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CHEMICAL MANIPULATION OF HILL COUNTRY PASTURES TO PRODUCE LEGUME DOMINANCE

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Abstract

Hill country pasture was sprayed with low fates of the herbicides paraquat, sethoxydim or Dowco 453 in late November. Legume content of the pasture 6 weeks after application increased from 29 to 61%, and from 12 to 31% in January 1983 and 1984 respectively. The chemicals reduced dry matter yields by 16 and 45%, 6 weeks after treatment, but yields were not reduced in subsequent harvests. The chemicals reduced dead matter content, strongly suppressed grass seed head production, increased clover seed head density and increased *in vitro* digestibility. Sethoxydim at high rates 150 g/ha reduced perennial ryegrass (*Lolium perenne)* content, but Dowco 453 increased perennial ryegrass and decreased browntop *(Agrosfis* tenuis) content. The effect of clover content and dead matter on sheep diet selection is shown and the implications of these results for management of hill country pastures in moist summers are discussed.

Keywords: herbicide, paraquat, sethoxydim, Dowco 453, white clover, *Trifolium repens*, hill country, *in vitro* digestibility, perennial ryegrass, *Lolium perenne* ryegrass, *Lolium perenne* browntop, *Agrostis tenuis.*

INTRODUCTION

Surplus herbage accumulation in late spring and early summer is common in hill country. Typically during this period, pasture production may increase 12 fold, while animal requirements may increase 5 fold (Lambert & Clark 1981). During November to April each millimetre of rainfall can increase herbage accumulation by 11 kg dry matter/ha (Lambert *et* al. 1983). Where herbage conservation is not possible because of contour, the development of long pastures in reproductive growth in excess of animal requirements represents a wastage of feed quantity and quality, and may present problems of pasture reversion, low plant density and poor stock performance (Suckling 1975, Korte 1982) and enhance the survival of insect larvae such as porina *(Wiseana* spp.) (Pottinger 1969, Fenemore & Allen 1969) and grass grub (*Costelytra zealandica*) (East & Willoughby 1980).

Late spring – early summer herbage surplus can be controlled by subdivision, and by grazing management options such as set stocking (Clark *et* al. 1982), or preferentially grazing steep land and using fast rotations (Sheath et al. 1984), or by the use of different grazing animals, especially cattle (Suckling et *al.* 1975), or goats (Clark et *al.* 1984).

Chemicals have also been used to control surplus growth by changing botanical composition. Paraquat at low rates suppresses Qrass growth and legume dominant pastures develop (Palmer 1968; Williams 1968) that result in higher lamb growth rates (Palmer 1967; Taylor & Arnst 1968; Williams & Palmer 1970). Mefluidide suppresses grass seed head formation, maintaining pasture quality (Jackson et *al.* 1980, Field & Whitford 1980) and increased lamb growth rates (Goold et *al.* 1982). Both paraquat and mefluidide decrease total herbage accumulation, but enhance pasture quality and allow surplus herbage of high quality to be used later in the summer.

Recently a range of new grass control herbicides has become available including sethoxydim (Naish et *al.* 1982) and Dowco 453. The aim of this work was to

compare the effectiveness of these new chemicals to enhance legume content of hill country pastures and to thereby produce high quality forage during mid and late summer.

METHODS

Two field trials were conducted at Ballantrae, Grasslands Division hill country research area, near Woodville. Monthly rainfall during the trials was recorded (Table 1).

Table 1: MONTHLY AND TOTAL RAINFALL (MM) FOR NOVEMBER TO APRIL DURING THE TRIAL PERIOD AND THE 14 YEAR AVERAGE.

