The Effect of Spring Application of Grass-Suppressing Herbicides on the Clover Content and Seed Yield Components of White Clover in Grass/White Clover Swards[1]

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ABSTRACT

An experiment was conducted which showed that clover-safe grass suppressants such as alloxydim-sodium and fluazifop-butyl, when applied in the spring to mixed grass/white clover swards, can control grass growth and significantly increase the flower production and seed yields of white clover (*Trifolium repens*). It has also been demonstrated that application of the suppressants after grazing in spring gives enhanced seed yields when clover is grown with a grass companion in an integrated livestock/seed production system.

Both herbicides increased clover content during the growing season, but this effect was only temporary as there were no significant differences in sward composition between treated and untreated plots when sampled ten weeks after harvest. Flower production and seed yields were highest at the higher application rates of alloxydim-sodium (1.5 and 2.25 kg a.i. ha^{-1}) but there was no significant difference between the application rates of fluazifop-butyl. The only component of seed yield affected by either herbicide at any rate of application was flower number. At the higher application rates of both chemicals, total dry matter production of the sward 10 weeks after harvest was reduced, suggesting that increasing seed yields by using these rates might be at the expense of the grazing subsequently available to the farmer.

Additional index words: **white clover, seed production, species composition, *Trifolium repens.***

INTRODUCTION

The demand for white clover (*Trifolium repens*) seed in the United Kingdom during the last 25 years has remained relatively stable at about 1000 mt per year but the proportion derived from home grown seed has declined to below 5%. This low level of UK production is due primarily to the difficulty of obtaining consistent economic seed yields (Hides, et al, 1984) despite the higher seed yield potential of recently bred UK varieties (Evans and Davies, 1978). If home production is to be increased, then management techniques which improve the reliability of seed yield of these recently bred varieties are required.

White clover can be grown for seed either in monoculture or, as in the traditional clover growing areas such as Kent, with a companion grass where the seed is taken as a catch crop after the sward is utilized for grazing. The seed yields obtained by this method are generally lower than when white clover is grown in monoculture (Zaleski, 1970), but the extended grazing ensures some financial return from the crop and gives some insurance against years when seed yields are low.

These lower seed yields achieved from mixed swards can be attributed partly to competition between the grass and clover components. Initiation of clover flowers is inhibited by shading of the stolons (Stern and Donald, 1962) and flower production is reduced in overdense seed crops. Carefully-managed grazing and manipulation of the closing date have been the traditional means of reducing competition between ryegrass and clover but this is only partially successful (Leonard, 1964). A further reduction in competition between the grass and clover components after grazing, either by controlling grass growth or by reducing crop density, could increase clover flower production and seed yield, thus increasing the potential white clover seed production from such a management system.

Experiments in New Zealand (Leonard, 1964; Wasmuth and Miles, 1972) and in the UK (Blood, 1962), have shown that the application of grass-suppressing herbicides, such as paraquat, after grazing can increase flower production and seed yields. However, some adverse effects on white clover growth have been observed (Blood, 1962; Sharp, 1968). Autumn and winter application of a number of clover-safe herbicides including alloxydim-sodium and fluazifop-butyl have increased the clover content of swards (Standell and Haggar, 1984) whilst carbetamide and propyzamide applied in late winter have increased flower production (Haggar and Bastion, 1980). However, little work has been carried out on the potential of spring applications of clover safe herbicides to mixed grass/white clover swards to suppress grass growth and increase clover seed yields.

This paper reports the results of a field experiment where two clover safe grass suppressants, alloxydim-sodium and fluazifop-butyl were applied in the spring to a mixed grass/-clover sward. The influence of these suppressants on herbage growth and seed yield components of white clover cv. Olwen was investigated.

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MATERIALS AND METHODS

A farm ley in its third year, initially sown with certified seed of perennial ryegrass (*Lolium perenne*) cv. S23 and white clover cv. Olwen was used.

Plots measuring 2 m x 2 m and separated by 1.5 m paths were marked in March 1984 and alloxydim-sodium and fluazifop-butyl applied (26 April 1984) at 0.75, 1.5 and 2.25 kg a.i. ha^{-1} and 0.25, 0.5 and 0.75 kg a.i. ha^{-1} respectively in 300 l water ha^{-1} at 30 psi. Control plots received no herbicide treatment. Each treatment was replicated six times and the experiment was designed as a randomized block. All plots received 150 kg ha^{-1} P and K in the spring.

Botanical Analysis

Botanical samples were collected at three dates, on 10 May, 16 July and 4 October, two weeks after herbicide application, two weeks before seed harvest and 10 weeks after harvesting respectively from a 0.05 m^2 quadrat thrown randomly in each plot and harvested 2 cm above ground level. The quadrats were separated into grass, clover and dead material and the fresh and dry weights of the grass and clover fractions assessed.

