TRINEXAPAC-ETHYL TIMING AND RATE EFFECTS ON CRIMSON CLOVER SEED YIELD

M. Morad, T.G. Chastain, N.P. Anderson, and C.J. Garbacik

Introduction

Crimson clover is one of the important forage legume seed crops grown in the Willamette Valley of Oregon. The Willamette Valley produces about 95% of the total U.S. crimson clover seed crop, and the value of production reached $20 million in 2014.

Crimson clover seed yields have more than doubled since the mid-1970s. Research in red clover seed crops suggests that further improvement in crimson clover seed yield is possible. One factor in yield increases in red clover seed crops has been foliar application of the plant growth regulator (PGR) trinexapac-ethyl (TE), an anti-lodging agent (Øverland and Aamlid, 2007; Anderson et al., 2015; Anderson et al., 2016).

The effects of application of TE or any other PGR to crimson clover seed crops have not been studied and published. Preliminary on-farm trials have shown that TE can increase crimson clover seed yield by 10 to 24% over the untreated control (Anderson et al., unpublished). More information is needed to identify the optimum application rate and stage of crimson clover development for TE application to achieve the best economic use of this product in crimson clover.

The objective of this multiyear study was to evaluate the effects of TE timing and application rate on crimson clover seed crops and to establish recommendations for TE application to crimson clover in the Willamette Valley.

Materials and Methods

The field trial was established at Hyslop Farm near Corvallis, OR. Crimson clover seed was planted on October 2, 2014 by using a Nordsten drill set at a 6-inch row spacing. The seeding rate was 17 lb/acre. SelectMax (Clethodim) and MCP Amine 4 (MCPA) herbicides were applied at 12 oz/acre and 10 oz/acre, respectively, at BBCH 12 to control weeds in the crop.

The experimental design was a randomized block design with four replications. Both TE rate and timing treatments were evaluated. TE was applied at stem elongation (BBCH 32, late March) and bud emergence (BBCH 50, mid-April). Four TE rates were applied at each of the two timings: 1, 2, 3, and 4 pt/acre. Application timings and rates were compared to an untreated control.

Soil water content was determined by time domain reflectometry (TDR) in early May. Seed yield components (including numbers of stems, heads, and florets) were determined on samples taken at peak bloom (BBCH 65, mid-May). Canopy characteristics (including above-ground biomass and canopy height) were also measured at peak bloom.

The crimson clover was swathed with a modified John Deere 2280 swather on June 10, 2015 and was combined with a Hege 180 plot combine on June 23, 2015. The seed was cleaned with a M2-B Clipper seed cleaner, and 1,000-seed weight was recorded after counting with an Old Mill Company Model 850-2 seed counter. Seed number was calculated based on seed yield and 1,000-seed weight values obtained from each plot. Analysis of variance (ANOVA) was used to test TE treatment effects, and Fisher's protected least significant difference (FPLSD) test was used to separate treatment means.

Results and Discussion

The ANOVA revealed that most characteristics of crimson clover seed production were not affected by application of TE PGR (Table 1). These characteristics

Table 1. ANOVA for trinexapac-ethyl treatment effects on crimson clover seed yield and seed yield components.

Characteristics	Treatment significance[1]
Seed yield	ns
Seed weight	**
Seed number	ns
Cleanout	**
Biomass	ns
Stems/ft^2	ns
Heads/ft^2	ns
Florets/ft^2	*
Canopy height	**
Soil water content	*

[1]*$P \leq 0.05$
**$P \leq 0.001$
ns = not significant

included seed yield, seed number, stem number, above-ground biomass, and head number. Very dry conditions prevailed in the spring of 2015, with only 58% of normal rainfall occurring April through June, and these dry conditions likely influenced the results.

Seed yields were variable and lower than the 10-year average yield of 910 lb/acre for the Willamette Valley as a result of extreme drought and high temperature conditions (Table 2). There was no effect of TE PGR on seed yield at either application timing or for any of the four rates tested. These results were inconsistent with the preliminary on-farm trials in prior years, which showed a seed yield increase with TE.

Seed weight was reduced with all TE treatments (Table 2). Overall, seed weight generally declined with increasing rate of TE and the later application time. There was no effect of TE on seed number, which was the primary factor responsible for the seed yield increase by TE PGR in red clover in previous studies (Anderson et al., 2015; Anderson et al., 2016).