	Nov	Dec	Jan	Feb	Mar	Apr	Total
Trial 1	91	178	79	56	75	110	589
Trial 2	72	108	42	81	107	51	461
Average	93	113	81	69	96	89	541

Trial 1 was on a southern aspect in a set stocked pasture of 22" slope. The soil, a Wilford silt loam, is an intergrade from mudstone, of moderate fertility, with Olsen P 12, and pH 5.4. Pasture composition at spraying was 14% legume, white clover (*Trifolium repens*) and *Lotus pedunculatus*, 14% dead matter, 72% grasses (12% *Lolium* spp, 12% other high fertility grasses; cocksfoot (*Dactylis glomerata*), Yorkshire fog (*Holcus lanatus*) and *Poa* species; 48% browntop (*Agrostis* spp.) and other 'low fertility tolerant' grasses, sweet vernal (*Anthoxanthum odoratum*) and crested dogstail (*Cynosurus cristatus*). Plots 1.5 x 3.0 m, were spelled one week before spraying on 1 December 1982, when herbage was 20 mm high. Herbicides used to suppress grass growth were paraquat dichloride salt ('Gramoxone') at 140 g active ingredient (a.i.)/ha with a non-ionic surfactant ('Agral LN') at 0.6% v/v; sethoxydim as an emulsifiable concentrate ('Alloxal S') at 50, 100, 150 and 200 g a.i./ha with an emulsifiable crop oil (1% v/v). Herbicides were applied in water at 300 litres/ha at 220 kPa. There were 5 replicates. The trial area was fenced. At regular intervals after treatment, 0.5 m^2 sample was cut from each plot for determination of dry matter, botanical composition and in *vitro* digestibility, and the trial site grazed with sheep for 24 hours.

Trial 2 was on a south west aspect of 13" slope, in the same paddock as trial 1. Pasture composition at spraying was 10% legume (white clover, suckling clover, suckling clover *(T. dubium),* and *Lotus* in about equal proportions) 7% other broadleaves species and 81% grasses (24% Lolium, 20% sweet vernal, 19% browntop, 12% crested dogstail). Plots 1.5 x 4 m were spelled 10 days before spraying on 28 November 1983 when herbage was 30 mm high. Herbicides used were a mixture of paraquat dichloride salt + diquat dibromide salt ('Spraygrow') at 150 + 25 g a.i./ha respectively; sethoxydim at 50, 100 and 150 g a.i./ha with 1% v/v crop oil, and Dowco 453 (2-[4-(3-chloro-5-trifluromethyl-2-pyridyloxy)phenoxy] propionic acid as the ethoxy ethyl ester) at 25 and 50 g a.i./ha with 1% v/v crop oil. Treatments were replicated 4 times. The trial was fenced and managed as in Trial 1.

PASTURE RESPONSES TO CHEMICALS

Legume content was significantly increased by the chemicals during the first 6 weeks following application (Table 2). Sethoxydim and Dowco 453 at 50 g a.i./ha were as effective as the recommended rate of paraquat (150 g/ha). In the second 6 week period the legume content was greater than in the controls, but were similar by autumn.

Table 2: PERCENT LEGUME (DRY WEIGHT) FOLLOWING HERBICIDE TREATMENT FOR TRIALS 1 AND 2.

Treatment	Rate (g/ha)	Trial 1			Trial 2		
		12 Jan	1 Mar	18 May	20 Jan	1 Mar	7 May
Control	-	29	30	7	12	8	2
Paraquat	140	38	27	8	-	-	
Paraquat + diquat	150 + 25	-	-	-	27	14	4
Sethoxydim	50	40	38	8	24	13	4
	100	44	34	7	31	18	3
	150	51	39	12	25	13	3
	200	61	31	11	-	-	-
Dowco	25	-	-	-	16	10	2
	50	-	-	-	27	12	2
LSD (0.05)		12	NS	NS	8	NS	NS

NS, non significant

Herbage accumulation was depressed by 16 to 45%, depending on treatment, during the first 6 weeks following application (Table 3, 4). During this period untreated plots had herbage accumulation rates of 95 and 110 kg DM/ha/day in the 2 trials. The lowest herbage accumulation rates of treated plots were 53 and 70 kg DM/ha/day in the two trials. This is in excess of animal requirements which may reach 40 kg DM/ha/day during this period. Total herbage accumulations were similar to untreated for subsequent harvests and importantly there was no carry-over effect during winter. Early spring growth was reduced by the higher rates of sethoxydim (150 and 200 g/ha).

Table 3: TOTAL HERBAGE ACCUMULATION (kg DM/ha) AND DEAD MATTER (% IN BRACKETS) AT EACH HARVEST DATE FOR THE HERBICIDE TREATMENTS IN TRIAL 1.

