Effects of Plant Growth Regulator Combinations on Turf-Type and Forage-Type Tall Fescue Seed Crops

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Introduction

Tall fescue is an important cool-season forage and turf grass, and ranks among the most important seed crops in Oregon. Unfortunately, cool-season grasses only produce a fraction of their potential seed yield. Young et al. (1998) reported that tall fescue seed crops produced 37 to 53% of their potential yield, making them inefficient seed producers.

There has been no previous research conducted in Oregon to indicate whether a combination of PGRs will affect seed yield in tall fescue. In New Zealand, forage-type cultivars make up a majority of the perennial ryegrass and tall fescue seed crops, whereas in Oregon, tall fescue and perennial ryegrass seed crops consist mostly of turf-type cultivars.

Objectives

1. Evaluate the impact of PGR combinations on lodging, above-ground biomass, plant height and stem length in turf and forage-type tall fescue cultivars

2. Determine the effect of PGR combinations on seed yield, seed weight, and seed number on turf-type and forage-type tall fescue

Methods

Trials were conducted near Corvallis, Oregon from 2016 to 2018. The experimental design was a randomized complete block with 4 replications. Each plot was 3.3 x 15.2 m.

Seven treatments were applied in the study:
- Untreated control
- 210 g ai/ha TE
- 1500 g ai/ha CCC
- 105 g ai/ha TE + 750 g ai/ha CCC
- 210 g ai/ha TE + 1500 g ai/haCCC
- 210 g ai/ha TE + 750 g ai/ha CCC
- 105 g ai/ha TE + 1500 g ai/ha CCC

Procedures:
- Planted October 8th, 2015 at seeding rate of 9 kg ha-1
- Soil: Woodburn silt loam (fine-silty, mixed, mesic, Aquultic Argixeroll)
- ANOVA was conducted and means separated by Fisher's protected LSD values (*P* = 0.05)
- Planted turf-type cv 'Spyder'; forage-type variety 'Fawn'
- Biomass sampled (BBCH 65)
- Crop height, length of stems, lodging assessment (BBCH 69)
- Harvest timing was determined based on seed moisture content
- Seed crop was harvested with a small-plot swather and seed was threshed with a small-plot combine after seed moisture content was reduced to approximately 12%
- Seed yield was determined on cleaned seed and seed number was calculated using seed yield and seed weight
- Samples were taken from the harvested seeds and were cleaned by the use of screens and blowers
- An electronic seed counter counted two, 1,000 seed samples, which were used to determine seed weight.

Gibberllic Acid Biosynthesis Pathway and PGRs

- Trinexapac-ethyl (TE) plant growth regulator (PGR) use in grasses grown for seed has been widely adopted in grass seed production around the globe
  - Tall fescue seed yield was increased 40% over the untreated control with applications of TE to control lodging (Chastain et al., 2015).
- Chlormequat chloride (CCC) is not currently registered for use in grass seed crops in OR
- The PGRs fall into one of two categories of GA biosynthesis inhibitors, acting at different locations of the pathway (Rademacher, 2015):
  - CCC is an onium-type compound
  - TE is an acylcyclohexandione
- In New Zealand, combinations increased seed yield by up to 95% in perennial ryegrass (Chynoweth et al., 2014) and up to 86% in orchardgrass (Rolston et al., 2014).

		Cultivar							
PGR	Rate	Fawn				Spyder			
		Year							
		2017		2018		2017		2018	
	g ai/ha	kg/ha^{-1}							
Control	0	791	e[2]	727	c	1698	bc	1065	c
TE[1]	210	1136	a	990	a	1819	bc	1106	c
CCC	1500	912	d	726	c	1721	bc	1050	c
TE + CCC	105 + 750	1016	c	893	b	1801	bc	1217	ab
TE + CCC	210 +1500	1123	ab	1051	a	2001	ab	1307	a
TE + CCC	210 + 750	1185	a	1068	a	2189	a	1138	bc
TE + CCC	105 + 1500	1031	bc	851	b	1591	c	1101	c

Table 1. Seed yield responses of tall fescue cultivars to combinations of PGRs. Fawn is a forage-type cultivar and Spyder is a turf-type cultivar..
1 TE = Trinexapac-ethyl
CCC = Chlormequat Chloride
2 Means followed by the same letter are not different by Fisher's protected LSD values (P = 0.05)