Canopy height of the crop was reduced with the TE application. Height reductions increased with increasing TE rate at the BBCH 32 timing, but not at the BBCH 50 timing (Table 3). The number of florets increased at the BBCH 32 application timing with 1 to 3 pt/acre rates, but not with 4 pt/acre. Only the 3 pt/acre rate

Table 2. Effect of trinexapac-ethyl timing and rate on seed yield, seed weight, and seed number in crimson clover.[1]

------------------ Treatment ------------------				
Timing	Rate	Seed yield	Seed weight	Seed number
	(pt/a)	(lb/a)	(mg/seed)	(seeds/ft^2)
Untreated control	—	362 a	5.67 a	667 a
BBCH 32	1	346 a	5.38 b	673 a
	2	364 a	5.17 c	733 a
	3	383 a	5.05 cd	792 a
	4	305 a	4.79 de	669 a
BBCH 50	1	278 a	5.11 c	566 a
	2	301 a	4.88 de	643 a
	3	290 a	4.49 f	676 a
	4	278 a	4.38 f	660 a

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

Table 3. Trinexapac-ethyl timing and rate effects on seed production characteristics in crimson clover.[1]

------------- Treatment -------------					
Timing	Rate	Soil water content	Canopy height	Floret number	Cleanout
	(pt/a)	(%)	(cm)	(floret/ft^2)	(%)
Untreated control		23.0 a	71.1 a	7,309 c	2.23 bc
BBCH 32	1	19.4 b	61.1 bc	9,374 ab	1.86 bc
	2	20.8 ab	58.3 cd	9,200 b	1.74 bc
	3	19.4 b	55.7 d	11,264 a	1.72 c
	4	19.9 b	53.6 d	7,329 c	1.87 bc
BBCH 50	1	23.1 a	65.2 b	7,981 bc	1.87 bc
	2	20.0 b	63.9 b	8,709 bc	2.29 b
	3	21.7 ab	63.8 b	9,776 ab	3.03 a
	4	20.8 ab	62.4 bc	8,663 bc	2.96 a

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

significantly increased floret production at the BBCH 50 timing. Cleanout represents the quantity of nonseed material harvested. Cleanout increased with 3 and 4 pt/acre of TE at the BBCH 50 timing.

The reduction in canopy height by TE most likely opened up the canopy, thereby allowing a greater loss of soil water through evaporation (Figure 1). Coupled with the abnormally dry and hot conditions, the reduction in canopy coverage with TE reduced the amount of soil water available for seed filling, likely contributing to the reduction in seed weight.

In summary, severe drought and heat during flowering and seed filling caused low and variable seed yields in crimson clover. Seed yield was not affected by TE application. The trials will be repeated in the 2015–2016 crop year.

References

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Acknowledgments

The authors wish to thank the Oregon Clover Commission, Agricultural Research Foundation, and Syngenta Crop Protection for their support of this research.

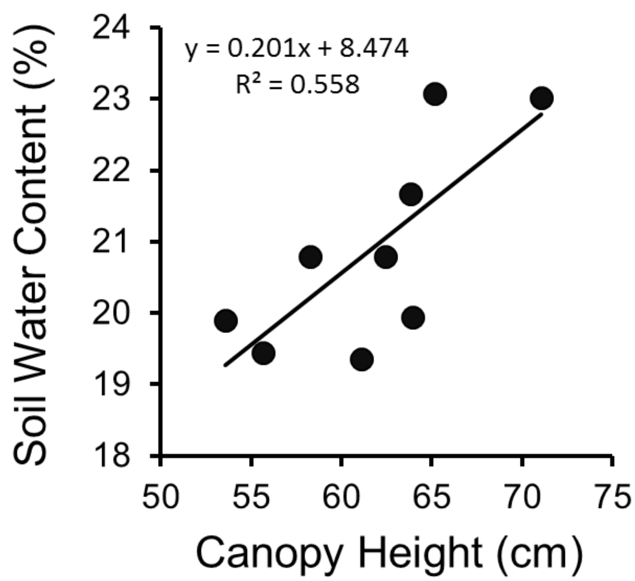

Figure 1. Effect of canopy height reduction by trinexapac-ethyl PGR on soil water content in crimson clover seed production trials.