

Some interactions of soil life



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Inoculation

Soil and seed inoculation depend on chosen microbes thriving instead of others. They should not be confused with human inoculation where vaccines are inoculated to help the body fight off a target microbe.

Seed inoculation

Seed inoculation uses a specific strain of microbe able to grow in association with plant roots, and soil conditions have to be favourable for the inoculant to perform well. Selected strains of nitrogen-fixing *Rhizobium* bacteria have proven effective as seed inoculants for legumes. *Penicillium radicum* and *Penicillium bilaiae* help plant roots obtain phosphorus and have been found to be effective on wheat, medics and lentils.

Soil inoculation

In soil inoculation, microbes are added directly to soil where they have to compete with microbes already living in the soil that are already adapted to local conditions and vastly outnumber the inoculum.

Results of trial soil inoculations have been mixed. Addition of free-living nitrogen fixers such as *Azotobacter* and *Azospirillum* have generally been less effective than growing a legume species within the rotation. Inoculations with vesicular arbuscular mycorrhiza (VAM) fungi such as *Glomus* and *Gigaspora* which assist plants in acquiring zinc and phosphorus, have not proven to be better than practices that favour native VAM such as reduced tillage and avoiding brassica or lupins before a VAM-dependent crop.

The use of one organism to suppress another undesirable organism is known as allelopathy. Many microbe preparations are currently being tried to suppress diseases. Even in favourable circumstances the effect seems to be very specific to certain diseases on particular crops. *Trichoderma* has been reported as effective against some strains of *Sclerotinia* but not others. *Plectospherella* has been effective against cyst nematode in Europe but less effective in Australian trials. Some experiments report *Bacillus megaterium* as antagonistic to *Rhizoctinia* on some plants but not on others.

Cellulose-digesting fungi such as *Cyanthus olla, Aspergillus awamori* and *Paecilomyces fusisporus* have been proposed as inoculum to accelerate the decomposition of stubble. There are reports of useful suppression of stubble-borne diseases in rape and canola, but other factors are more influential on decomposition rates. Improving soil contact or nitrogen supply are both effective means of accelerating decomposition. Stubble breakdown will be slow in dry conditions regardless of added microbes.

Microbes are naturally occurring organisms, but they need to be handled with respect. For instance, *Aspergillus niger* may be useful to suppress some plant diseases but actually causes collar rot in peanuts. Two other agents tried as disease suppressants, *Trichoderma virides* and *Agrobacterium radiobacter*, have been implicated in allergic reactions or opportunistic infections in humans.

Foliar microbial sprays

Foliar application of soil microbes or compost extracts may be useful in suppressing some diseases. Compost tea is currently being used with varied results. It is a liquid mix of a variety of microorganisms from compost brewed in aerobic conditions for 24-48 hours. The effectiveness of applications also depends on management practices to limit the source of infection, and control breeding points and transmission of the pathogens.

Preparations of live bacteria, particularly those enriched with molasses, may contain human pathogens, so particular care is needed to avoid any risks to consumers. Any fresh food products treated with live bacterial preparations should be thoroughly washed and sterilised before being sent to market.

More information

Soil biology basics is an information series describing basic concepts in soil biology. For more detailed information we recommend the Australian book *Soil biological fertility:A key to sustainable land use in agriculture* (2003), edited by Lyn Abbott & Daniel Murphy.

NSWDPI has online soil biology information at http://www.agric.nsw.gov.au/reader/soil-biology.

The University of WA has online soil biology information at http://ice.agric.uwa.edu.au/soils/soilhealth.

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