Herbicide	Rate (g/ha)	Harvest date 12.1.82	1.3.83	18.5.83	1.9.83	28.10.83	Total
Control	-	4010(4)	2630(17)	1400(14)	610(6)	1460(2)	10110
Paraquat	140	2580(7)	2770(8)	1210(7)	590(6)	1420(2)	8570
Sethoxydim	50	2790(6)	2880(9)	1160(5)	550(6)	1300(3)	8680
	100	2610(7)	2610(10)	1350(6)	700(5)	1560(2)	8830
	150	2350(6)	2870(10)	1160(9)	590(5)	1150(2)	8120
	200	2220(5)	2460(8)	730(5)	560(6)	1190(1)	7160
LSD (0.05)		590(NS)	NS(**)	560(**)	NS(NS)	330(NS)	1810

NS, not significant; ** significant P <0.01

During late summer dead matter contents of pastures were significantly lower in the treated plots (Tables 3, 4). Green herbage accumulation on treated pasture was higher than untreated during the late summer in trial 1. This was associated with higher than average rainfall during summer (Table 1). Even in a drier than average summer (trial 2), green herbage accumulation was not reduced in treated plots during late summer.

Table 4: TOTAL HERBAGE ACCUMULATION (kg DM/ha) AND DEAD MATTER (% IN BRACKETS) AT EACH HARVEST DATE FOR THE HERBICIDE TREATMENTS IN TRIAL 2.

Herbicide	Rate (g/ha)	Harvest date 20.1 .a4	1.3.84	7.5.84	Total
Control	-	4660(6.7)	1820(20.3)	2090(10.6)	8570
Paraquat + diquat	150 + 25	2810(7.0)	1400(4.4)	1730(8.6)	5940
Sethoxydim	50	3920(8.4)	1330(8.9)	1720(9.3)	**6970**
	100	2820(6.3)	1750(3.4)	1850(7.7)	6420
	150	2870(7.8)	1340(3.1)	1790(9.0)	6000
Dowco 453	25	341 O(6.2)	1990(10.1)	1990(11.6)	7390
	50	3180(5.3)	1610(5.2)	1670(8.7)	6460
LSD (0.05)		660(NS)	NS(***)	NS(NS)	

NS, non significant; * * . significant P<0.001

Table 5: GRASS AND CLOVER SEED HEADS (PER M²) IN MID JANUARY 6 WEEKS AFTER HERBICIDE APPLICATION.

Treatment	Rate (g/ha)	Trial 1 Clover	Trial 1 Grass	Trial 2 Grass
Set stocked	-	2	77	108
Control	-	30	1060	370
Paraquat	140	35	260	-
Paraquat + diquat	150 + 25	-	-	40
Sethoxydim	50	51	114	67
	100	69	43	10
	150	56	53	14
	200	95	30	-
Dowco	25	-	-	110
	50	-	-	57
LSD (0.05)		45	218	76

Grass seed head formation was severely reduced by all treatments (Table 5). Grass head numbers were high on untreated plots spelled for 6 weeks compared to the set stocked continuously grazed pasture adjacent to the trial area. Clover seed head numbers on untreated plots increased with spelling (compared with continuously grazed pasture). Treated plots had significantly more clover seed heads than untreated plots (Table 5). Reseeding of white clover could occur during a6 week spelling from grazing (Suckling, 1954).

In vitro digestibility of treated plots was increased by 3 to 5% units during early summer, and 1 to 4% units during late summer (Table 6).

The effect of the chemical treatments on grass species was studied in the second trial. There was a trend for sethoxydim at 150 g/ha to reduce ryegrass content while browntop increased. In contrast, Dowco 453 increased the ryegrass content and reduced the browntop content.

There was no significant change in the botanical composition of broadleaf herbs and weeds following chemical treatments.

Table 6: *IN VITRO* DM DIGESTIBILITY (%) OF TOTAL HERBAGE AT TWO HARVEST DATES FOR DIFFERENT HERBICIDE TREATMENTS IN TRIALS 1 AND 2.