Seed Yield Components

Permanent quadrats of 0.25 m^2 were established in each plot and flower numbers within the quadrat counted at regular intervals after herbicide application. Flowers were categorized as ripe (completely brown), reflexing (partially brown) or as completely white heads. Two weeks before harvest (16 July), all flowers from a further 0.05 m^2 quadrat were collected and categorized as above and into a further category of green buds.

One day prior to harvest (31 July 1984), ten ripe heads were collected at random from each plot and the number of florets per head counted. A subsample of five florets was selected at random from each head, rubbed by hand and seed set per floret counted before all florets from the head were rubbed to obtain the seed yield per flowering head.

All plots were harvested 3 cm above ground level on 1 August 1984 using a Brott Flail mower harvesting a 0.6 m strip from the middle of each plot giving a total harvested area of 1.2 m^2 per plot. The harvested material was placed in cotton bags and cool air-dried before the seed was threshed and cleaned.

Seed Quality

Germination tests at 20°C were carried out on Copenhagen tanks on four replicates of 25 scarified seeds from each treatment and counts made of germinating seeds until no more seeds had germinated.

Soil emergence was assessed in boxes on four replicates of 25 scarified seeds from each treatment sown in John Innes No. 3 potting compost in a temperate glasshouse. Counts of seedling emergence were made at regular intervals until no more seedlings emerged.

RESULTS

Herbage Growth

Table 1 shows the effect of the herbicide treatments on the clover content of the sward. Chemical treatment significantly increased clover content as early as 10 May, two weeks after application. Two weeks before seed harvest (on 16 July) all treatments had a significantly ($P < 0.05$) higher clover content than the control. The highest application rate of both chemicals had the greatest effect on clover content; fluazifop-butyl and alloxydim-sodium increased the clover content from 25% in the control to 92.5% and 85.0%, respectively. There were no significant differences in the effectiveness of the two herbicides at the two highest rates; however, at the lowest application rate plots sprayed with alloxydim-sodium (0.75 kg a.i. ha^{-1}) had a significantly higher clover content than the corresponding fluazifop-butyl (0.25 kg a.i. ha^{-1}) treatment. It is also clear from Table 1 that the effects of herbicide treatment on the clover components were transient as there were no significant differences in the clover content ten weeks after the seed crop was harvested. However, this lack of a significant difference can be attributed partly to the increased clover content in the control treatment presumably as the competitive influence of the grass component is removed by harvesting.

Table 1. Effect of grass suppressing herbicides on clover content (% of total dry weight) of a grass/white clover sward on 3 sampling dates, herbicides applied 26 April 1984.

Chemical	Rate of application (kg a.i. ha^{-1})	Sampling dates		
		10 May	16 July	4 October
Control	-	28.2	20.1	47.5
Alloxydim-sodium	0.75	46.4	69.0	54.2
	1.5	43.1	76.4	66.0
	2.25	58.3	85.7	77.0
Mean		49.2	77.0	65.7
Fluazifop-butyl	0.25	40.7	47.7	48.5
	0.5	46.6	69.3	69.0
	0.75	48.5	92.3	73.5
Mean		45.3	69.8	63.6
LSD (P = 0.05)				
Chemical		10.72	10.62	NS
Rate		NS	12.27	NS
Chemical x rate		NS	NS	NS

Although there were no significant differences in the grass and clover components, total dry matter production (t ha^{-1}) was significantly lower at the highest application rate of both chemicals when measured on 4 October (Table 2). Significantly increased dry matter production was observed when alloxydim-sodium and fluazifop-butyl were applied at 1.5 and 0.25 kg a.i. ha^{-1} respectively. This is rather unexpected given the lack of significant differences in the components of yield but it probably reflects the smaller error when the data were bulked to give total dry matter yield.

Table 2. Effect of grass suppressing herbicides on grass, clover and total dry matter production of a grass/-white clover sward, sampled 4 October 1984.

Chemical	Rate of application (kg a.i. ha^{-1})	Dry matter production (t ha^{-1}) Grass	Clover	Total
Control	-	2.36	1.85	4.21
Alloxydim-sodium	0.75	2.28	2.42	4.69
	1.5	1.82	3.20	5.01
	2.25	0.86	2.94	3.81
Mean		1.65	2.85	4.50
Fluazifop-butyl	0.25	3.08	2.29	5.46
	0.5	1.42	3.08	4.50
	0.75	1.08	2.53	3.60
Mean		1.86	2.63	4.52
LSD (P = 0.05)				
Chemical		NS	NS	NS
Rate		NS	NS	0.84
Chemical x rate		NS	NS	NS

Seed Yield Components

Both total flower number and the number of ripe heads at harvest were significantly increased by the herbicide treatments (Table 3) and whilst there was no significant difference between the application rates of fluazifop-butyl, there were significantly more flowers following the higher application rates of alloxydim-sodium. The herbicide treatments had no effect on seed set per floret, florets per head or 1000 seed weights, and the calculated potential seed yield (ripe flowers per unit area x seed per head x individual seed weight) reflects the increased flower production from the treated plots. All treatments significantly increased potential seed yield, the highest yields being obtained from plots receiving the two highest levels of application of alloxydim-sodium and the two lowest rates of fluazifop-butyl (Table 3).

