RESEARCH

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THE USE OF SULPHUR AS A FERTILISER

Summary

In 36 field experiments on grassland widely distributed through the country, twelve sites gave a response of greater than 10% to sulphur applied as gypsum ($CaSO_4 2H_2O$). Soil or plant analyses are not yet reliable enough to predict sulphur deficiency but the condition may be expected to occur most frequently on light textured soils in the August-September-October period. Ammonium sulphate or single superphosphate are the most readily available sources of sulphur to correct deficiencies.

Introduction

A previous Research bulletin (Index 2, 7-71) on Sulphur Nutrition drew attention to the low level of sulphur in air and rainfall in Ireland compared to Europe and the UK and to the low level of sulphur in many of our fertilisers and suggested that sulphur deficiency might occur in Irish grasslands. Subsequently grasses and clovers were found to respond to sulphur in pot and field experiments. However, the field experiments were conducted in 1975 and 1976 which had exceptionally dry summers so it was thought that these results might not represent the general condition.

In 1977 some 116 samples of herbage were taken from silage crops and analysed for nitrogen and sulphur and it was found that 25% of them had sulphur contents of less than 0.20% and that 50% of them had an N/S ratio of greater than 12 : 1, indicating inadequate sulphur nutrition for plants and possibly livestock, according to the literature on the subject.

Experiments

In 1978, therefore, 36 field experiments were carried out to measure the effect of five rates viz., 0, 25, 75 or 100 kg S/ha, applied as gypsum, on the DM yield of herbage. Three cuts of herbage were taken from all sites in April, June and August and a fourth cut was taken in October from four of the most responsive sites. One hundred (100) kg N, 10 kg P and 40 kg K per hectare was applied for each cut.

Results

1) Twelve sites or approximately one third of the total, gave a statistically significant increase in yield of more than 10% for the sum of three cuts.
2) Twenty sites responded significantly by more than 10% at one of the harvests.
3) One site at Dunmore, Kilkenny responded by 45% over four cuts and at the fourth cut the yield from the sulphur-treated plots was more than double that from the controls (Table 1).
4) Two sites with dominantly *Agrostis tenuis* type swards responded by 17% and 12%.
5) All but one site (Dunmore, Kilkenny) reached maximum yield with 25 kg S/ha.
6) The responsive sites were widely distributed and were not clustered nor confined to particular areas. See Figure 1.

There is, therefore, strong evidence available that sulphur deficiency is of widespread and frequent occurrence on Irish grasslands. However, it is not always a simple matter to identify the problem even when it exists. With phosphorus or potassium a deficiency will usually persist through the season and will even intensify in successive years as the nutrient is removed in the crop and the limited soil reserve is depleted. This pattern is not characteristic of sulphur deficiency. In many instances the deficiency symptoms and reduced yields will be obvious at one harvest but may disappear later in the season. In two long term experiments responses of 15% were obtained on both sites over four years but there was little response in the fifth year. This suggests that nutrient sulphur is being supplied to the crop from the air or the large reserve in soil organic matter and that the rate of supply is controlled in either case by the weather. Because of this it is difficult to recognise it as a separate factor. Sulphur deficiency may also be difficult to recognise since it results in pale green or yellow foliage similar to nitrogen deficiency.

Prediction and identification

During 1978 soil analyses for sulphate sulphur and herbage analyses for total sulphur in March were unsatisfactory at predicting sulphur responses later in the season. However it was found that soils which contained less than 3% carbon and less than 50% silt and clay were more likely to respond than those soils which were above either of these limits (See Figure 2). Essentially this means that responses occur more frequently on light textured soils of low carbon content. Deficiencies have also been obtained on reclaimed soils even when the carbon content was high. Unfortunately analyses for silt and clay are very laborious and expensive and cannot be offered as a standard service but it is hoped that this aspect can be developed further.

