AN EVALUATION OF THE EFFECTIVENESS OF STEELWORKS SLAG AS A FERTILIZER FOR USE ON GRASSLAND

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ABSTRACT

The objective of this work was to evaluate the steelworks by-product, steelworks slag, for use on established grassland. The effects of three rates of slag application were compared against those of lime and phosphate applications calculated to be equivalent to those applied in slag. Experiments were conducted at seven grassland sites, differing in initial pH, in the north east of England, and the treatments were evaluated in terms of their effects on both soil pH and herbage production over a three year period. Slag was effective at increasing soil pH at all sites, producing responses similar to those of limestone. Positive dry matter (DM) yield responses were observed at five of the seven sites. Effects were often similar to those produced by equivalent liming treatments, but at two sites, a phosphate effect was also apparent.

INTRODUCTION

Basic or Thomas slag, which was produced from the limestone flux used in the purification of iron ore, was valued in Europe as a grassland fertilizer principally because of its phosphate content (16-18%) and for the micronutrients it contained, but also for its liming properties. Devine(1980) estimated that, by the late 1960's, 15% of the world phosphate requirement was accounted for by basic slag, and over one million tonnes was being used per annum in the UK. However, as a result of changes in the steelmaking process in the 1970's, basic slag has virtually disappeared. The current use of ores with low levels of phosphorus means that the slags now have a low phosphate content (about 1.5%). Much of this new steel industry by product has recently been discarded as waste material, even though some research has previously indicated that such slags can still have value as liming materials (White *et al.*) and as sources of micronutrients (Barber, 1984). The purpose of this work was to evaluate the new slag for use as a liming agent on established grassland in the UK, and to investigate the relative importance of the liming and phosphate effects of slag addition.

MATERIALS AND METHODS

Seven established grassland sites on commercial farms in the north-east of England were selected to represent a range of environment and intensity of management. The main characteristics of the sites are shown in Table 1.

At each site, a similar range of treatments was applied, once only, in early Spring 1992. The standard calculation of liming requirement (Ministry of Agriculture, Fisheries and Food, 1986) suggested that 4 tonnes of ground limestone (at 55%CaO) would normally be required for sites other than G. Assuming a neutralising value of 50% CaO for Slag, this indicated that a slag application of 4.4 tonnes / ha would be appropriate. Three application rates of slag were therefore used, 4.4, 6.6 and 8.8 tonnes / ha., representing 1, 1.5 and 2 x liming rate respectively. These were compared against an untreated control, against limestone applied at 4 tonnes / ha and against triple superphosphate (TSP) applied at 0.176 t/ha (equivalent to the phosphate in slag 1). A combination of limestone and TSP was also included. At the more fertile site G, slag rates of 2.2, 4.4 and 6.6 were used as slag 1, 2 and 3 respectively. The seven treatments were arranged in randomised block designs with three replicates at each site. Plots (2m x 5m) were cut three or four times in each of three growing seasons and DM yields were recorded on each occasion. Site E was only available until the end of 1993. Soils from each plot were sampled to determine pH in November 1992, April 1993 and April 1994.

RESULTS AND DISCUSSION

The mean values for soil pH in April 1993 are given in table 1. These indicate that slag was an effective liming material at all sites. However, the neutralising value of slag may have been overestimated because it was generally necessary to apply 1.5 times the calculated rate in order to achieve an increase in pH equivalent to that achieved by the use of limestone at liming rate. In terms of DM yield (Table 2), sites A and B were neither phosphate or lime-responsive, and there was little or no effect of slag at these sites. DM yield at Site C increased in response to lime but not to phosphate. There was a yield response to slag at C, presumably because of the liming effect. At site G there was a yield response to phosphate but not to lime, and a progressive response to increasing amounts of slag suggesting that this was a response to phosphate. Sites D, E and F showed responses to both lime and phosphate, and generally also responded to slag application, although at D the response was only apparent at the highest rate of application. These results show that slag has a liming effect and that when used on established grassland, this may result in increased herbage yield. A positive effect of the phosphate component of slag was apparent at two of the sites.

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Table 1
Site descriptions, initial pH and P status (Spring 1982), and soil pH at six sites in April 1994 and at 1 site (E) in April 1993

Site Characteristics	A intensive lowland	B extensive lowland	C improved hill	D intensive lowland permanent	E intensive upland pasture	F intensive lowland	G medium intensity upland
Initial soil pH	5.9	5.5	5.6	5.7	5.6	5.5	6.4
Initial P Status	10 ppm	23 ppm	15 ppm	28 ppm	25 ppm	13 ppm	20 ppm
Subsequent soil pH							
Control	5.89	5.56	5.44	5.76	5.62	5.13	6.18
Slag 1	6.32	6.08	5.60	6.41	5.94	5.72	6.30
Slag 2	6.67	6.12	5.86	6.79	6.11	5.95	6.72
Slag 3	6.70	6.40	6.19	6.44	6.41	6.10	6.67
Lime	6.62	6.17	5.97	6.18	5.99	6.18	6.70
TSP	6.19	5.53	5.38	5.81	5.69	5.34	6.10
L+TSP	6.62	6.07	5.89	6.19	5.94	6.08	6.83

Table 2
Mean Herbage Dry Matter (DM) yields (tonnes / hectare) over three years at seven sites

Site	A	B	C	D	E	F	G
Control	8.6	11.7	6.9	9.2	10.2	9.9	9.0
Slag 1	8.7	11.4	7.4	9.0	11.0	10.9	8.9
Slag 2	8.7	12.4	7.8	9.0	10.9	10.9	9.2
Slag 3	8.5	11.8	7.8	9.8	10.6	10.4	9.5
Lime	8.3	10.3	7.4	10.1	10.6	10.5	8.9
TSP	8.1	10.8	6.4	9.6	10.9	10.6	9.5
L+TSP	8.5	12.0	8.1	9.6	10.5	10.7	9.5

* Data derived from **two** years only for this site.