THE USE OF SELECTIVE HERBICIDES TO CONTROL WEED GRASSES IN HEATHER MOORLAND

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ABSTRACT

The overgrazing of heather moorlands, by sheep and to a lesser extent red deer, has reduced the coverage of Calluna vulgaris leading to an increase of coverage of Molinia caerulea and other grazing resistant species, reducing the productivity of the moorland. In order to promote the heather regeneration the use of selective herbicides to control the grass species has been considered.

In this paper the preliminary results of field and laboratory studies using carbetamide, diuron and sethoxydim, for the control of grass species present on heather moorland are presented. Of the three compounds sethoxydim appears to be the most appropriate in selectivity and mode of action. In addition the effectiveness of the compounds at a range of soil organic contents will be discussed.

INTRODUCTION

Much of the heather (Calluna vulgaris) moorland in this country is overgrazed by sheep and, to a lesser extent in Scotland, by red deer. The effect of the excessive grazing is to reduce the numbers of broadleaved species, and to favour the grazing-resistant grasses, particularly purple moor grass (Molinia caerulae). Together with bad burning practices which further weakens C. vulgaris, and the introduction of fothering (feeding concentrates to the sheep on the hill in the winter), the invasion of heather moorland by M. caerulae and other 'weed' grasses has greatly increased in recent years (Welch, 1984).

Methods of regenerating C. vulgaris stands, such as cessation or reduction of the grazing levels, are used. In cases of prolonged and or severe overgrazing, however, these methods of regeneration have failed, often caused by the growth habit of M. caerulea.

The effect of M. caerulea development is to prevent seed germination and growth of heather plants. The build up of dead leaf material from previous seasons tends to smother existing heather plants which have already been suppressed through grazing pressure, further reducing the stand of C. vulgaris. This coupled with the aggressive, tussocky nature of M. caerulea and the reduced vigour of the C. vulgaris has allowed the M. caerulea to flourish.

In some instances, the regeneration of heather may be achieved by the removal of excess M. caerulea leaf litter and selective suppression of the grass plants. Previous use of herbicides on heather moorland was aimed at

total kill of all plant species (Williams, 1979). In this project, however, selective herbicides were used to control the M. caerulea and other grass species, enabling the C. vulgaris plants to develop with the reduction of grass competition.

The herbicidal compounds selected for study were:-

diuron, a substituted urea which inhibits cyclic photophosphorylation in susceptible species, killing a wide range of plant species including grasses and broadleaved species (Stranger & Appleby, 1972).

carbetamide, a carbamate which kills many grasses and a few selected broadleaved species by disrupting the growth zones of the plant.

sethoxydim, an oxy phenoxypropionic acid graminicide which inhibits lipid synthesis (Burton et al., 1987).

The suitability of each compound were tested in laboratory studies and a field trial, using formulated herbicides (diuron 500g AI/kg; carbetamide 700g AI/kg; sethoxydim 193g AI/1).

MATERIALS AND METHODS

Laboratory Studies

The laboratory studies were conducted on eight test species:-

C. vulgaris, the major food plant for adult grouse, M. caerulae, an aggressive tussock forming grass species, which is beginning to dominate heather moorlands. Deschampsia flexuosa, a tussock forming needle grass, Nardus stricta, a species which tends to replace overgrazed C. vulgaris in drier areas in the absence of M. caerulea, Festuca ovina and Agrostis tenuis which are both useful species palatable to sheep, Eriophorum vaginatum, the seed heads of which are the main source of energy and calcium for the female grouse during egg production and Juncus squarrosus, an important food plant for grouse feeding on the seeds in the autumn.

M. caerulea has not been included in the laboratory studies to date due to propagation difficulties.

Grass plants were grown until the tillering stage or at 6 cm height in the case of C. vulgaris. The herbicide treatments were applied using a laboratory bench sprayer with 'T' jet-flat fan nozzles with a pressure of 2.5 bar at the following rates:-

sethoxydim	0, 0.25, 0.5, 1.0 and 2.0 kg AI/ha
diuron	0, 1.0, 2.0, 4.0 and 8.0 kg AI/ha
carbetamide	0, 0.5, 1.0, 2.0 and 4.0 kg AI/ha

After spraying the plants were left to grow for a further four weeks (sethoxydim and diuron) or eight weeks (carbetamide) in the greenhouse. The variation in treatment period was based on the mode of action of the compounds. The effect of each herbicide was evaluated using the following methods:-

The chlorophyll content of leaf material was measured by homogenising the tissue in 80% acetone, followed by centrifugation at 2000 G. Supernatant absorption at 663 nm and 645 nm was read and chlorophyll content calculated.

