Introduction
Droughts are predicted to become increasingly common as the climate changes, with the potential to severely affect the UK’s food supply, as well as the other natural services healthy soils provide. So there is an urgent need to understand what soil characteristics make it more or less able to withstand and recover from drought conditions.

What makes soil communities resilient is still poorly understood, but the diversity of microbes seems to be important to the stability of the community as a whole. Previous research by the group showed that predominantly bacterial soil communities are more strongly affected by drought conditions than those containing a high abundance of fungi.

To find out more, Richard Bardgett (The University of Manchester) led a team of researchers to investigate how bacterial and fungal communities in grassland soils respond to drought and how quickly they are able to recover.

Unravelling how food webs respond to drought

Extreme weather is becoming more common and this trend is expected to continue as a result of climate change, so it is essential to understand what effect these droughts will have on soils and the natural services they provide. Diverse soil microbial communities are thought to make the soil more able to withstand and recover from extreme weather events like droughts, but the processes that determine their stability are poorly understood. To address this, Professor Richard Bardgett and colleagues investigated how microbes and invertebrates in grassland soils respond to and recover from drought in lab and field experiments. They found that drought reduces the amount of carbon stored by microorganisms in the soil.

The Basics

The soil is teeming with life, from soil invertebrates like beetles, earthworms, springtails and nematodes to soil microbes like bacteria and fungi.

Beneficial fungi called ‘mycorrhiza’ grow in or on plant root cells and extend their hyphae out into the soil. They help plants take up water and nutrients and dispose of waste products. Their long hyphae are easily damaged by physical disturbance.

More diverse ecosystems are also thought to be more stable and better equipped to withstand extreme events such as droughts.

below: soil communities under different management practises.
Intensive land-management tends to reduce the abundance of fungi and favour opportunistic bacterial and fungal species.


Methodology

The team measured the physical and chemical properties of soil samples from fifteen pairs of sites, under different land management regimes, in Aberdeenshire, Yorkshire and Devon. They identified the arthropods and nematode communities and used molecular tools to understand which bacterial and fungal species were present based on their ribosomal DNA.

They simulated drought by covering the plants with rain covers during the summer months, monitored the effect on soil biodiversity and tracked the transfer of carbon from plants to soil microbes and arthropods.

Results

They found that less intensively managed soils tended to have a greater abundance of fungi, and the soil communities tended to be more diverse. “Generally, less disturbed systems have a greater abundance of fungi and they have more complex soil communities... Human intervention tends to reduce the diversity and complexity of soil communities but also shift them to be more bacterial”, said Bardgett.

Soil communities dominated by bacteria showed greater changes to the architecture of their food web, and were slower to recover from drought. The team has previously shown that predominantly bacterial soil communities are more strongly affected by drought conditions than those dominated by fungi.

Although the effect of drought on soil communities was clear, many microbes were highly resistant, and recovered rapidly. “What surprised me is that microbial communities... seem remarkably resilient to drought under field conditions. It’s only a very small proportion of the community that’s affected”, said Bardgett.

They found that drought reduced the amount of carbon being taken up by soil microbes and invertebrates. “Drought ... strongly decreased the transfer of carbon from plants to the soil food web, reducing the abundance of some groups of invertebrates known to play important roles in soil”, said Bardgett.

KEY FINDINGS

- Intensively managed soils are home to fewer fungi and more bacteria.
- Intensive management favours more opportunistic, ‘boom-bust’ microbial species, which tend to be less resilient to drought.
- Drought reduces the amount of carbon that plants release from their roots and which is taken up by soil microbes and invertebrates and possibly stored in the soil.

Bacterial Response to Drought

Contact Details: Professor Richard Bardgett (richard.bardgett@manchester.ac.uk)

References