TABLE 1: Dry matter yields (kg/ha) and % response to sulphur at Dunmore, Co. Kilkenny

	Cut 1		Cut 2		Cut 3		Cut 4		Cuts 1–4	
	Yield	Response %	Yield	Response %	Yield	Response %	Yield	Response %	Yield	Response %
Control	3640	8	2286	11	1589	72	2050	113	9575	45
50 kg/ha S	3917		2546		2735		4369		13866	

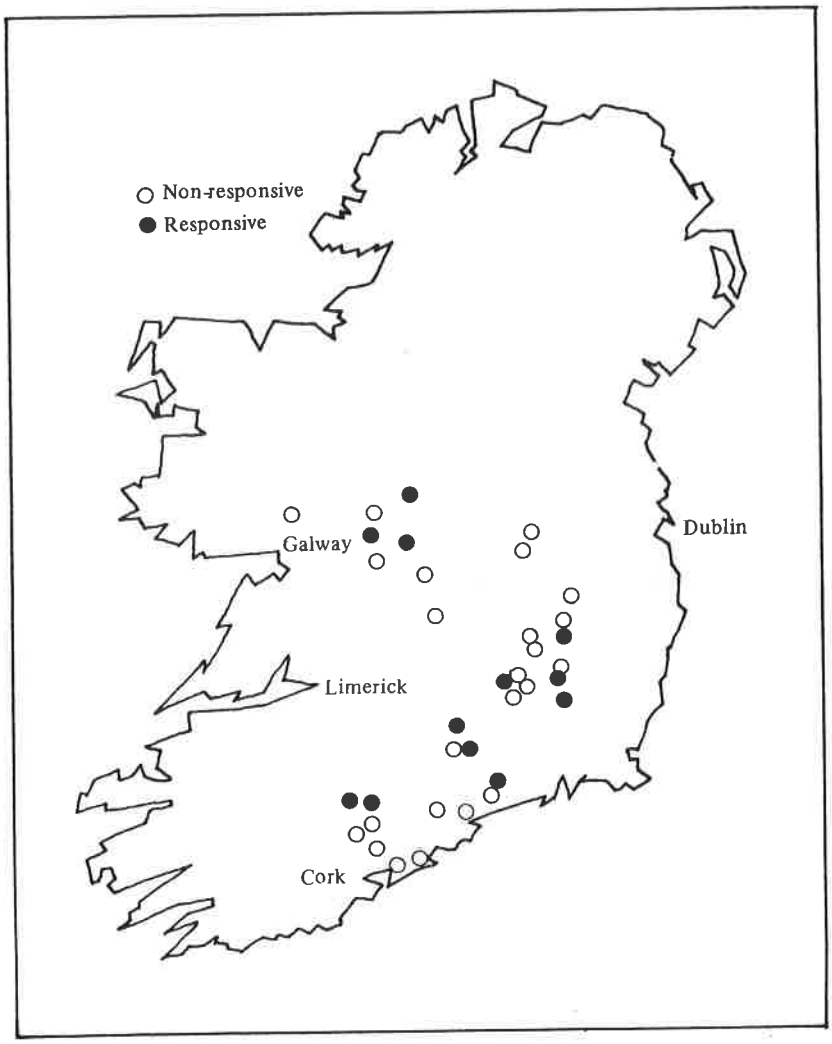

Fig. 1. Location of sulphur sites, 1978

So far no work has been carried out on sulphur under grazing conditions but it is an essential element for animals as well as plants and it is known to be especially important in sheep for growth and quality of wool. Therefore, it is possible that both plants and animals will respond to sulphur on a grazed pasture if the supply of sulphur from the soil and atmosphere are very low.

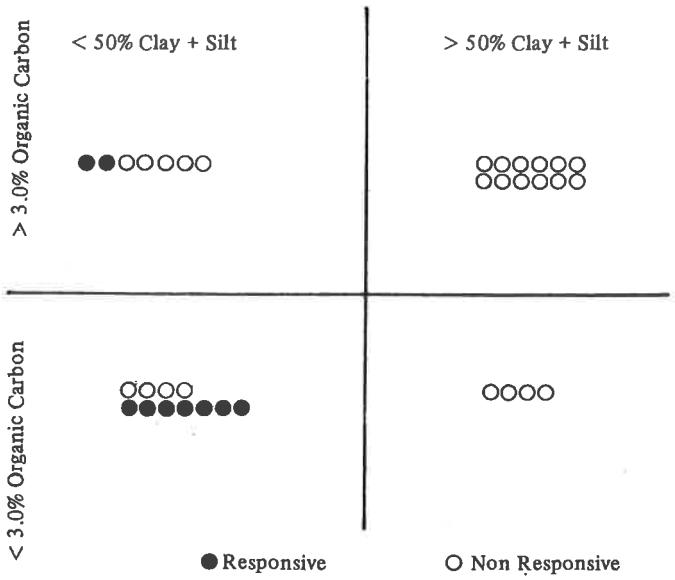

Fig 2. The relationship between the organic carbon, clay and silt content of soils and their responsiveness to sulphur

