Bournemouth University

CENTRE FOR LAND REHABILITATION
The University of Western Australia

Does the soil microbiology of chemically restored lowland heath resemble that of native heaths?

I.D. Green[1], M. Tibbett[2], A. Diaz[1] & M.T.E. Smith[1]

1 - The School of Conservation Sciences, Bournemouth University, Wallisdown, Poole, Dorset, BH12 5BB, Great Britain.

2 - Centre for Land Rehabilitation, School of Earth and Environment, University of Western Australia, Crawley, WA 6009, Australia.

Introduction

Acidifying soil with elemental sulphur (S^0) can restore heathland vegetation on grassland by suppressing competitive grasses (Fig 1). For the long-term persistence of the restored heath, the re-growth of these grasses needs to be curtailed through the locking up of nutrients within a well developed soil O horizon. This will require restoration of the ecosystem processes that in heathland result in slow mineralisation and decomposition of organic matter. This in turn will depend on the soil microbial community changing from a high bacteria/low fungi community typical of agricultural soils to a low bacteria/high fungi community typical of heathland. In theory, soil acidification should achieve this change. We tested this by investigating changes the in numbers of bacteria and fungi in the soil after S^0 amendment.

The Experiment

In 1999, a series 0.25 ha plots were set up on grassland improved from heathland *ca.* 50 years previously (Fig. 1). S^0 amendments totalling 3,600 kg ha^{-1} were applied to 10 plots in 2000. A further 10 plots were left untreated as a control. Nine years later, soil samples were taken from the top 5 cm of each plot with restored heathland vegetation, the control plots and two native heaths adjoining the experimental area. The number of colony forming units (CFUs) of bacteria and fungi in the soils where determined by a selective viable count procedure.

Findings

- Significant differences were found in both the number of bacterial (F= 35, P = 0.001; Fig 2) and fungal (F = 5.1, P = 0.02; Fig 3) CFUs in the soils. In both cases, the number of CFUs in the restored heath was comparable to that of the native heaths.
- Significant differences were found for soil pH (F = 0.91, P = 0.002; Table 1), Al concentration (F = 4.6, P = 0.03), moisture (F = 19.2, P <0.001) and C:N ratio (F = 125, P <0.001).
- The number of bacterial and fungal CFUs in soil were correlated with soil pH and bacterial CFUs with C:N ratio (Table 2). There were no significant correlations with other factors potentially affecting bacteria or fungi.

Figures and Tables

Figure 1. Our study site was lowland heath until 'improved' to pasture (as seen just outside the plot fence on the left). Elemental sulphur successfully restored the heathland vegetation community shown in the picture, but what about the community below the soil?

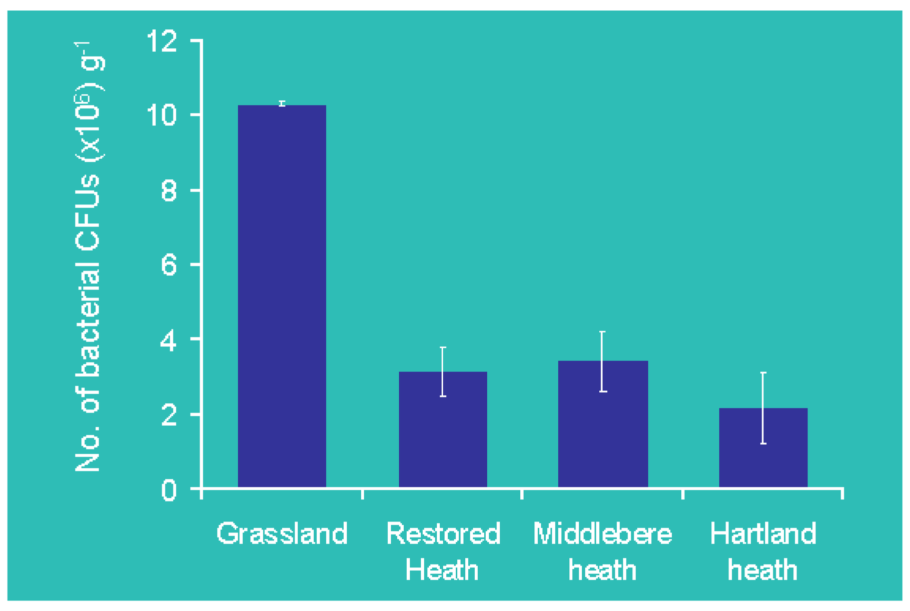

Figure 2. Numbers of bacterial colony forming units (CFUs) found in the soil of grassland, restored heathland and two native heathlands (error bars ± 1SE).

