IRRIGATION AND TRINEXAPAC-ETHYL EFFECTS ON SEED YIELD IN A SECOND-YEAR RED CLOVER STAND

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Introduction

Red clover is the most widely grown legume seed crop in the Willamette Valley. In previous articles, we've shown that trinexapac-ethyl (Palisade), an acylcyclohexanedione plant growth regulator (PGR), and irrigation can increase seed yield of red clover under Willamette Valley conditions (Anderson et al., 2012; Chastain et al., 2013).

In this article, we will examine the effects of irrigation and trinexapac-ethyl (TE) as well as potential interactions of irrigation and the PGR on seed yield and yield components in a second-year stand of red clover.

Methods

Two plantings (2011 and 2012) of red clover seed crops were established in the fall at Hyslop Crop Science Research Farm near Corvallis, and each has been followed over a two-year period to examine the effects of irrigation and PGRs. PGR treatment subplots (11 feet x 50 feet) were randomly allocated within irrigated and non-irrigated main plots in a split-plot arrangement of treatments in a randomized block experimental design. Trials were replicated in four blocks. The TE PGR treatments were made on the subplots at two application timings and at five rates of TE. Control plots were not treated (Table 1).

Table 1. Trinexapac-ethyl (Palisade EC®) application timings and rates used in a second-year stand of red clover grown for seed production.

Application timing (BBCH scale)	TE application rate
	(pt/acre)
Untreated control	—
BBCH 32 (stem elongation)	1
	2
	3
	4
	5
BBCH 50 (bud emergence)	1
	2
	3
	4
	5

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 four inches of irrigation water was applied to main plots over a two-day period by 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).[1] TE 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 an M2-B Clipper cleaner, and clean seed yield was determined.

Plots were sampled at peak bloom (BBCH 65) to determine the number of heads (inflorescences), florets within the heads, 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.

Results and Discussion

Irrigation increased seed yield of red clover (Tables 2 and 3). Rainfall for July and August was only 37% of the long-term average. These dry conditions were preceded by a normal spring, so the water was clearly needed by the crop during the critical flowering period for best seed yield results. The strategic irrigation increased seed yield by 10% over the non-irrigated crop in the second-year stand (Table 2). Irrigation also increased yield in the first-year stand (results not shown). Above-ground biomass, stem number, harvest index, and inflorescence production were not influenced by irrigation (Table 3). Seed weight was increased by nearly 5% with irrigation (Table 2). Seed yield was likely increased by irrigation because of increases in both seed weight and seed number. Irrigation had no effect on cleanout of the crop. There were no

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

interactions of irrigation and PGR for any of the seed production characteristics (Table 3).

Seed yield was increased by TE with applications made at stem elongation (Figure 1). The 1 pint/acre rate increased seed yields by 10% over the untreated control, while higher rates (2 to 5 pints/acre) increased seed yield by an average of 18%. Application of TE at bud emergence had no effect on yield at the 1 pint/acre rate. At rates of 2 to 5 pints/acre, TE application decreased yield by 8 to 21%, depending on the rate used. Cleanout was significantly reduced by applications of TE at stem elongation but not at bud emergence (data not shown).

There are several possible explanations for the seed yield trends observed with regards to application timing and rate of TE. The application of TE at stem elongation either had no effect on the number of inflorescences produced or increased production at higher rates (Figure 2). On the other hand, inflorescence production tended to be reduced by applications of TE at bud emergence. With reduced inflorescence production, seed yield potential can also be reduced.

Additional contributing factors to the seed yield trends were seed weight and seed number. Application of TE at both timings reduced seed weight, especially with increasing rates of TE (Figure 3). But seed weight was reduced more by TE applications at bud emergence than by applications at stem elongation. Seed number was greatly increased by TE applications at stem elongation, but applications at bud emergence had little effect on seed number (Figure 4). With applications at stem elongation, seed number was increased in proportion to the rate of TE applied, reaching a maximum at 4 pints/acre.

Since seed yield is the product of seed weight and seed number, small reductions in seed weight resulting from TE application at stem elongation were more than offset by increased seed number, leading to increased seed yields. In bud emergence timings, on the other hand, somewhat greater reductions in seed weight were not compensated for by increases in seed number; as a result, seed yield was reduced.

This is the second in a series of reports on irrigation and PGR effects in red clover seed production. Future updates will continue to follow the results of the two experimental red clover seed fields as they age.

Acknowledgments
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Table 2. Irrigation effects on a second-year red clover seed crop in 2013.

	Treatment[1]	
Characteristic	Irrigated	None
Seed yield (lb/acre)	746 b	678 a
Seed weight (mg)	1.71 b	1.63 a
Seed number/m^2 (x 10^4)	48.8 b	46.5 a
Heads/ft^2	71 a	75 a
Cleanout (%)	3.7 a	3.3 a

[1]Means in rows followed by the same letter are not significantly different ($P = 0.05$).

