THE SULPHUR NUTRITION OF WINTER OILSEED RAPE IN NORTHERN BRITAIN

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INTRODUCTION

Changes in fertiliser practices and reduction in atmospheric deposition have resulted in lower amounts of sulphur being available to crops in northern Britain. At the same time sulphur removal from the soil has increased markedly with the production of higher crop yields (Syers et al 1987).

Winter oilseed rape has a higher sulphur requirement than most other arable crops, although the response of high glucosinolate varieties to sulphur fertilisation on S deficient sites in the U.K. has generally been poor (Withers 1989). With the recent introduction of low glucosinolate varieties, symptoms of sulphur deficiency have become more widespread in northern Britain. Marquard et al (1968) showed that seed glucosinolate levels are strongly influenced by plant sulphur status, while Schnug (1989) demonstrated a clear difference between high and low glucosinolate varieties in their sulphur metabolism.

This study was initiated to determine the sulphur status of commercial crops of low glucosinolate winter rapeseed in northern Britain and to investigate the effect of sulphur applications on yield and seed glucosinolate contents.

MATERIALS AND METHODS

A survey of leaf sulphur status and seed glucosinolate contents was carried out during the 1989-90 growing season in two locations in northern Britain. The first, along the River Tweed in south east Scotland, is characterised by low depositions of atmospheric sulphur and light textured soils. The second area surveyed extended along the north east coast of England from mid Northumberland to north Yorkshire. The soils of this area are more variable, but generally contain higher clay and organic matter levels, coupled with higher levels of atmospheric sulphur deposition.

The relationship between leaf sulphur status, yield and seed glucosinolate levels was further examined in a series of field trials in south east Scotland during the 1989-90 growing season. Five experiments were established in commercial crops of the low glucosinolate variety Cobra. Site details are given in Table 1.

At each site, three levels of sulphur were compared 0, 50 and 100 kg S ha. The sulphur was applied by hand as potassium sulphate at the start of spring growth. The potassium balance was maintained over the trial sites with variable inputs of potassium chloride. Other agronomic inputs were applied in accordance with general farm practice. All crops were dessicated prior to harvest. Subsamples were retained for moisture and glucosinolate analysis.

Fully expanded leaves were collected from both the experimental plots and surveyed crops at the start of flowering. These were removed from the upper third of the flowering plant and air dried at 70 degrees C for 48h prior to analysis by X-ray fluorescence (Schnug 1984). Seed samples were analysed for their total glucosinolate content by the X-ray fluorescence method described by Schnug and Haneklaus (1988). A total of 46 crops were surveyed in south east Scotland and 64 crops in northern England.

RESULTS

Crop Surveys

Data from the two locations have been analysed and presented separately. The mean leaf sulphur concentration at the start of flowering for crops surveyed in the north of England was 5.7 mg/g with a range from 3.3 to 8.3 mg/g (Figure 1). The corresponding mean value for south east Scotland was 4.3 mg/g with a range from 2.8 to 5.6 mg/g.

In south east Scotland 25% of the sites sampled showed visible symptoms of sulphur deficiency. This was confirmed by the survey data which showed that 13 of the 46 sites sampled had leaf sulphur values below 4.0 mg/g. This contrasts markedly with the position in northern England, where only three crops gave leaf sulphur values below 4.0 mg/g at the corresponding growth stage.

The mean seed glucosinolate content for crops in the north of England was 26.4 micro moles per gram of seed (Figure 2). Overall, 10% of the sampled crops failed to achieve the current EC glucosinolate premium standard of 35 micro moles per gram of seed. The seed glucosinolate levels recorded in south east Scotland were considerably lower with a mean value of 10.9 micro moles per gram of seed; all samples having achieved the EC standard.

Field Trials

Leaf sulphur concentrations in the absence of applied sulphur were significantly higher on the Big Birks and Earnslaw sites on the Whitsome soil series compared to the other three sites (Figure 3a). Differences were also recorded between sites in the effects of applied sulphur on the subsequent leaf sulphur concentrations at the start of flowering. On the Whitsome soil series applications of sulphate had little effect on leaf sulphur concentrations.

The yield response to applied sulphur was generally low at all sites (Figure 3b). The three sites which showed the largest increase in leaf sulphur concentration also gave the highest yield responses of between 0.16 and 0.38 t ha from an application of 100 kg S ha.

Seed glucosinolate contents were generally low at all sites in the absence of applied sulphur (Figure 3c). On the Earnslaw site, applications of potassium sulphate did not influence glucosinolate concentration, while on the other four sites seed glucosinolate concentration increased by an average of 7.2 micro moles per gram of seed in response to an application of 50 kg S ha. A further application of 50 kg S ha increased the glucosinolate concentration by 1.7 micro moles per gram of seed.

DISCUSSION

The results of this investigation have highlighted the wide variation that exists in plant sulphur content in winter oil seed rape grown in northern Britain. Total sulphur levels of fully expanded leaves at the start of flowering were significantly lower in south east Scotland compared to northern England. Deposition of atmospheric sulphur is generally lower in Scotland than in many other parts of the UK (Syers et al 1987) and is clearly reflected in plant sulphur contents.