Herbicide	Rate (g/ha)	Trial 1		Trial 2	
		12.1.83	1.3.83	20.1.84	1.3.84
Control	-	63.4	64.3	63.0	68.9
Paraquat	140	67.9	67.3	-	-
Paraquat + diquat	150 + 25	-	-	67.8	73.2
Sethoxydim	50	66.2	64.2	66.1	72.8
	100	69.4	65.8	68.4	72.7
	150	68.0	65.3	68.8	72.9
	200	69.0	65.0	-	-
Dowco 453	25	-	-	67.1	72.0
	50	-	-	67.6	73.5
LSD (0.05)		2.3	NS	1.5	2.5

NS, non significant

The new chemicals are as effective as paraquat, and offer the advantage of maintaining pastures in a green condition, after application, compared to the brown appearance after paraquat use. The factor governing choice of chemical should be cost.

COSTS

The treatment cost depends on both the chemical and application cost. Paraquat or paraquat/diquat treatment at 140 to 175 g/ha would cost $7 to $12/ha, and sethoxydim at 50 g/ha, $12/ha for the chemical. Application costs vary on the type of aircraft (helicopters are more expensive than fixed-wing aircraft); distance from air strip; size of area to be treated, and particularly on the volume of carrier or water used to dilute the chemical.

The less water used, the lower the costs. With the current recommended water rate for these products being 200-300 litreslha, the cost of application would exceed the chemical costs. At 250 litreslha application would cost $25/ha, compared with $10 **and** $5/ha for 50 **and** 10 litreslha ULV (ultra low volume) respectively. Future research must test the effectiveness of these chemicals applied at low water rates. Sethoxydim could be formulated in oil for ULV application and used without water just as certain formulations of 2,4-D are currently used for thistle control in hill country.

Thus treatment costs of less than $20/ha are likely if low volume applications are effective.

DIET CONTRIBUTION

White clover is markedly superior to grass species in feeding value with sheep liveweight gains nearly double those obtained from perennial ryegrass (Ulyatt, 1981). The addition of white clover to grasses has consistently improved the feeding value compared with grasses alone, the response being proportional to the amount of clover in the pasture (Rattray & Joyce, 1974). Pasture allowance trials (Jagusch *et al.,* 1979) have shown that the high growth rates required for both replacement and prime lambs are achieved at lower pasture allowances on legume compared with grass swards.

The effect of seasonal variation in sward legume content on legume in the diet for hill country ewes was studied at Ballantrae (Clark & Ulyatt 1984). When sheep

were presented with white clover in a short sward they were unable to actively select; however, when presented in paraquat sprayed 'strips' containing 70-80% white clover dietary content of white clover is significantly increased (Clark & Harris 1984). Weaned lambs may be better able to select white clover than older ewes (Geenty & Sykes, 1981).

The increased legume content of the experimental swards can be predicted to increase the dietary content of grazing sheep by a similar margin, (Clark et al. 1982) with likely increases on animal production. Presentation of 'strips' of high-clover content could further increase dietary content of clover.

The small increases in in *Vitro* DM digestibility with herbicide treatment (Table 6) are consistent with the small changes in dead matter on treated swards (Tables 3 and 4) and the small differences in DM digestibility between live white clover and live grass leaf.

IMPLICATIONS

The use of chemicals to manipulate the legume content of pastures is not a new idea, although to date there has been a low adoption rate by farmers. The technique allows surplus herbage produced in late spring — early summer to be accumulated as legume dominant, low dead matter content herbage available in mid to late summer when lambs are being finished and ewes flushed before mating. Additional benefits could be to provide special purpose pasture for grazing when ryegrass staggers is a problem (Keogh 1973, 1983). By increasing the grazing pressure on the rest of the farm, while sprayed areas are spelled, pasture cover will be reduced, offering the possibility of reduced scrub invasion and high mortality of porina and grass grub larvae.

Pastures in summer moist regions, or in years when late spring surplus of herbage occurs, that have moderate phosphate levels, reasonable legume contents and probably south facing or have good moisture retention would be suitable for treatment. Suitable sites should receive phosphate and sulphur fertiliser in spring before treatment. The suggested time of application of chemicals to browntop dominant hill pastures is mid to late November, once excess herbage accumulation is evident and before seed heads emerge in early December.

Farmers need to re-evaluate the benefits of using chemicals to increase legume content on a portion of the farm. If ULV application is feasible the technique should be cost effective and demonstrations to verify the benefits and costs would be required.

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