Table 3. Analysis of variance for effects of irrigation and PGR in a second-year stand of red clover seed in 2013.[1]

	Source of variation		
Characteristic	Irrigation (I)	PGR (P)	I x P
Above-ground biomass	NS	NS	NS
Stem number	NS	NS	NS
Harvest index	NS	***	NS
Seed yield	**	***	NS
Seed weight	**	***	NS
Inflorescence number/ft^2	NS	*	NS
Cleanout	NS	*	NS

[1]*$P \leq 0.05$; **$P \leq 0.01$; ***$P \leq 0.001$;
NS = Not significant

References

Anderson, N.P., T.G. Chastain, C.J. Garbacik, and T.B. Silberstein. 2012. Effect of foliar applications of trinexapac-ethyl plant growth regulator on red clover seed crops. In W.C. Young III (ed.). *2011 Seed Production Research Report*. Oregon State University, Ext/CrS 136.

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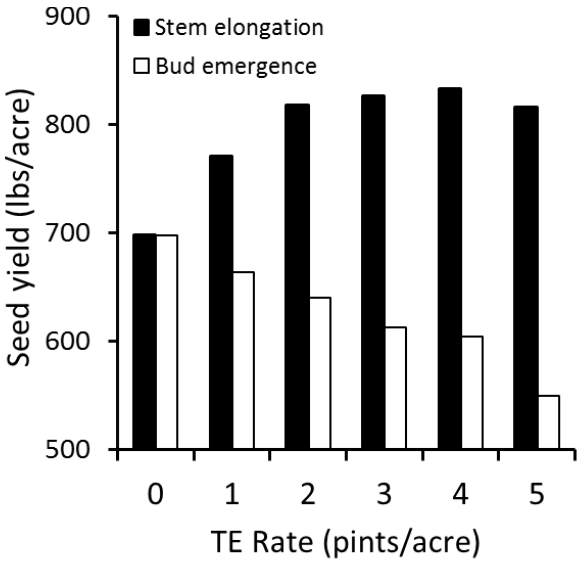

Figure 1. Effect of trinexapac-ethyl applied in two timings on seed yield in a second-year stand of red clover.

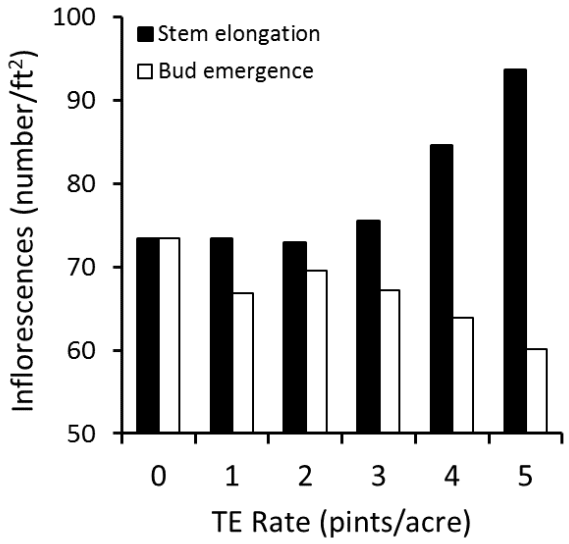

Figure 2. Effect of trinexapac-ethyl applied in two timings on inflorescence production in a second-year stand of red clover.

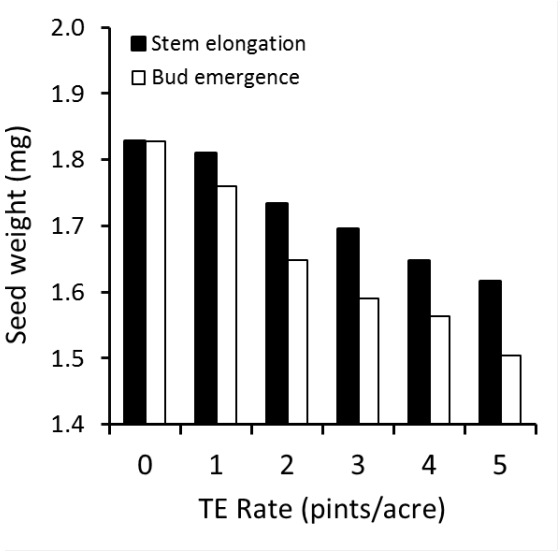

Figure 3. Effect of trinexapac-ethyl applied in two timings on seed weight in a second-year stand of red clover.

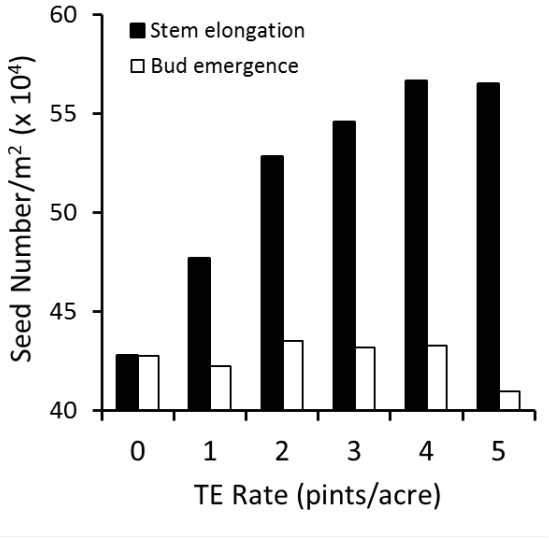

Figure 4. Effect of trinexapac-ethyl applied in two timings on seed number in a second-year stand of red clover.