Ministry for Primary Industries
Manatū Ahu Matua

Manaaki Whenua
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# SOIL MICROBES AND DROUGHT

Microbial function and adaptation in response to climate change driven drought and the resulting effects on plant production and nutrient cycling

*Microbes are important for many soil processes that contribute to the production of food and fibre on which humans rely. Under climate change, there is likely to be an increase in the intensity and frequency of drought in New Zealand but little remains known about how drought affects soil microbes. Therefore, we conducted a literature review to assess what we do and do not know about the effects of climate change driven drought on soil microbial function and adaptation and how this might affect plant production and nutrient cycling.*

We assessed a broad range of literature that considered how microbes respond to drought and how that affects carbon, nitrogen, and phosphorus cycling in soils. We reviewed the interaction between microbes and soil water repellency and how plant production and pathogens might behave under drought. Further, we evaluated how advanced genetic techniques could contribute to understanding the effects of drought on microbial community composition and the ability of microbes to cycle organic matter. We also looked at how the effects of drought on microbial processes and communities might differ between pastoral grazing, production forestry and cropping systems. Finally, we also investigated possible mitigation strategies to lessen the effects of drought on soil microbes.

## Drought effects on soil microbes

During drought:

- Microbial function decreases and reduces C, N, and P cycling
- Microbial community structure is altered
- Soil water repellency may worsen the effects of drought
- Pathogen disease expression varies
- Nutrient cycling and plant production will decrease

The persistence of drought effects on microbes will be affected by the duration, intensity, and timing of drought and the subsequent rewetting phase.

**The Team:**
Suzanne Lambie (lead)[1] Kate Orwin[1] Karin Müller[2] Gavin Lear[3] Steven A Wakelin[4] Simeon Smaill[5]
[1] Manaaki Whenua – Landcare Research [2] Plant & Food Research [3] The University of Auckland [4] AgResearch [5] SCION

Manaaki Whenua Landcare Research
Plant & Food RESEARCH RANGAHAU AHUMĀRA KAI
THE UNIVERSITY OF AUCKLAND NEW ZEALAND Te Whare Wānanga o Tāmaki Makaurau
agresearch
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## What don't we know about the effect of drought on microbes?

We found a lack of information applicable to New Zealand and identified a large number of research areas that need more information to adequately understand and be able to prepare for future drought events. We do not fully understand how microbes will respond to nitrogen (urine or fertiliser) or phosphorus additions during drought periods and whether these may decrease or increase the effects of drought on microbial processes.

In the bigger picture, while there was information on how reduced soil moisture, increased temperatures, and elevated $CO_2$ might effect microbes, they were often assessed separately. These factors will often occur together in future climate change drought scenarios but experimental data that has assessed all three of these factors at once are very rare. Further, the short- and long-term impacts of drought vary widely and the relative lack of studies of long-term impacts of drought on soils contributes to a significant knowledge gap that inhibits our understanding of future soil health and plant production.

## What can we do prepare for climate change

While the most obvious solution to drought is irrigation, this is not always a viable option and, with increasing pressure on our water resources, it may not be a long- term solution with increasing number and length of droughts.

Increasing the soil organic matter contents of soil will increase the amount of water a soil can hold as well as feed microbes and plants to maintain their growth in drought periods. Further, preventing or remediating water-repellent soil conditions will also decrease the effects of drought on soil microbes. However, as increasing organic matter can enhance water repellency in some soils further site specific assessments would be required.

There are strategies that are more directed at helping plants survive drought conditions, including spraying plants with chemicals to increase their drought tolerance and developing more drought tolerant plants.

The introduction of biofertilisers (fertilisers that include specific microorganisms that can enhance drought tolerance of plants, e.g. mycorrhizal fungi) is also being researched internationally but results remain inconclusive in New Zealand.

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