PLANT AND SOIL NEMATODES

EARTHWORMS AND ENCHYTRAEIDAE: VITAL COMPONENTS OF A HEALTHY SOIL

When the health of a soil is being assessed, earthworm abundance is often used as a benchmark. This fact sheet describes the roles earthworms play in the soil environment and explains why they are commonly used as an indicator of soil health.

Earthworms

Of all the animals in soil, earthworms have perhaps the greatest impact on the soil environment. Charles Darwin recognised this in 1881 when he wrote: "It may be doubted whether there are many other animals which have played so important a part in the history of the world, as have these lowly organised creatures". Some earthworm species live in leaf litter on the soil surface, others make horizontal burrows in the upper soil layer, while anecic species build permanent burrows deep into the mineral layer of soil. However, regardless of their ecological grouping, all earthworms ingest litter and soil during the feeding process and this has a huge impact on the soil environment.

The Enchytraeidae (potworms)

One group of soil organisms that are sometimes mistaken for earthworms are the enchytraeids, also known as 'potworms'. Although they are much smaller than earthworms, they belong to the same subclass of animals (Oligochaeta). Enchytraeids occur at very high densities in soils where there is a distinct litter layer and they play a similar role to earthworms. They ingest organic matter together with microorganisms associated with decaying litter and roots, thereby contributing to the breakdown of organic matter and the mineralisation of nutrients.

An earthworm (left) creating macropores in the soil. Enchytraeids (right) are much smaller than earthworms but play a similar role in soil

Impact of earthworms on soil health

When large numbers of earthworms are present, they can move huge quantities of soil. In some situations, the amount of soil relocated by earthworms is equivalent to bringing a layer of soil 1-5 mm thick to the surface every year. Thus, earthworms have a major impact on the soil environment. When burrowing through the soil they create macropores, and this opens channels that improve soil structure and allow air and water to infiltrate. This means that rainfall moves into the soil rather than being shed, and so the soil is not lost due to erosion. The macropores also enable smaller animals to move throughout the soil profile, and they also provide a pathway through which roots can move. Earthworms also play an important role in litter decomposition, redistribute organic matter within the soil profile, and stimulate the microflora in three different ways: by making plant litter more accessible to microbes; by producing nutrient-rich casts; and by improving aeration and soil moisture conditions.

The casts produced by earthworms also have a major impact on soil fertility. Bacteria in the earthworm gut break down the organic matter that is ingested, and as the castings contain huge numbers of bacteria, breakdown continues in the soil. During this process, nutrients are liberated and become available to plants. In fact, the combined action of earthworms and their bacteria means that worm castings have much more available

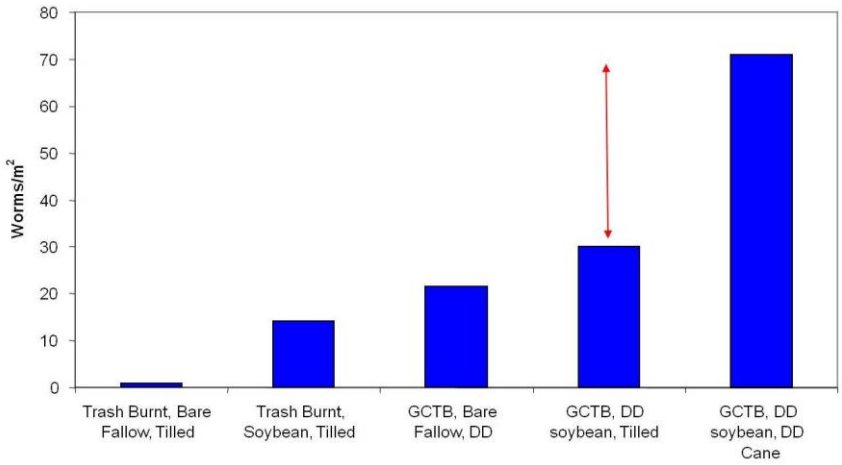
nitrogen and other nutrients than the parent soil. The key point here is the term 'available'. The minerals have been transformed from an organic form into a form that can be taken up by plants.

Impact of soil management practices on earthworms

Earthworms are highly sensitive to disturbance caused by tillage implements, and that is the main reason they have largely disappeared from most agricultural soils. However, they are also sensitive to many of the pesticides used in agriculture. Insecticides, fungicides, and herbicides are often detrimental, with some decimating earthworm populations and others affecting burrowing behaviour or having sub-lethal effects.

Impact of management on earthworms: an example from sugarcane

Three key components of best-practice sugarcane farming systems are to grow a soybean rotation crop, retain the crop residues on the soil surface as mulch, and use direct drilling procedures to plant the following sugarcane crop in a way that does not disturb the 'trash blanket'. An experiment in Bundaberg clearly showed that these practices are beneficial to earthworms. Data collected 9 months after sugarcane was planted showed that earthworms were almost undetectable in conventionally tilled bare fallow plots, whereas there were about 70 earthworms/m^2 in direct-drilled plots that had previously grown soybean. However, the benefits of growing soybean were annulled to a certain extent if the soil was tilled prior to planting sugarcane, as earthworm numbers declined by more than 50% (see figure below).



The impact of burning trash, green cane trash blanketing (GCTB), direct drilling (DD) and a soybean rotation crop on earthworm populations 9 months after sugarcane was planted. Earthworm numbers increased markedly when both the soybean and cane crops were direct drilled, but the red arrow indicates that numbers were reduced by about 50% when the soil was tilled prior to planting sugarcane. Note that earthworms almost disappeared when plots were burnt, tilled and bare fallowed.

Assessing earthworm numbers in a soil

It is reasonably easy to get some idea of the number of earthworms in a soil.

- Take a spade 20 cm wide and remove all the soil in a 20 x 20 cm square to a depth of 20 cm. Pass the soil through a mesh screen, or carefully look through the soil, and count the number of earthworms present. Repeat the process at four other randomly selected sites in the same field.
- Multiply the total number of earthworms found in the five samples by five to obtain the number of earthworms/m^2.

The number of earthworms present in a soil will be influenced by environmental factors such as soil type, soil moisture, and temperature, but healthy soils will generally contain more than 250 earthworms/m^2.

Author: Graham R Stirling, Plant and Soil Nematodes. **Contact details:** graham.stirling@biolcrop.com.au