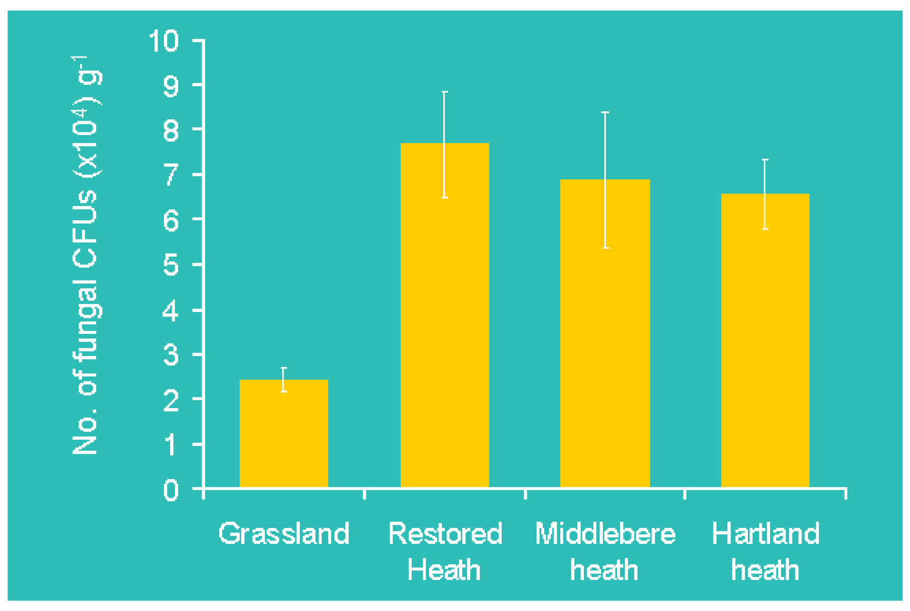

Figure 3. Numbers of Fungal colony forming units (CFUs) found in the soil of grassland, restored heathland and two native heathlands (error bars ± 1SE).

Table 1. pH, extractable Al concentration (mg kg^{-1}), moisture content (%) and C:N ratio in soils (mean ± 1SE).

	pH	Al conc.	Moisture	C:N
Grassland	5.4 ± 0.2	2.0 ± 1.0	32.0 ± 5.9	16.2 ± 0.4
Restored heath	4.4 ± 0.1	2.2 ± 1.0	22.1 ± 2.1	17.6 ± 1.0
Middlebere heath	4.4 ± 0.2	4.4 ± 0.9	60.4 ± 2.7	30.9 ± 0.5
Hartland heath	4.4 ± 0.2	6.0 ± 1.1	45.7 ± 3.3	32.7 ± 1.0

Table 2. Correlation coefficients between soil parameters and the number of bacterial and fungal colony forming units in soil.

	Fungi	pH	Al	Moist.	C:N
Bacteria	-0.65**	0.78**	-0.48	-0.26	-0.61*
Fungi		-0.57*	0.09	0.13	0.32
pH	-0.57*		-0.34	-0.14	-0.49
Al	0.09	-0.0.34		0.52	0.79**
Moist	0.13	-0.14	0.52		0.77**

Conclusions

- The reduction in bacterial CFUs and increase in fungal CFUs in the soil of the restored heath demonstrated that S^0 application resulted in the required change in the soil microbiology. Consequently, the microbial community in the soil of the restored heath showed considerable similarity to that of native heathland and not the grassland it was restored from. This was despite the restored heath retaining some soil properties (i.e. lower extractable Al and C:N ratio) more favourable for soil bacteria than the heathland.
- This indicates that restored heath has a microbial community with a functionality appropriate for a heathland ecosystem and that the restored vegetation should persist over the long-term. However, this requires confirmation by more detailed analysis of the structure and function of the microbial community.
- S^0 application was still acidifying the soil pH to a level consistent with heathland nine years after application. The results strongly indicate that this acidification was the principle factor driving the change in the soil microbial community.
- S^0 appears to be an effective tool to restore small areas of heath, which should persist over the long-term and may be particularly useful in heathland conservation when used to connect patches of native heath or expand the area covered by small heaths.