Heathland creation on improved grassland using sulphur: is there a conflict between optimal application rates for plant and invertebrate communities?

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Introduction

In the last 200 years the area of lowland Britain covered by heath has greatly declined. The reasons for this decline are many, but one of the principle causes has been the 'improvement' of heathland soils for agricultural use. Such conversions require radical alteration of soil chemistry, e.g. an increase in the pH and nutrient status of the soil. Restoration of heathland vegetation on improved soils requires equally radical treatment, such as stripping the surface layer of the soil away or using acidifying soil amendments such as elemental sulphur (S^0). While S^0 amendment is effective in controlling mesotrophic grasses and establishing heathland vegetation, the effects on the invertebrate community have not been established.

Materials and methods

A block of thirty 3 x 3 m plots was set up in 2000 on pasture improved from heathland ca. 50 years ago. Restoration of heathland on these plots was mediated through the application of an acidifying amendment, S^0. Sulphur pellets (Brimstone 90^{Tm}) were applied to the plots at rates of 0, 900, 1,800, 2,400 or 3,600 kg ha^{-1}. Treatments were allocated to each plot on a random basis and each rate was replicated 6 times. During June 2005, the vegetation volume, plant species diversity, and area covered by mesotrophic grass on each plot was recorded. Soils (top 15 cm) and invertebrates (pitfall trapping) were also sampled from the plots at this time.

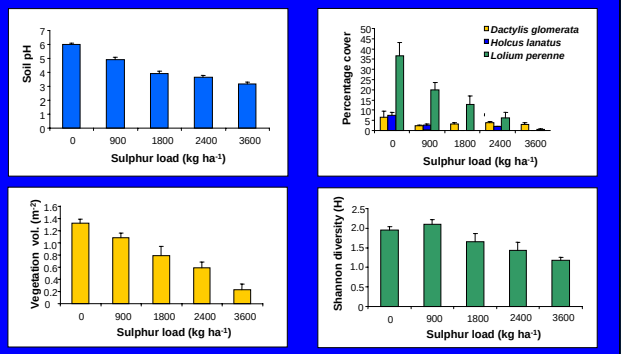

Figure 1. Soil pH and vegetation parameters.

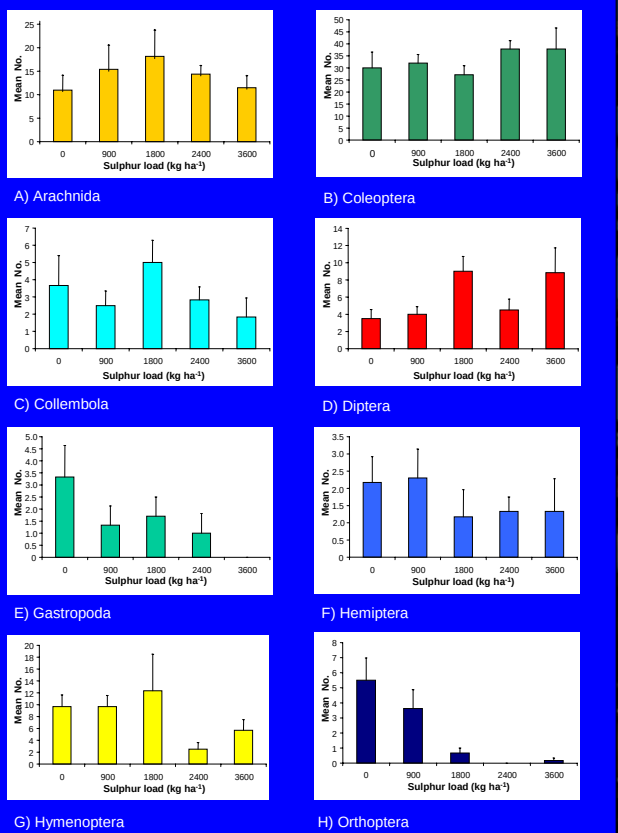

Figure 2. Number of individuals belonging to selected invertebrate groups captured in plots subject to sulphur amendment.

Results

•S^0 amendment significantly lowered soil pH (Fig. 1; H = 25.5, *P* = <0.001) and the cover of mesotrophic grasses (Fig 1), but this was significant only for *L. perenne* (H = 22.3, *P* <0.001).

• There was also a significant decrease in vegetation volume (Fig. 1; H = 21.1, *P* <0.001), plant diversity (H = 14.4, *P* = 0.006) and plant species richness (H = 16.0, *P* = 0.003) as a result of S^0 amendment.

• There was a significant decrease in the abundance of Collembola (H = 12.1, *P* = 0.017), Gastropoda (H = 16.1, *P* = 0.003), Hymenoptera (H = 14.2, *P* = 0.007) and Orthoptera (H = 19.8, *P* = 0.001) due to S^0 amendment (Fig. 2).

• Abundance of Coleoptera, Dermaptera, Hemiptera, Diptera, Arachnida, Oligocheate, Isopoda and Thysanoptera were not affected.

• For the affected groups, significant negative correlations were found between abundance and % bare earth. Positive correlations were found between abundance and vegetation volume and soil pH (Table 1).

Table 1. Spearman rank order correlation between soil pH and vegetation parameters and the abundance of invertebrate groups.

	% bare earth	Veg. volume	Soil pH
Coleoptera	0.08	-0.08	-0.10
Collembola	**-0.51****	**0.43***	**0.56****
Dermaptera	-0.03	-0.001	0.21
Hemiptera	0.13	-0.20	0.02
Diptera	**0.38***	**-0.39***	-0.23
Hymenoptera	**-0.57*****	**0.53****	**0.51****
Orthoptera	**-0.55****	**0.47****	**0.42***
Arachnida	0.17	-0.13	-0.21
Gastropoda	**-0.75*****	**0.39*****	**0.68*****
Oligocheata	0.14	-0.09	-0.21
Isopoda	-0.11	0.03	-0.001
Thysanoptera	-0.12	0.19	-0.18

Discussion and conclusions

• Competition from mesotrophic grasses is a major limiting factor in the restoration of heathland. The largest S^0 treatment rate was the most successful in controlling these grasses and this treatment rate has been successful in restoring *Calluna vulgaris* in another experiment on the same site.

• The abundance of most invertebrate groups was not affected by S^0 treatment, suggesting that they were not avoiding treated areas.

• Decreased abundance of Hymenoptera, Gastropoda & Orthoptera appeared to be related to the avoidance of areas with decreased vegetation volume and increased bare earth caused by the S^0 amendments, whilst partial correlations suggested that Collembola were affected by the increased soil acidity.

• The ecological consequences of the decrease in some invertebrate groups resulting from the amendment of soil with S^0 at effective restoration rates are not clear, but important ecosystem processes such as litter decomposition and nutrient recycling may be affected by reduced numbers of Collembola.