Membrane leakage of treated leaf material was determined by shaking 0.1g leaf material in distilled water at 100 rev/min for 24h after which conductance was measured using a conductivity meter. The samples were then boiled and conductance re-measured. The readings were expressed as percentage of total conductivity of the sample.

Field Trials

The field trials were carried out at Milngavie (near Glasgow) and the island of Islay (both Strathclyde Region), and Keld (Yorkshire). At Milngavie, the driest of the three sites, the trial area contained a patchwork of N. stricta, M. caerulea, C. vulgaris, Erica tetralix and E. cineraria as the predominant species. The site on the island of Islay was typical of most overgrazed Scottish heather moorlands, being grazed by red deer as well as sheep. The dominant species was M. caerulea with little or no C. vulgaris. Keld in Yorkshire was typical of overgrazed Yorkshire heather moorland with well established tussocks of M. caerulea and D. flexuosa which have smothered the previously dominant C. vulgaris.

The plot size at Keld and Islay was 4m x 5m and 4m x 4m at Milngavie. At each site, plots were treated with two rates of sethoxydim (1.0 and 2.0 AI kg/ha), or fluazifop-P-butyl (0.375 AI kg/ha). Control plots were left untreated. For each treatment there were three replicates. The treatments were made using a hand held boom at pressure 2.5 bar. Applications were made as follows:-

Late spring - April/May 1991
Early summer - June/July 1991
Autumn - August /September 1991 (not reported here)

All treated and control plots were assessed using a vigour score for each major species of zero to five.

Zero - a healthy growing plant.
One - little affect on plant growth on whole plant or one or two leaves affected.
Two - whole or part of plant affected and plant growth slightly stunted.
Three - still growing but whole plant affected and growth significantly stunted.
Four - plant severely affected, no seed production and plant growth minimal.
Five - plant dead.

