

# Effect of Growth Regulators on Seed Yield Components of White Clover<sup>1</sup>

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## ABSTRACT

A comparison of the effects of a number of plant growth regulators on the growth and seed yield components of white clover (*Trifolium repens*) cv. Olwen showed that whilst some rates of chemicals (Cerone and Cycocel) increased total flower number and the number of ripe heads at harvest, this was not reflected in higher seed yields. This was because there were fewer florets per head in these treatments. The chemical treatments had no effect on the proportion of ripe heads at harvest or thousand seed weight. Although harvested seed yields obtained from all treatments were lower than calculated potential yields, they could still represent a profitable return to the farmer despite harvesting losses of 10 to 40%.

Paclobutrazol (PP333) applied at 0.5 and 1.0 kg a.i. ha<sup>-1</sup> reduced petiole height but not peduncle height. This had the effect of elevating the flowers above the leaf canopy. Although no differences in seed set were observed, elevating flowers in this manner could improve pollination and facilitate harvesting particularly of cultivars with short peduncles and in years less suitable for pollination.

*Additional index words:* *Trifolium repens*, flowering.

## INTRODUCTION

The problems of achieving consistent economic seed yields of white clover (*Trifolium repens*) in the United Kingdom have been well documented (Hides, et al., 1984). In good years yields of 600 to 700 kg ha<sup>-1</sup> can be achieved, yet the average seed yield of the highest yielding cultivar is only about 150 kg ha<sup>-1</sup>. Average yields of 250 to 300 kg ha<sup>-1</sup> are necessary to compete economically with other seed crops (Hides, pers. comm.)

A number of factors, both climatic and biological contribute to this variability in seed yield. Poor weather conditions at the critical times of pollination and harvesting can reduce yields, while the intermittent pattern of flower production along the stolon dictates that inflorescences appear over a period of time. This extended flowering period and the resultant range of flower ripeness categories in the crop makes it difficult to optimize harvest date. Early harvesting can result in unripe heads being gathered but a late harvest can miss the

older, earlier produced heads which may have sprouted or fallen below cutting height (Norris, 1984). Furthermore, flowers with short peduncles which do not extend above the leaf canopy may be poorly pollinated and are slow to dry which makes threshing out difficult and increases the risk of sprouting.

Clearly, both concentrating and increasing flower production and maintaining the flowering heads above the leaf canopy could help to improve the reliability of white clover seed yields. Plant growth regulators have been used in a number of species including grasses (Hampton and Hebblethwaite, 1984) and cereals (Hutley-Bull and Schwabe, 1982; Koranteng and Matthews, 1982) to manipulate crop growth and increase yields. However, no work has been carried out to assess the potential of this large group of chemicals for increasing seed yields in white clover.

This paper reports the results of a field experiment carried out to assess the potential of a number of plant growth regulators for manipulating the flowering pattern and growth of white clover and to study their effect upon seed yield and its components.

## MATERIALS AND METHODS

Third year field plots (2 m x 2 m) of the large leaved white clover cv. Olwen were used. Paclobutrazol (PP333), Cerone and New 5C-Cycocel were applied at 3 rates (Table 1) on 29 April 1984 with a tractor mounted sprayer. The growth regulators were applied in 300 l water at 30 p.s.i. Control plots received no growth regulator. All plots received 3 kg ha<sup>-1</sup> Carbetamide in February to control grass weeds and 150 kg ha<sup>-1</sup> P and K in March. Each plot was replicated once in each of eight randomized blocks.

Flower production was assessed from permanent quadrats (0.25 m<sup>2</sup>) established in each plot. One day prior to harvest (30 July 1984) all heads from within a 0.05 m<sup>2</sup> quadrat were collected and divided into ripe and unripe heads. Ten ripe heads were chosen at random and the number of florets per head counted. A subsample of five florets was then selected at random from each head, rubbed by hand and seed set per floret counted before all florets from the head were rubbed out to obtain seed yield per ripe head.

All plots were harvested 3 cm above ground level on 31 July 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<sup>2</sup> per plot. The harvested material was placed in cotton bags and cool air-dried before the seed was threshed and cleaned. 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.

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## RESULTS

Growth regulators had no significant effect on peduncle height (Table 1); however, petiole height was significantly ( $P < 0.05$ ) reduced compared to the control by the application of PP333 (at 0.5 and 1.0 kg a.i. ha<sup>-1</sup>) and Cerone (at 1.92 kg a.i. ha<sup>-1</sup>). This reduction in petiole height resulted in the flowering heads being elevated above the leaf canopy at the higher rates of application of the two compounds (Table 1). In the other treatments, mean flower height was lower than mean petiole height and flowers, therefore, remained below the height of the leaf canopy.