Small increases in seed yield were recorded on three of the five sites in south east Scotland, although the leaf sulphur concentrations on all sites were below the level regarded as optimal for high yielding oilseed rape crops. This may have been due to the extremely dry conditions following sulphur fertilisation, thereby restricting crop uptake.

Both field trial and leaf survey data have clearly shown a strong relationship between leaf sulphur concentration at the start of flowering and the final seed glucosinolate content. This has also been found by Schnug (1989) in Germany and Withers (1989) in the UK. The use of leaf sulphur analysis offers the possibility of predicting glucosinolate levels in the mature seed and therefore deserves further investigation.

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Table 1 Site details

Location	Soil series	Soil analysis		
		pH	OM%	SO_4 -S mg/kg
Big Birks	Whitsome	6.5	3.3	4.5
Earnslaw	Whitsome	5.3	3.4	5.6
West Learmouth	Wick 1	5.9	3.0	4.6
Hadden	Wick 1	5.7	2.3	3.8
Caverton Mill	Hobkirk	6.0	3.8	5.4

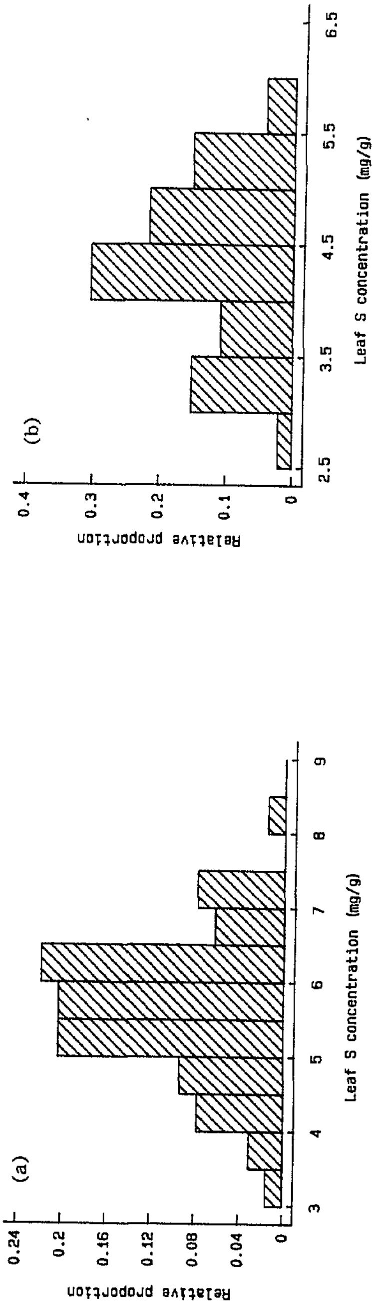

Fig. 1 Frequency of leaf sulphur concentrations in sampled crops of winter oilseed rape in (a) north England and (b) south-east Scotland

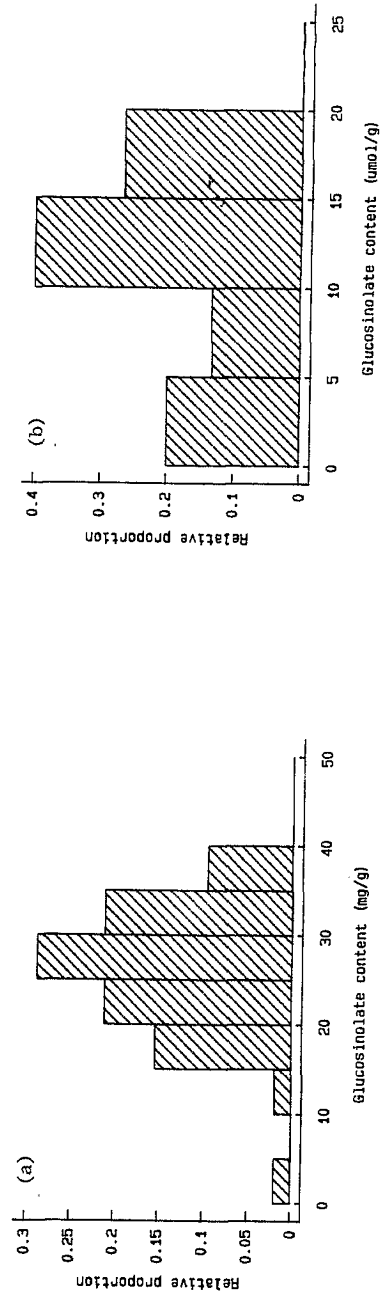

Fig. 2 Frequency of seed glucosinolate content in sampled crops of winter oilseed rape in (a) north England and (b) south-east Scotland

Fig. 3 The effect of sulphur application on (a) leaf sulphur concentration (b) seed yield and (c) glucosinolate content of oilseed rape grown in S.E. Scotland during 1989-90