Seed Yield

Although the actual harvested seed yields ranged from 27.1% to 62.3% of the potential seed yield, seed yields from all treatments were still significantly higher than in the control (Table 3), the highest seed yields being obtained from plots receiving the highest application rate of alloxydim-sodium. The large difference between potential and actual seed yields can be attributed partly to harvesting losses.

Seed Germination

The herbicide treatments had no significant effect on either germination or soil emergence of the harvested seed; germinations were betwen 69 and 78% and soil emergence between 68 and 82%.

DISCUSSION

This experiment has demonstrated that grass-suppressing herbicides, when applied in the spring to mixed swards of grass and white clover, can significantly increase the content, flower production and seed yields of white clover. The results confirm those of Haggar and Bastion (1980) who showed the potential of using late winter applications of a number of other herbicides to manipulate the white clover content of mixed swards and have demonstrated their potential for giving increased seed yields in an integrated livestock/seed production system.

Previous experiments (Blood, 1962; Zaleski, 1970) have shown that a March application of paraquat can increase clover content and seed yields from mixed swards; however, some evidence of scorch damage to the clover was observed (Blood, 1962). In the present experiment, applications of both

Table 3. Effect of grass suppressing herbicides on seed yield and seed yield components of Olwen white clover.

Chemical	Rate of application (kg a.i. ha^{-1})	Total flowers m^{-2} at harvest	Ripe flowers (m^{-2})	(%)	Florets per head	Seed set per floret	1000 seed wt (g)	Potential yield (kg ha^{-1})	Harvested yield (kg ha^{-1})
Control	-	593	440	(73.5)	76.8	2.4	0.619	473.0	246.0
Alloxydim-sodium	0.75	897	653	(71.3)	79.3	2.5	0.622	754.0	470.0
	1.5	1240	990	(78.6)	79.8	2.9	0.651	1524.0	526.0
	2.25	1493	1150	(78.5)	76.5	2.8	0.651	1578.0	567.0
Mean		1210	931	(76.1)	78.5	2.7	0.641	1285.3	521.0
Fluazifop-butyl	0.25	963	813	(84.2)	79.0	2.9	0.668	1280.0	347.0
	0.5	1130	933	(82.8)	81.6	2.6	0.665	1334.0	488.0
	0.75	963	703	(73.2)	76.8	2.8	0.663	985.0	481.0
Mean		1019	816	(80.1)	79.1	2.7	0.665	1199.7	439.0
LSD (P = 0.05)									
Chemical		185.9	159.3	NS	NS	NS	NS	300.58	70.7
Rate		NS	NS	NS	NS	NS	NS	NS	80.17
Chemical x rate		325.4	278.6	NS	NS	NS	NS	518.04	NS

alloxydim-sodium and fluazifop-butyl at the end of April increased white clover seed yields with no subsequent damaging effects on clover growth. Both chemicals increased clover content and flower production. Seed yields were increased even at the lowest application rates, although the best harvested yields were obtained at the highest rate. These increased seed yields resulted primarily from an increase in flower production as there was no increase in the other components of seed yield. Potential yields were considerably higher than actual harvested seed yields in all treatments. In the control plots harvested seed yields were approximately 50% of the potential seed yields but were as low as 30% of the potential where grass growth had been suppressed. However, despite these harvesting losses seed yields from the treated plots were still significantly higher than the control and even when harvesting 30% of the potential seed yield represents a profitable return for the farmer. Whilst this demonstrates the effectiveness of suppressing grass growth in mixed swards in terms of white clover flower production, it also demonstrates clearly the need for developing suitable harvesting equipment not only for experimental plots but also for commercial seed crops where harvesting losses can be as high as 90% (Hides, et al, 1984).

Whilst higher application rates increased seed yield there was no difference in the percentage clover content between treatments ten weeks after harvest. However, the total dry matter production of the sward was reduced by some chemical treatments. This suggests that the higher seed yields were at the expense of dry matter production from the grass component, confirming previous results from experiments using carbetamide and propyzamide (Hagger and Bastion, 1980). If the crop is to be grazed after the seed has been harvested then this reduction in dry matter production would reduce the amount of potential grazing available. Ideally, the herbicide should be used at an application rate that controls grass growth yet does not lead to reduced productivity from the ley after harvest. Further studies are in progress to investigate the effect of lower rates of herbicide on clover seed yield and sward components after harvest.

In the present experiment, the grass suppressants were applied at the end of April, but in an integrated seed production system they would be applied when grazing had stopped. In practice this could vary from the middle of April to the end of May, depending on the season and the grazing requirements. The effect of timing of herbicide application in relation to grazing is therefore being assessed. Traditionally this system has been used to grow Kent wild white clover, a small leaved cultivar especially suited to grazing. However, the use of this system to grow the larger-leaved cultivars such as Olwen for seed is an interesting alternative and a comparison of leaf types in a grazing experiment using suppressants would be valuable.

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