TABLE 2: Sulphur content of Irish fertilisers

Fertiliser	Range (percent S)
0–7–30, 0–10–20, 10–10–20, 18–6–12, 27–2.5–5, CAN, Urea, KCl	0.1–2.0
8–6–16, 0–16–0, 8–8–16, 5–5–10, 8–5–18, 9–6–15	2.0–5.0
14–7–14, 0–8–0, 7–6–17, 8–5–18, $(NH_4)_2SO_4$, K_2SO_4	Over 5.0

TABLE 3: Sources of sulphur

Sources	% Sulphur
Elemental sulphur (Flowers of Sulphur)	100
Ammonium sulphate	24
Gypsum	18
Potassium sulphate	12
Single superphosphate (8%)	18

Fertilisers

The sulphur content of fertilisers varies quite widely from 0.1% to 24% as seen in Table 2. Many of the concentrated compounds contain very little sulphur and would, therefore, need supplementation on a deficient area. The most concentrated sources of sulphur are set out in Table 3.

Recommended farm practice

Evidence to date indicates that one sward in three will give a response to sulphur as a fertiliser. So far soil or plant analyses are not satisfactory to predict such responses.

However, if a sward is pale and stunted especially during the period August to October on a light textured soil and where nitrogen has been applied, the cause may be sulphur deficiency. At that stage analysis of the plant for sulphur may be helpful in diagnosis. Cold weather or drought will often produce similar symptoms in the field.

Deficiency may also be confirmed by spreading gypsum or single superphosphate in two strips at right angles to form a cross through the centre of the field and omitting other sulphur containing fertilisers from the field. If the sward in the strip darkens, the rest of the field is too low in sulphur, but it may not be possible to recognise differences lower than 15% with this visual method. We would like to hear of any cases of sulphur deficiency diagnosed in this way.

If sulphur deficiency is present apply:—

125 kg/ha (1 bag/ac) of ammonium sulphate per annum

or

200 kg/ha (1½ bags/ac) of gypsum per annum

or

250 kg/ha (2 bags/ac) of superphosphate per annum.

The single superphosphate although effective is not the ideal system as it implies the use of straight fertilisers for phosphorus and potassium including double spreading. As well as this there is evidence that sulphate can be readily leached so it would be desirable to apply it in spring rather than autumn or winter and it may even be necessary to split the dressing through the season. This suggests that

it would be more suitable to combine the sulphur with nitrogen rather than phosphorus especially in view of the known N/S linkage in protein and some evidence that extra nitrogen can depress the sulphur content of the plant. Ammonium sulphate is a suitable source of sulphur but it is only available in limited amounts and urea and calcium ammonium nitrate will continue to be the large scale sources of nitrogen. As nitrogen is applied in several stages it would seem convenient that some of the nitrogen could be applied as ammonium sulphate, say 250 kg/ha, for a first application to grazing supplying 52.5 kg N and 60 kg S/ha followed by other nitrogen sources later in the season. Alternatively there are mixtures of ammonium nitrate and ammonium sulphate available in other countries which could possible be made available here and used right through the season.

Tillage crops

Sugar beet gave a significant response to gypsum on two sites during 1976 (Table 4). However in 1977 there was no response on one further site. The standard sugar beet compound contains 4% sulphur and this should supply sufficient sulphur for the crop.

TABLE 4: The effect of added sulphur on the yield of sugar beet at two sites, 1976

Location	Treatment	Roots (t/ha)
Borris	Control	36.56
	100 kg/ha S	39.02*
Carlow	Control	33.70
	100 kg/ha S	35.60*

*Significantly ($P > .05$) different from control

Cereals are not considered sensitive to sulphur deficiency as they have low sulphur requirements. However one field experiment will be carried out in 1979 to test for response of winter barley to sulphur.

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