EXAMINING POSSIBLE BENEFITS OF PLANT GROWTH REGULATOR MIXTURES ON SECOND-YEAR TALL FESCUE SEED CROPS

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Introduction

Tall fescue is the most widely grown grass seed crop in Oregon. Like other cool-season grasses, tall fescue produces only a fraction of its potential seed yield. In a study conducted by Young et al. (1998), tall fescue crops produced 37–53% of potential seed yield under Oregon conditions. Lodging of the crop during flowering and seed shattering are two primary factors limiting seed yield production. Lodging reduces seed yield in tall fescue by as much as 31%, compared to a crop that is artificially supported in the upright position (Griffith, 2000).

Two stem-shortening growth regulators—chlormequat chloride (CCC, trade name Cyclocel) and trinexapac-ethyl (TE, trade name Palisade EC)—enhance seed yield in forage grasses. These products act by blocking gibberellic acid (GA) biosynthesis.

Since being developed as a plant growth regulator (PGR), TE has been widely adopted for use as a lodging control agent in grass seed production globally. Studies conducted in western Oregon have recently shown reductions in lodging, a result of stem shortening, ranging from 46 to 62%, when TE was applied to tall fescue at 1.5 pt/acre and 3 pt/acre, respectively (Chastain et al., 2015).

Prior to the development of TE, CCC was used commercially in ryegrass seed crops in New Zealand, where it produced seed yield increases of 34 to 44% (Hampton, 1986). Since TE produces higher seed yield responses than CCC, rapid grower adoption of TE resulted. Although both CCC and TE are GA inhibitors, CCC acts in the early steps of GA biosynthesis, whileTE acts late in the pathway.

The objective of this 2-year study was to investigate whether combinations of PGRs that act at different points in the GA pathway have additive effects on seed yield. Results from year 1 of this trial conducted by Anderson et al. (2017) on first-year tall fescue (turf-type) stands indicate that a single application of TE (1.5 pt/acre) increased seed yield by 24.9% across four trials, but there was no additional benefit of adding CCC to the PGR applications. The second year of this study aimed to evaluate whether there were differences between treatments in second-year stands.

Materials and Methods

In 2017, field trials were continued on four commercial second-year tall fescue (turf-type) seed fields, located across the Willamette Valley. Each field was spring planted in 2015, and PGR treatments were applied in the spring of 2016. The trial was reestablished in 2017 on the same footprint as the previous year. The experimental design for the trials was a randomized complete block with three replications. Plot size was approximately 28 feet x 300 feet. Each trial was fertilized by the grower at standard nitrogen rates, and routine fungicide sprays were applied to manage stem rust.

Treatments included the following PGR products and application rates:

- Untreated control (No PGR)
- 1.5 pt TE/acre applied at BBCH 32–37 (two nodes to early flag leaf emergence)
- 1.34 lb CCC/acre applied at BBCH 32–37
- 1.5 pt TE/acre + 0.67 lb CCC/acre applied at BBCH 32–37
- 1.5 pt TE/acre + 1.34 lb CCC/acre applied at BBCH 32–37
- 0.75 pt TE/acre + 0.67 lb CCC/acre applied at BBCH 32–37

Above-ground biomass samples were taken from each plot near crop maturity, and dry weight (biomass) of the standing crop was determined. The length of stems was measured for each treatment at harvest maturity to determine crop height. Lodging ratings were taken prior to swathing and harvest.

Seed was harvested with grower swather and combine equipment, and seed yield was determined with a weight wagon. Harvested seed was cleaned to determine clean seed yield. Seed weight was determined by counting two 1,000-seed samples with an electronic seed counter and weighing these samples on a laboratory balance. Harvest index (HI), the ratio of seed yield to above-ground biomass, was also determined.

Results and Discussion

All treatments that contained TE reduced lodging in second-year tall fescue, in comparison with the untreated control (Table 1). The control treatment was moderately lodged (52%) across the trials. Reduction in lodging from TE alone was large (92%) with the 1.5 pt/acre rate. However, CCC alone was inconsistent and weak in its effect on lodging. When CCC was added to mixtures containing 1.5 pt/acre TE, lodging tended to be reduced slightly more than with TE alone, but the difference was not significant.

Lodging reduction with TE across study sites was made possible by reduction in canopy height (stem length), as compared to the untreated control (Table 2). There was no difference in above-ground biomass between any treatments, except for Polk County, where treatments containing 1.5 pt/acre TE reduced biomass.

Seed yields were variable but were higher than the 10-year yield average. Application of TE consistently controlled lodging in tall fescue in all cultivars in these studies. There was a positive effect of TE and mixes of TE + CCC on seed yield at all locations, except at Linn County. The 1.5 pt/acre TE treatment increased seed yield by 17% across all four sites.

The use of CCC alone or in mixtures with TE did not influence seed yield (Table 2). Results indicated that PGR mixtures provided no additional benefit over the 1.5 pt/acre TE treatment in these second-year stands. Seed weight changes were variable between treatments and sites, but there were no negative effects on seed weight from PGRs. Seed number was significantly increased by TE, but not by CCC, at three of the four study sites. The increase in seed yield with TE is likely attributable to this increase in seed number.

Harvest index provides a measure of how grass seed crop management impacts partitioning of seed in relation to total above-ground biomass production. Harvest index was significantly affected by TE and/or TE + CCC mixture applications at two of the four sites (Table 2).