**Table 1. Effect of plant growth regulators on petiole and peduncle heights at peak flowering of white clover cv. Olwen.**

Chemical	Rate (kg a.i. ha <sup>-1</sup> )	Peduncle height (cm)	Petiole height (cm)	Peduncle-petiole height (cm)
Control	--	25.3	29.8	-4.5
PP333	0.25	25.8	27.0	-1.2
	0.5	23.7	23.2	+0.6
	1.0	23.6	20.4	+3.1
Cycocel	0.64	25.9	28.2	-2.2
	1.28	24.3	29.5	-5.2
	2.56	25.1	27.5	-2.4
Cerone	0.48	22.7	30.5	-7.8
	0.96	25.1	27.4	-2.3
	1.92	25.4	25.3	+0.1
LSD (P = 0.05)				
Chemical		NS	1.64	2.74
Rate		NS	1.79	3.0
Chemical x rate		NS	3.52	5.88

Only the highest application rate of Cerone (1.92 kg a.i. ha<sup>-1</sup>) and Cycocel (1.28 kg a.i. ha<sup>-1</sup>) significantly increased total flower number and the number of ripe heads at harvest (Table 2); however flower size (florets per head) was also significantly reduced by both of these treatments. The growth regulators had no significant effect on the percentage ripe heads at harvest, seed set or 1000 seed weight.

The significant increases in flower numbers were not reflected in higher potential seed yields (number of ripe heads per unit area at harvest x seed per head x individual seed weight) or higher harvested seed yields (Table 3). Although

**Table 3. Effect of plant growth regulators on potential seed yield, harvested seed yield and per cent seed losses of white clover cv. Olwen.**

Chemical	Rate (kg. a.i. ha <sup>-1</sup> )	Potential seed yield (kg ha <sup>-1</sup> )	Actual harvested seed yield (kg ha <sup>-1</sup> )	Seed lost at harvest (%)
Control	--	1011	802	20.2
PP333	0.25	1040	819	21.0
	0.5	1070	802	25.4
	1.0	1357	786	42.4
Cycocel	0.64	1008	796	21.0
	1.28	1168	763	32.0
	2.56	885	760	13.0
Cerone	0.48	954	872	8.0
	0.96	992	845	12.0
	1.92	1155	783	32.0
LSD (P = 0.05)				
Chemical		NS	NS	NS
Rate		NS	NS	NS
Chemical x rate		NS	NS	NS

**Table 2. Effect of plant growth regulators on seed yield components of white clover cv. Olwen.**

Chemical	Rate (kg a.i. ha <sup>-1</sup> )	Total flowers m <sup>-2</sup> at harvest	Ripe heads m <sup>-2</sup> at harvest	Florets per head	Seed set per floret	Seed yield (kg ha <sup>-1</sup> )
Control	--	643	603	77.9	3.1	802
PP333	0.25	673	665	77.1	3.2	819
	0.5	640	615	81.1	3.1	802
	1.0	810	792	83.1	3.1	786
Cycocel	0.64	653	625	76.3	3.3	796
	1.28	888	865	68.9	3.0	763
	2.56	578	550	78.1	3.2	760
Cerone	0.48	603	583	70.5	2.8	872
	0.96	633	613	75.4	2.9	846
	1.92	880	853	69.8	2.9	783
LSD (P = 0.05)						
Chemical		NS	NS	5.37	NS	NS
Rate		NS	NS	NS	NS	NS
Chemical x rate		241.6	225.4	NS	NS	NS

the actual harvested seed yields were lower than the potential seed yields, with 10 to 40% of the potential yield being lost, there were no significant treatment differences in potential yields, harvested yields or percentage seed lost during harvesting.

The treatments had no significant effect on seed quality; germinations of all treatments ranged from 70 to 79%.

### DISCUSSION

In general, the plant growth regulators used in this study had little effect on the components of seed yield. Although some of the chemicals at some levels of application increased flower production, this was not reflected in increased seed yields as floret numbers per head were significantly reduced. However, Norris (1984) has demonstrated that flower number has a greater effect on seed yield than floret number. Further work is needed to identify whether the different application rates or times of application can increase flowering without a reduction in flower size. Further investigations are also required to ascertain whether the increase in flower production results from increased flower production per individual stolon or from increased stolon production.

There was no significant increase in the percentage ripe heads at harvest which suggests that the length of the flowering period was not influenced by the growth regulators. Olwen, the white clover cultivar used in this experiment, is usually a good seed producer with numerous florets and a comparatively narrow flowering period compared to other cultivars (Evans and Davies, 1978). It is, therefore, possible that its flowering period may not be further contracted. It is necessary to study the effect of these chemicals on a large leaved cultivar such as cv. Nesta which has a more extended flowering period (Evans and Davies, 1978). This would more clearly identify whether plant growth regulators have the potential to reduce the flowering period.

Although these growth regulators had no effect on peduncle height, the reduced petiole height led to the elevation of flowers above the leaf canopy. There are considerable differences among cultivars in peduncle length (Norris, 1984), Olwen having particularly long peduncles (Evans and Davies, 1978). Despite this, it is clear from this experiment that most flowering heads were below the leaf canopy at peak pollination. Clearly, the application of chemicals which reduce petiole height and yet maintain flower height, thus elevating flowers above the leaf canopy, should be advantageous for

both improved pollination and for ease of harvest particularly for cultivars with shorter peduncles than Olwen. No differences in seed set between treatments were observed. This may reflect the good weather conditions during the experiment which were ideal for pollination. The effects of the present treatments are being further monitored to assess their potential in years which are less favorable for pollination.

Although harvested seed yields were lower than potential seed yields, such yields if achieved on a commercial farm would represent a considerable economic return to the farmer. Nevertheless, the losses incurred during harvesting highlights the need to develop machinery for efficiently harvesting white clover, both in small experimental plots and in commercial practice where harvesting losses of up to 90% have occurred (Hides, et al., 1984).

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