EXAMINING POSSIBLE BENEFITS OF PLANT GROWTH REGULATOR MIXTURES IN 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 to 53% of potential seed yield under Oregon conditions. Lodging of the crop during flowering and seed shattering are two primary factors limiting seed yield. 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 (ranging from 46 to 62%), a result of stem shortening, when TE was applied to tall fescue at 1.5 pt/acre and 3.0 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, while TE acts late in the pathway.

Recent studies in perennial ryegrass and orchardgrass have investigated whether combinations of PGRs that act at different points in the GA pathway have additive effects on seed yield. For example, when a tank-mix of CCC and TE was applied to orchardgrass, seed yields were increased by 84% across five New Zealand experiments (Rolston et al., 2014).

There is no information available locally or in international literature on stem-shortening effects or seed yield responses of tall fescue crops to CCC or mixes of CCC and TE plant growth regulators. The objectives of this study were to determine the effects of CCC and TE + CCC combinations on seed yield, seed weight, seed number, percent lodging, above-ground biomass, crop height, and harvest index in tall fescue seed crops.

Materials and Methods

In 2016, field trials were conducted on four commercial first-year tall fescue seed fields, located across the Willamette Valley. Each field was spring planted in the previous year, and none of the fields received spring irrigation prior to harvest. The experimental design for the trials was a randomized complete block with three replications. 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

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. 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, the ratio of seed yield to above-ground biomass, was also determined.

Results and Discussion

All treatments that contained TE reduced lodging in tall fescue, in comparison with the untreated control (Table 1). The control treatment was mostly lodged (93%) across the trials. Reduction in lodging from TE alone was large (73%) 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. When the amount of TE in the TE + CCC mix was reduced to 0.75 pt/acre, reduction in lodging was not as large (22%).

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 at any site.

Seed yields were variable, but were higher than the 10-year average yield of 1,535 lb/acre for the Willamette Valley.

Application of TE consistently controlled lodging in tall fescue in all four cultivars in these studies. There was a positive effect of TE and mixes of TE + CCC on seed yield at all locations. The 1.5 pt/acre TE treatment increased seed yield by 23.9%.

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.

Seed weight was not affected by any of the PGR treatments and did not contribute to the increased seed yield observed when TE was applied. 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 not significantly affected by TE or CCC application, either when applied alone or in a mixture (Table 2).

The results of the first year of this 2-year study indicate that adding CCC to TE applications does not have any economic advantage. This work will be repeated in 2017 on the same four commercial tall fescue fields to examine the results of these treatments on second-year 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	80.0 c	96.7 c	100.0 c	96.7 c
TE 1.5 pt/a	23.3 a	20.0 a	46.7 ab	20.0 a
CCC 1.34 lb ai/a	76.7 c	90.0 b	100.0 c	90.0 b
TE 1.5 pt/a + CCC 0.67 lb ai/a	20.0 a	20.0 a	30.0 a	20.0 a
TE 1.5 pt/a + CCC 1.43 lb ai/a	20.0 a	20.0 a	26.7 a	20.0 a
TE 0.75 pt/a + CCC 0.67 lb ai/a	44.3 b	23.3 a	66.7 b	23.3 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	H.I.[2]
	(lb/a)	(mg/seed)	(ton/a)	(cm)	(seeds/m²)	(%)
Untreated control	1,492 a	2.431	9.45	129.0 b	68,896 a	7.9
TE 1.5 pt/a	1,913 b	2.422	10.17	107.4 a	88,571 b	9.6
CCC 1.34 lb ai/a	1,575 a	2.347	11.61	126.1 b	75,204 a	6.9
TE 1.5 pt/a + CCC 0.67 lb ai/a	1,969 b	2.392	9.96	105.7 a	92,146 b	10.4
TE 1.5 pt/a + CCC 1.43 lb ai/a	2,066 b	2.365	10.94	106.2 a	98,021 b	9.6
TE 0.75 pt/a + CCC 0.67 lb ai/a	1,961 b	2.362	10.43	108.5 a	93,101 b	9.5

	Polk County					
Treatment	Yield	Seed weight	Biomass	Height	Seed number	H.I.[2]
	(lb/a)	(mg/seed)	(ton/a)	(cm)	(seeds/m²)	(%)
Untreated control	2,422 a	2.572	9.13	109.1 c	105,596 a	13.7
TE 1.5 pt/a	3,011 b	2.529	9.23	84.8 a	133,679 c	16.3
CCC 1.34 lb ai/a	2,544 a	2.497	9.77	108.0 c	114,179 ab	13.2
TE 1.5 pt/a + CCC 0.67 lb ai/a	3,224 b	2.568	10.41	88.9 ab	140,849 c	15.6
TE 1.5 pt/a + CCC 1.43 lb ai/a	3,225 b	2.512	9.84	82.3 a	143,918 c	16.4
TE 0.75 pt/a + CCC 0.67 lb ai/a	2,995 b	2.567	9.73	92.9 b	130,754 bc	15.4

	Linn County					
Treatment	Yield	Seed weight	Biomass	Height	Seed number	H.I.[2]
	(lb/a)	(mg/seed)	(ton/a)	(cm)	(seeds/m²)	(%)
Untreated control	2,183 a	2.536	11.32	128.1 c	96,496	9.8
TE 1.5 pt/a	2,630 bc	2.518	13.51	103.0 ab	117,150	10.0
CCC 1.34 lb ai/a	2,348 ab	2.507	13.69	122.8 c	104,973	8.6
TE 1.5 pt/a + CCC 0.67 lb ai/a	2,666 c	2.582	14.77	104.3 ab	115,837	9.1
TE 1.5 pt/a + CCC 1.43 lb ai/a	2,593 bc	2.555	11.32	96.2 a	113,875	11.5
TE 0.75 pt/a + CCC 0.67 lb ai/a	2,516 bc	2.529	13.90	107.3 b	111,529	9.2

	Benton County					
Treatment	Yield	Seed weight	Biomass	Height	Seed number	H.I.[2]
	(lb/a)	(mg/seed)	(ton/a)	(cm)	(seeds/m²)	(%)
Untreated control	2,033 a	2.363	13.21	133.2 b	96,538 a	7.7
TE 1.5 pt/a	2,490 c	2.355	12.92	110.4 a	118,532 c	9.7
CCC 1.34 lb ai/a	2,082 a	2.357	12.63	129.4 b	99,047 a	8.4
TE 1.5 pt/a + CCC 0.67 lb ai/a	2,576 c	2.375	12.54	108.9 a	121,692 c	10.3
TE 1.5 pt/a + CCC 1.43 lb ai/a	2,476 bc	2.378	14.40	104.4 a	116,814 bc	8.7
TE 0.75 pt/a + CCC 0.67 lb ai/a	2,356 b	2.367	12.27	112.8 a	111,651 b	9.7

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

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