The results of the second year of this 2-year study indicate that adding CCC to TE applications can further reduce lodging but does not have any economic seed yield advantage in turf-type tall fescue stands.

Table 1. Effect of trinexapac-ethyl (TE) and chlormequat chloride (CCC) mixes on lodging in tall fescue crops.[1]

	Lodging (%)			
	Washington County	Polk County	Linn County	Benton County
Untreated control	76.7 c	35.0 b	61.7 b	33.3 b
TE 1.5 pt/a	15.0 ab	0.0 a	15.0 a	3.3 a
CCC 1.34 lb ai/a	73.3 c	33.3 b	60.0 b	28.3 b
TE 1.5 pt/a + CCC 0.67 lb ai/a	15.0 ab	1.7 a	15.0 a	3.3 a
TE 1.5 pt/a + CCC 1.34 lb ai/a	10.0 a	0.0 a	15.0 a	0.0 a
TE 0.75 pt/a + CCC 0.67 lb ai/a	26.7 b	5.0 a	23.3 a	1.7 a

[1]Numbers followed by the same letters are not significantly different by Fisher's protected LSD values ($P = 0.05$).

Table 2. Effect of trinexapac-ethyl (TE) and chlormequat chloride (CCC) mixes on seed yield, seed weight, above-ground biomass, canopy height, seed number, and harvest index in tall fescue crops.[1]

	Washington County					
Treatment	Yield	Seed weight	Biomass	Height	Seed number	HI[2]
	(lb/a)	(mg/seed)	(ton/a)	(cm)	(seeds/m^2)	(%)
Untreated control	2,381 a	2.463 ab	10.36	130.1 c	108,400 a	11.6 a
TE 1.5 pt/a	2,975 b	2.548 c	10.53	108.7 a	130,856 bc	14.7 abc
CCC 1.34 lb ai/a	2,489 a	2.440 a	11.17	126.3 c	114,281 ab	11.6 a
TE 1.5 pt/a + CCC 0.67 lb ai/a	3,074 b	2.525 bc	8.11	111.5 ab	136,483 c	20.3 c
TE 1.5 pt/a + CCC 1.34 lb ai/a	3,112 b	2.471 ab	8.83	106.3 a	141,273 c	17.7 bc
TE 0.75 pt/a + CCC 0.67 lb ai/a	2,742 ab	2.489 abc	10.44	116.7 b	123,612 abc	13.3 ab
	Polk County					
Treatment	Yield	Seed weight	Biomass	Height	Seed number	HI[2]
	(lb/a)	(mg/seed)	(ton/a)	(cm)	(seeds/m^2)	(%)
Untreated control	2,134 a	2.374 a	9.41 c	116.2 c	100,945 a	11.4 a
TE 1.5 pt/a	3,084 b	2.439 b	5.92 a	86.2 a	141,798 b	26.3 c
CCC 1.34 lb ai/a	2,177 a	2.375 a	9.87 c	111.4 bc	102,690 a	11.3 a
TE 1.5 pt/a + CCC 0.67 lb ai/a	3,227 b	2.443 b	6.30 ab	85.5 a	148,105 b	26.3 c
TE 1.5 pt/a + CCC 1.34 lb ai/a	3,252 b	2.388 a	6.83 ab	88.0 a	152,636 b	23.8 bc
TE 0.75 pt/a + CCC 0.67 lb ai/a	3,171 b	2.413 ab	8.68 bc	906.0 b	147,347 b	13.3 ab
	Linn County					
Treatment	Yield	Seed weight	Biomass	Height	Seed number	HI[2]
	(lb/a)	(mg/seed)	(ton/a)	(cm)	(seeds/m^2)	(%)
Untreated control	2,184	2.511	10.04	114.1 b	97,517	10.9
TE 1.5 pt/a	2,197	2.588	8.99	98.4 a	95,165	13.1
CCC 1.34 lb ai/a	2,142	2.492	9.86	111.9 b	96,506	11.0
TE 1.5 pt/a + CCC 0.67 lb ai/a	2,270	2.592	10.36	99.6 a	98,294	11.1
TE 1.5 pt/a + CCC 1.34 lb ai/a	2,332	2.517	8.62	89.8 a	113,875	13.8
TE 0.75 pt/a + CCC 0.67 lb ai/a	2,302	2.519	8.05	97.0 a	111,529	14.6
	Benton County					
Treatment	Yield	Seed weight	Biomass	Height	Seed number	HI[2]
	(lb/a)	(mg/seed)	(ton/a)	(cm)	(seeds/m^2)	(%)
Untreated control	2,405 ab	2.085	10.20	111.6 b	129,335 ab	12.0
TE 1.5 pt/a	2,734 c	2.045	9.81	91.8 a	150,032 c	14.2
CCC 1.34 lb ai/a	2,132 a	2.017	10.52	113.1 b	119,077 a	10.2
TE 1.5 pt/a + CCC 0.67 lb ai/a	2,648 bc	2.054	10.86	96.5 a	144,511 bc	12.2
TE 1.5 pt/a + CCC 1.34 lb ai/a	2,719 bc	1.979	9.64	89.3 a	154,064 c	14.3
TE 0.75 pt/a + CCC 0.67 lb ai/a	2,712 bc	1.988	9.82	99.2 a	152,863 c	14.2

[1]Numbers followed by the same letters are not significantly different by Fisher's protected LSD values ($P = 0.05$).
[2]HI = harvest index

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