Changes in Nutrient Turnover and Supply During the Reversion of Arable Land to Acid Grassland/*Calluna* Heathland

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Introduction Lowland heath is of high conservation value because of the specialised and rare assemblages of plants and animals that it supports. Combinations of agricultural and urban development, and lack of appropriate management have resulted in large-scale loss and fragmentation of this habitat throughout the UK. Current UK conservation policies seek to re-create 6,000 ha of this habitat on land previously in agricultural and forestry production. Previous research indicated that high soil pH and fertility, together with a lack of propagules of heathland species, made it difficult to achieve this objective. The aim was to evaluate techniques to establish grass-*Calluna* heathland on ex-arable land in the Brecklands Environmentally Sensitive Area (ESA) in Norfolk, in particular, to assess the need for soil acidification to reduce competition and aid the establishment of *Calluna*.

Materials and methods Between 1994 and 1995 a number of different restoration treatments were applied to two ex-arable sites with contrasting soil pH and fertility levels in the Brecklands ESA: Euston (soil pH 5.7; ADAS Phosphorus Index 3) and Honington (soil pH 8.0; ADAS Phosphorus Index 4). These included elemental sulphur (S) additions (at two rates) to acidify the soil in combination with contrasting establishment techniques of a sown seed mixture (*Calluna* litter and acidic grassland species). Topsoil (0-15 cm) samples were taken periodically between 1994 and 2003 and analysed for pH, extractable phosphorus (P), potassium (K) and magnesium (Mg), cation exchange capacity (CEC) and potentially mineralisable nitrogen (PMN, 2003 samples only). Additional soil samples were taken to 90 cm depth and analysed for soil mineral N (ammonium-N plus nitrate-N, 1994-1998). Porous ceramic samplers were also installed on selected treatments at 90cm depth to measure nitrate concentrations in the drainage water during winters 1994/95 – 1998/99.

Results Elemental S was very effective in reducing soil pH in the first 12 months after application (Figure 1a). Thereafter, pH levels gradually increased to reach an equilibrium of *ca* 4.4 and 4.2 at Euston (3 & 6 t/ha S) and *ca* 5.0 and 4.1 at Honington (9 & 18 t/ha S) during the period 1999-2003. The soil pH of the untreated control treatments remained relatively constant throughout at *ca* 5.6 at Euston (range 5.2-6.2) and *ca* 7.8 at Honington (range 7.4-8.0). *Calluna* established only on the acidified S treatments (Figure 1b).

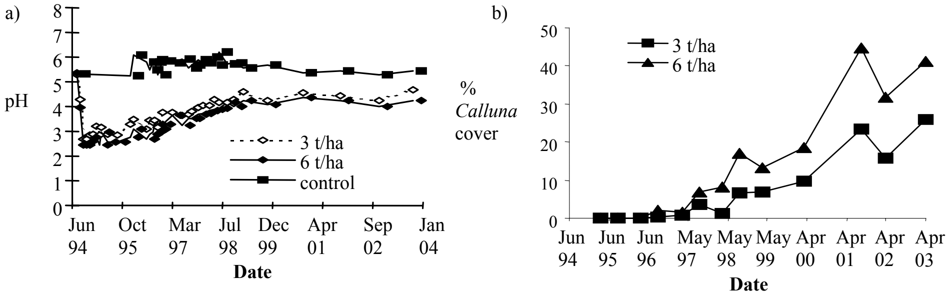

Figure 1 Effects of restoration treatment on a) topsoil pH and b) the mean % cover of *Calluna vulgaris* (Euston)

Soil acidification resulting from elemental S additions, led to long-term increases in soil extractable P at both sites (by 20-76 mg/l; *P*<0.001), but PMN and extractable Mg were reduced (by 22-57 mg/kg and 7-18 mg/l, respectively; *P*<0.001). In addition, extractable K was reduced by 38-50 mg/l at Honington (*P*<0.001). The higher rate of S addition at each site increased SMN in each measurement year, compared with the control, which was largely due to a larger ammonium-N pool, suggesting that nitrification had been inhibited at low soil pH. Reverting arable land to acid grassland/*Calluna* heath was very effective in reducing nitrate leaching losses; losses in drainage water were generally <5 kg/ha N and mean nitrate-N concentrations below 5 mg/l.

Conclusions Soil acidification was required for the recreation of heathland on ex-arable land in the Brecklands ESA. Elemental S was very effective in reducing soil pH and also changed other soil nutrient supply properties.