FACT SHEET

Using biological approaches for soil and pasture recovery after fire

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Fire and soil microbes

Fire affects the soil microbes, directly through heating the soil profile, and indirectly by altering/modifying soil characteristics and depleting soil organic matter.

Following fires there is a significant change in the environmental conditions, such as an increase in pH, light, aeration, soil texture, nutrient content and availability, soil temperature, and moisture content.

All of these parameters affect microbial recovery. Microbes do return to pre-fire populations over time but this may take many years (4-25 years depending on regularity of burns) and is closely related to vegetation succession. The more regular the burns the greater is the loss of microbial diversity.

Burn types and fungal diversity

Hot fast burns with light fuel loads may be intense, but slow fires with heavy fuel loads can cause more damage to the chemical, physical and biological components of the soil.

Wet soil causes more loss of all soil microbes than dry soil. Moisture in soil may prevent sudden rises in temperature but it conducts heat more efficiently killing soil microbes more effectively.

Generally, temperatures greater than 70-80°C kill many soil microbes, including protozoa, non-sporing forming fungi, nitrifying bacteria, while 115-150°C kills almost all microbes.

Next paddock management only chemical salts such as superphosphate, lime & urea (Image credit: Agpath P/L)

Weedy species after fire and before remediation (image credit: Roz McNaught)

High intensity fires that destroy host plants reduce mycorrhizal fungal diversity because some species are reliant of particular host trees. Where islands of unburnt vegetation remain, recovery of mycorrhizal diversity is much quicker (note: this is an example of the unseen benefits of historical indigenous mosaic burning).

Filamentous fungi, including mycorrhizal fungi, are more sensitive than bacteria or actinobacteria. Resistant propagules such as sclerotia are more resistant to heat damage than other fungal structures such as the mycelium and spores. Depending on factors such as soil pH, total soil biomass is 30-80% fungal compared with bacterial biomass.

Soils immediately following fire are bacterially dominated partly because of the loss of the fungal biomass and increase in pH, but also because of the ability of bacteria to better use the soluble organic compounds released by the heat.

Microbial biomass comprising fungi, bacteria, protozoa, etc, contains 0.5-5% of the total organic soil carbon. In perennial systems such as forest and pastures, the fungal biomass is greater than the bacterial biomass.

Weeds and fire

A post-fire environment benefits weedy species as the primary colonisers of the burnt soil. Weedy species are taking advantage of the bare soil and bacterially dominated soil biomass.

It is important that the weedy species be allowed to grow because they are stimulating the nitrogen-fixing soil biota to replace nitrogen lost in burning.

Germination of the weed seeds helps to deplete the soil seed bank. These species are fast growing, shallow rooted and quick to flower and provide a green cover on the soil to prevent erosion from the first rains and assist the recovery of the fungal biomass and increase the mycorrhizal population which will support the pasture species into the future.

Steps to remediation

1. Do not let the weedy species flower
2. Mulch or drill prior to flowering to aerate the soil to incorporate the plant material as microbe food
3. Shape the paddocks with swales or shallow open grassed drain lines following the contours of the land to take maximum advantage of any rainfall
4. Plant 'diverse seed mix for recovering land' (see next page) into the drill lines at the time of aeration
5. Immediately following drilling and seeding, apply a 'general recipe with compost tea' (recipe on next page)
6. Allow the seed mix to establish. It can be used for hay, mulching and light grazing in the first year. Allow the plant mix to seed in the first season to further establish the perennial species.
7. Keep applying the fungal compost tea monthly or immediately following short, intensive grazing. Graze to 10cms only, spread the manure and apply the recipe.
8. Allow the mixed stand to recover before the next rotational short, intensive grazing.

Diverse seed mix

Diversity is the key to healthy pasture and soil. Mixes of plant species vary with their intended use and the time of the year in which they are sown.

The ideal seed mix for recovering land should contain diverse species, including:

- **grasses such as perennial and annual ryegrass, oats, rye corn, millet, sorghum**
- **legumes such as Persian and Balansa clovers, blue lupin, grey peas, tic peas**
- **chicory**
- **upright plantain (tonic)**
- **sunflowers**
- **native grass species**

For specific recipes for summer and winter plantings visit agpath.com.au/information/general

General recipe

- **3-5L/ha fish hydrolysate**
- **5L/ha kelp/seaweed hydrolysate**
- **1-2L/ha humates**
- **7-10L/ha molasses**
- **250-350L/ha of high-quality, fungal-dominated compost tea or clean water**

Good-quality, fungal-dominated compost tea is difficult make. If it is not readily available, use clean water.

Reticulated water (containing chlorine) is not suitable for making or diluting compost tea because the microbiology will be killed. Chlorinated water can be cleaned by blowing air through a volume for an hour; leaving a volume stand open overnight; by adding 100mLs humate/1000L water and agitating for a few minutes.

This recipe, especially with fungal dominated compost tea, will change the soil microbial dynamics from bacterial dominated to fungal dominated. Weedy species, such as capeweed, will be eliminated over time without the need for herbicides.

Learn more

For more information on Mary Cole's research and recipes, visit agpath.com.au.

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