IRRIGATION AND TRINEXAPAC-ETHYL EFFECTS ON SEED YIELD IN FIRST- AND SECOND-YEAR RED CLOVER STANDS

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Introduction

Red clover is an important forage legume, with annual worldwide seed production second only to that of alfalfa (*Medicago sativa* L.) (Boller et al., 2010). In Oregon, red clover is harvested for seed on approximately 15,000 to 21,000 acres annually, making it the state's most important forage legume seed crop. In this region, red clover is commonly grown for two years in mostly dryland environments; however, irrigation is becoming increasingly available. There is continued interest among red clover seed producers in evaluating agronomic management practices that increase seed yield.

Oliva et al. (1994) showed that irrigation strategically timed to coincide with flowering increased seed yield over that of non-irrigated red clover. It is unclear how the combination of irrigation and use of a plant growth regulator (PGR) might affect seed yield and yield components in red clover.

Plant growth regulator use in seed crop production aims to increase the number of seeds produced per unit. Harvest index may be increased by producing a higher seed yield and by reducing the amount of vegetative biomass produced in relation to seed produced. Previous work with PGRs in legume seed production has centered on gibberellin biosynthesis inhibitors such as paclobutrazol and uniconazole (Silberstein et al., 1996). More recently, trinexapac-ethyl (Palisade EC®) was evaluated on red clover seed crops in Oregon, New Zealand, and Norway. In Norway, red clover seed yield was increased when trinexapac-ethyl (TE) was applied at BBCH 32[1] (Øverland and Aamlid, 2007). Anderson et al. (2015) reported a 9 to 16% seed yield increase across New Zealand and Oregon environments when 1.7 and 3.4 pt/acre was applied at the same timing.

The objective of this study is to quantify the impact of irrigation and its potential interaction with PGR use in first- and second-year stands of red clover seed crops grown under western Oregon conditions.

[1]BBCH refers to the Biologische Bundesanstalt, Bundessortenamt und CHemische Industrie system of crop development staging.

Methods

Two plantings (2011 and 2012) of red clover seed crops were established in the fall at Hyslop Research Farm near Corvallis, OR, and each was followed over a two-year period to examine the effects of irrigation and TE PGR. The experimental design was a randomized complete block with a split-plot arrangement of treatments and four replications. Plant growth regulator treatment subplots (11 feet x 50 feet) were randomly located within irrigated and non-irrigated main plots. The TE PGR treatments were made on the subplots at two application timings and at three rates of TE. Control plots were not treated (Table 1).

The red clover seed crop was flailed in mid-May (prior to bud emergence), and residue was removed from the field. Once regrowth occurred, approximately 4 inches of irrigation water was applied to main plots over a two-day period using a custom-designed Pierce AcreMaster linear system equipped with minimum-drift Nelson sprinklers. This single irrigation was strategically timed to coincide with first flowering (BBCH 60). Trinexapac-ethyl was applied at rates listed in Table 1 to subplots at stem elongation (BBCH 32) and bud emergence (BBCH 50). Seed was harvested with a small-plot swather (modified JD 2280) and threshed with a Hege 180 small-plot combine. Harvested seed was processed through a M2-B Clipper cleaner, and clean seed yield was determined.

Table 1. Trinexapac-ethyl (TE) application timings and rates used in two first- and second-year stands of red clover grown for seed production.

Application timing (BBCH scale)	TE application rate
	(pt/a)
Untreated control	0
BBCH 32 (stem elongation)	2
	3
	4
BBCH 50 (bud emergence)	2
	3
	4

Plots were sampled at peak bloom (BBCH 65) to determine the number of inflorescences, florets per inflorescence, primary stems, and above-ground biomass. Harvest index was determined for each plot based on harvested seed yield and above-ground biomass. Seed weight was measured by counting two 1,000-seed samples from harvested, cleaned seed material and determining the weight. Seed number was calculated based on seed yield and 1,000-seed weight values obtained from each plot.

Analysis of variance was conducted for each year and stand age. Irrigation and PGR means were separated by Fisher's protected LSD values at the 5% level of significance.

Results and Discussion

There was no interaction of TE and irrigation for seed yield in first- or second-year stands across all three years of the study. Nevertheless, irrigation consistently increased seed yield across both stand ages and years. Red clover seed yield was increased by application of TE at BBCH 32 only in second-year stands.

A single irrigation application consistently increased seed yield of red clover by an average of 13.1% across first- and second-year stands from 2012 to 2014 (Table 2). Irrigation consistently increased seed weight across all years and stand ages by an average of 5% (data not shown). Seed number was increased by an average of nearly 10% with irrigation in first- and second-year stands in 2013, but no significant differences in seed number attributable to irrigation were noted in the first-year stand in 2012 or the second-year stand in 2014. Together, the increases in seed weight and seed number contributed to the seed yield increases as a result of the single irrigation. Irrigation did not have an effect on above-ground biomass, stem number, inflorescences or harvest index, but had varied effects on florets.

Seed yield was not affected by application of TE at any rate or timing in first-year stands, regardless of year (Table 3). However, TE applied at BBCH 32 produced seed yield increases of 15 to 19% in second-year red clover seed stands. Seed number was increased by TE application at BBCH 32 but not at BBCH 50 (data not shown). This increase in seed number likely resulted from increased inflorescences with TE application. Seed weight was reduced by TE regardless of application timing or rate, but the decline in seed weight was more pronounced when TE was applied at BBCH 50.

Table 2. Effect of irrigation on red clover seed yield in first- and second-year stands. A single irrigation (4 inches) was applied at BBCH 55.[1]

		Stand 1		Stand 2		
Irrigation	Water applied	1st year	2nd year	1st year	2nd year	Yield increase
	(in)	(lb/a)				(%)
None	0	787 a	678 a	505 a	667 a	0
Single	4	867 b	746 b	624 b	723 b	13.1

[1]Means within columns followed by the same letter are not significantly different by Fisher's LSD values (*P* = 0.05).

Table 3. TE rate and stand age effects on red clover seed yield with TE applied at BBCH 32.[1]

	Stand 1		Stand 2		Yield increase	
TE rate	1st year	2nd year	1st year	2nd year	1st year	2nd year
(pt/a)	(lb/a)				(%)	
0	818 a	698 a	621 a	639 a	0.0	0.0
2	860 a	818 b	618 a	717 b	2.7	14.8
3	852 a	826 b	630 a	741 b	3.0	17.2
4	844 a	833 b	614 a	754 b	-1.4	18.7

[1]Means within columns followed by the same letter are not significantly different by Fisher's LSD values (*P* = 0.05).

Seed yield was likely increased by TE applied at BBCH 32 in second-year stands because the losses in seed weight were more than offset by increased seed numbers. The lack of seed yield response to TE in first-year stands might have been the result of the TE-induced increases in seed number not being able to offset the reductions in seed weight. When TE was applied early (BBCH 32), the harvest index generally increased with increasing application rate. When TE was applied at BBCH 50, the harvest index decreased as the TE rate was increased. Application of TE did not affect above-ground biomass or stem number.

Conclusion

Irrigation and TE can independently increase seed yield in red clover seed crops, but there was no interaction between the two. A first- or second-year stand likely will benefit from a single irrigation; however, data from this study indicate that, under Oregon conditions, TE likely will increase seed yield only when applied at BBCH 32 in second-year stands.

References

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