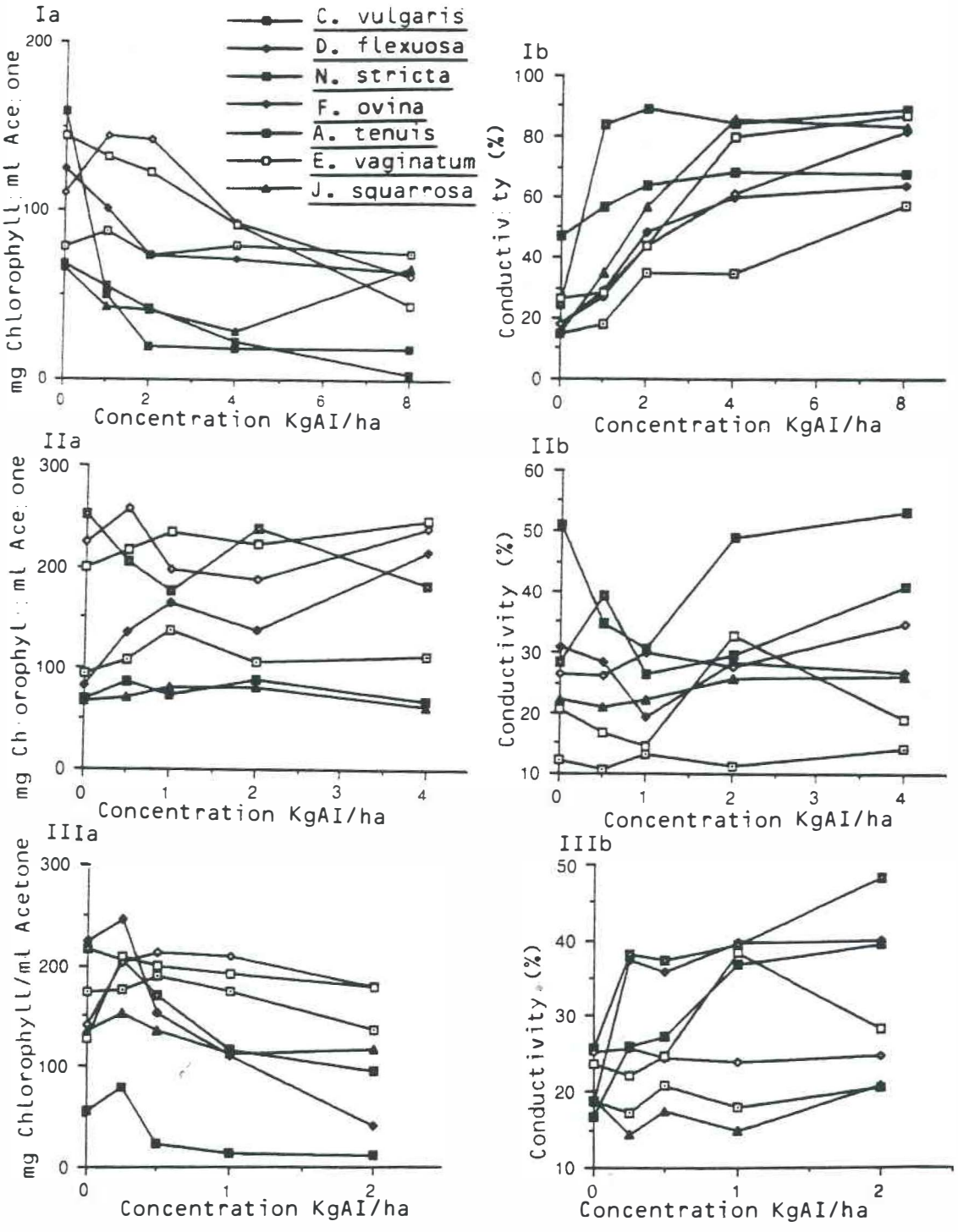
RESULTS

Laboratory Studies

The effects of herbicide treatment on chlorophyll content and membrane leakage are shown in Figure 1. In all experiments carbetamide produced no significant visual effects and membrane leakage, and chlorophyll content was not significantly altered.

In all species diuron significantly increased membrane leakage, and reduced chlorophyll; treatments caused a reduction in growth or death of the plants.

Figure 1 The effect of I) diuron II) carbetamide and III) sethoxydim on a) chlorophyll content and b) membrane permeability of selected species in the laboratory.



Sethoxydim produced more variable results. In D. flexuosa, N. stricta and A. tenuis, chlorophyll content was greatly reduced and conductivity greatly increased. In other species there was little or no effect. The lack of control of F. ovina was unexpected, but may reflect the relatively small receptive leaf surface area of this grass which can receive the spray.

Since sethoxydim controlled the required range of species with little side effects on C. vulgaris or F. ovina, it was regarded as the major candidate for field trials. This was confirmed by a preliminary assessment of a field trial sprayed in October 1990 at Milngavie. Visual assessment indicated that diuron and carbetamide were relatively less suitable for field use in grass-invaded heather moorland than sethoxydim. Accordingly the major trials sprayed in 1991 have concentrated on the effect of sethoxydim.

FIELD STUDIES

Spring Treatment

Results showing the visual effects of sethoxydim treatments are presented in Table 1. At all three sites C. vulgaris and M. caerulea appeared to be totally unaffected, and only slight effects were seen on E. vaginatum and Polytrichum spp. (Keld). However, as the Molinia was still visibly dormant at the time of application the plant appeared unable to take up sufficient herbicide to have any affect.

Table 1. Vigour scores of selected species one month after spring spraying with sethoxydim and fluazifop-P-butyl applied post-emergence at Milngavie (M), Islay (I) and Keld (K).

Dose (Kg AI/ha)		sethoxydim		fluazifop-P-butyl	control
Species		1.0	2.0	0.375	
N. stricta	M	4.0	5.0	2.6	0.0
D. flexuosa	I	3.0	4.3	3.3	0.0
	M	3.0	4.3	3.3	0.0
	K	3.3	4.0	3.3	0.0
E. vaginatum	K	0.2	0.0	0.0	0.0
Polytrichum	K	0.0	1.0	1.3	0.0

D. flexuosa produced red pigments (anthocyanins) in all green leaves and shoots, and seed head production was suppressed. The affect was particularly marked at Keld where there was a high proportion of D.

flexuosa in the sward. At Islay and Milngavie, similar effects on D. flexuosa were obtained, but the effects were less striking as there was a smaller content in the sward.

