Trinexapac-Ethyl Application Increased Seed Yield of Diploid Red Clover (*Trifolium pratense* L.)

Dave Monks
Department of Environment and Primary Industries, Australia

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Dave Monks

Department of Environment and Primary Industries, PO Box 905, Mildura, Victoria, 3502 Australia
Contact email: dave.monks@depi.vic.gov.au

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Introduction

Red clover (*Trifolium pratense* L.) is a perennial legume grown for forage that, when grown with a seed yield focus in New Zealand, averages 260 kg seed/ha (Clifford, 1979). One way to shift the production focus from biomass to seed yield is the use of plant growth regulators (PGRs). Prior work with PGRs in legume seed production has centred on the gibberellin biosynthesis inhibitors paclobutrazol, uniconazol and cycocel that aim to increase the harvest index of a crop by reducing the ratio of vegetative to reproductive biomass. Inhibiting gibberellin synthesis decreases cell division and cell enlargement; reducing the length of internodes and stems (Hedden and Kamiya, 1997). Trinexapac-ethyl (TE), an alternative synthetic gibberellin-biosynthesis inhibitor with low soil persistence was released in New Zealand in 2000.

This work aims to quantify the effect of TE application on the number of inflorescences and seed yield of red clover.

Method

The experimental site was in Canterbury, New Zealand on an imperfectly drained Templeton silt loam displaying strong mottling (*Udic ustochrept*, USDA Soil Taxonomy) conventionally prepared from 18 March to 24 March 2010. The experiment was a randomised complete block design sown with either 1 or 4 kg/ha 'Sensation' red clover and four PGR rates with five replicates into 8.4 m by 12 m plots on 30 March 2010. The trinexapac-ethyl (TE) was applied as Moddus (250 g TE/litre) with 300 litres water/ha at a rate of 500 g TE/ha when 10% of stems had a flower bud visible (23 December 2010, three weeks after cutting) or as 10% of stems were elongated (20 January 2011, 7 weeks after cutting), or as a split application of 250 g TE/ha at both times. A nil-application was used as the control.

Plots were mown to 8 cm on 24 September 2010 and sprayed for weeds. On 29 November 2010 the site was grazed then mown to 8 cm and immediately followed by an application of 25 kg/ha elemental sulphur (90% S) and 25 kg/ha maxi sulphur superphosphate (0%, 5.1%, 0%, 47% (NPKS)) followed by 25 ml irrigation. Plots were desiccated (200 g diquat/litre) on 23 March 2011 at 3.5L/ha with Contact wetting agent (600 g non-ionic ethoxylates/litre) at 100ml/100L water. On six occasions between 7 January 2011 and 18 February 2011 the number of open inflorescences, that is, inflorescences with more than 50% of florets open and able to be pollinated, was counted from two 0.2 m^2 quadrats. On 30 March 2011 the central 6 m by 10 m from all plots was harvested for seed. The harvested material was air dried then threshed and dressed. All results were analysed as a split plot design by ANOVA, with sowing rate as main plots and TE application as split plots. The row number was used as a covariate to account for flooding that occurred through the growing season, adversely affecting the south-western most plots.

Table 1. The seed yield and total inflorescences/m^2 'Sensation' red clover sown in Canterbury, New Zealand.

Treatment	Seed yield (kg/ha) (30 March)	Total inflor/m^2 (18 Feb)
Control	463 b	832 c
2L 23Dec	537 a	1067 a
2L 20Jan	397 c	888 bc
1L 23Dec 1L 20Jan	426 bc	940 b
Grand mean	456	932
P Value	<0.001	<0.001
LSD	48.6	90.8

Results

Seed yield increased (P<0.001) from 463 kg/ha to 537 kg/ha with the application of 500 g TE/ha on 23 December (when 10% of stems had flower buds visible) (Table 1). When the full rate of TE was applied later, as stems began to elongate, seed yield decreased to 397 kg/ha and when TE was applied as a split application, seed yield did not change (426 kg/ha).

The total number of inflorescences increased (P<0.001) from 832/m^2 to 1067/m^2 with the application of 500 g TE/ha on 23 December and to 940/m^2 with a split application of TE.

Discussion

The seed yield increase was driven by an increase in the number of open inflorescences/m^2 throughout the pollination period. The mechanism for the increase in inflorescences/m^2 is likely driven by an increase in stems/m^2, itself shown, for white clover, to be driven by increased light interception by the youngest node (Thompson, 1993). In which case, trinexapac-ethyl retarded

canopy expansion leading to an increase in light penetration in to the crop. This, in turn, then led to an increase in the number of nodes/m^2 or to an increase in the conversion of nodes in to stems. Further work with detailed components of yield is required for this hypothesis to be confirmed in red clover.

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