At Milngavie, N. stricta was affected and the plant turned brown with no seed head production. Three months after application there appeared to be no visual recovery of the Nardus and in certain cases the treated plots were colonised by Potentilla erecta and Galium saxatile.

Sethoxydim (2.0 kg Al/ha) and fluazifop-P-butyl caused some scorching of Polytrichum moss at Keld, though this effect may reflect the drought conditions, which prevailed during the treatment period.

Fluazifop-P-butyl caused similar but less effective control of the named species. The lower activity could be due to the lower rate of application (0.375 kg Al/ha) compared to the sethoxydim (1.0 and 2.0 kg Al/ha).

The apparent lack of control of M. caerulea in all cases was disappointing but it is assumed that herbicide uptake was inadequate since the grass had not started to grow at the time of application.

Summer Spraying

Results showing the visual effects of sethoxydim treatments are presented in Table 2. At Keld and Islay sethoxydim produced good control of M. caerulea, with all treated plants being stunted and the actively growing leaves turning red or brown, there was no seed head production; fluazifop-P-butyl showed a similar rate of control compared to sethoxydim. D. flexuosa appeared unaffected except that panicle maturation was suppressed.

Table 2. Vigour scores of M. caerulea one month after summer spraying treated with sethoxydim and fluazifop-P-butyl applied post-emergence at Islay (I) and Keld (K).

Dose (Kg AI/ha)		sethoxydim 1.0	sethoxydim 2.0	fluazifop-P-butyl 0.375	control
Species					
M.caerulae	I	4.0	4.0	3.0	0.0
	K	4.0	4.0	3.0	0.0

On Islay there appeared to be an increase in the amount of Vaccinium myrtilis and P. erecta on the sethoxydim-treated sites, reflecting the suppressed undergrowth of these species on the untreated plots.

At Keld there was not such a strong undergrowth of other plant species, but where there was such growth, the plants had expanded to fill part of the opened canopy. In one such plot there was a large growth of Empetrum

nigrum and V. myrtilis; C. vulgaris was recorded in the plot for the first time. In another plot P. erecta was greatly increased as a large clump had grown in a cleared area. The recovery of Keld to a large stand of C. vulgaris is expected to be slow as there was little or no heather present in the sward.

Milngavie plots were not treated with herbicide, due to weather conditions, until mid August, and currently results are not available.

DISCUSSION

The laboratory results were quite clear cut, there was little or no effect of diuron or carmetamide whereas sethoxydim successfully controlled a selected range of grasses. The limited range of control of diuron and carbetamide, even when used at rates three or four-fold higher than for normal agricultural use, could be attributed to the wrong timing of application. Ideally the herbicides should be applied when the plant is beginning active growth or just before the onset of dormancy. Unpublished field trial data from Milngavie showed that even when these herbicides were applied at the correct timing there was a lack of activity. This may be due to several factors. For example, it may be attributed to the adsorption of active ingredient to the organic content of the soil; root absorption would be affected and foliar uptake restricted due to leaf senescence. Experiments are planned to calculate the mobility of diuron and carbetamide in ericaceous compost and their activity in varying soil organic matter contents.

The selectivity of sethoxydim to date was satisfactory. While M. caerulea was not included in the laboratory trials, a preliminary trial at Keld in 1989 showed that sethoxydim was able to retard the growth of M. caerulea significantly (D. Newborn, pers. comm.). The field trial results have shown that sethoxydim (1.0 and 2.0 kg Al/ha) has a greater activity on the weed grass population than fluazifop-P-butyl, but the results may reflect the different application rates as sethoxydim was applied at 1.0 and 2.0 kg Al/ha and fluazifop-P-butyl at 0.375 kg Al/ha. The range of species varied from the laboratory trials in that there was an effect on E. vaginatum and Polytrichum spp. The latter species were only affected at Keld, a site which was suffering from drought conditions.

While control of D. flexuosa and N. stricta was evident from the results of the spring spraying, control of M. caerulea was disappointing, doubtless reflecting the relative dormancy of these plants at that time; the summer spraying produced much more satisfactory results.

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