		Cultivar							
PGR	Rate	Fawn				Spyder			
		2017		2018		2017		2018	
	g ai/ha	no/m^2 (no x 10^4)							
Control	0	2.80	d[2]	4.44	c	7.50	c	4.44	c
TE[1]	210	4.02	a	4.51	c	8.12	bc	4.69	c
CCC	1500	3.24	c	4.45	c	7.63	c	4.46	c
TE + CCC	105 + 750	3.51	bc	5.17	ab	7.99	bc	5.22	ab
TE + CCC	210 +1500	3.80	ab	5.47	a	9.27	ab	5.13	a
TE + CCC	210 + 750	4.09	a	4.83	bc	9.82	a	4.91	bc
TE + CCC	105 + 1500	3.64	b	4.65	c	7.36	c	4.72	c

Table 2. Seed number responses of tall fescue cultivars to combinations of PGRs. Fawn is a forage-type cultivar and Spyder is a turf-type cultivar.
1 TE = Trinexapac-ethyl
CCC = Chlormequat Chloride
2 Means followed by the same letter are not different by Fisher's protected LSD values (P = 0.05)

Results

Above-ground biomass production was not affected by any PGR treatments within either cultivar (data not shown). However, as expected, the forage-type cultivar produced 25% more biomass than the turf-type cultivar. Tiller height was reduced by TE alone but not by CCC alone in both 'Spyder' and 'Fawn' cultivars (data not shown).

Seed yield (Table 1):
- Seed yield response to PGRs and PGR mixtures varied between the forage-type and turf-type cultivar
- Application of PGRs affected seed yield of both cultivars, when compared with the untreated control
- The CCC alone treatment did not produce increased seed yields over the untreated control.
- In 'Spyder', highest seed yield was observed in the 210 g ai/ha TE + 750 g ai/ha CCC in 2017 and the 210 g ai/ha TE + 1500 g ai/ha CCC in 2018
- In 'Fawn', the highest seed yields were evident in all treatments that contained 210 g ai/ha TE
- Yield responses in both cultivars can largely be attributed to the effects of PGR treatments on reducing lodging and resultant seed number increases from better pollination and seed set (Table 2)

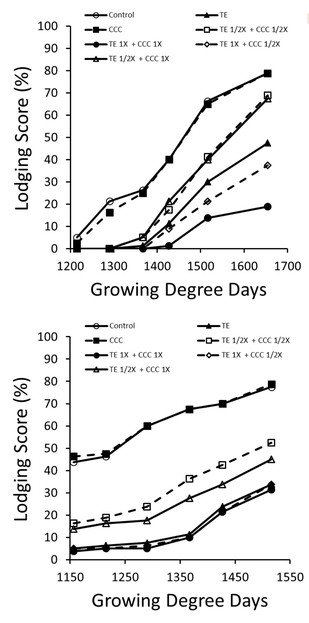
Seeds m^{-2} (Table 2):
- Largest increases in seed number were observed in 'Fawn' with 210 g ai/ha TE + 750 g ai/ha CCC and TE alone in 2017
- In 2018, the largest increases in seed number in 'Fawn' were observed with 210 g ai/ha TE + 1500 g ai/ha CCC
- In 'Spyder' 210 g ai/ha TE + 750 g ai/ha CCC and 210 g ai/ha TE + 1500 g ai/ha CCC both had high seed number and seed yield in 2017
- Largest increase in seed number observed in 'Spyder' for 2018 was the 210 g ai/ha TE + 1500 g ai/ha CCC treatment

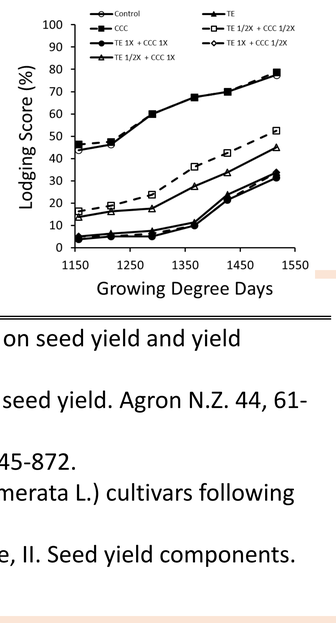
Seed weight :
- Seed weight was affected by PGR mixtures in 'Fawn' in 2017
- In 'Fawn' the 210 g ai/ha TE + 1500 g ai/ha CCC combination increased seed weight over control in 2017
- Seed weight did not appear to have any effect on seed yields
- There was no significant difference in seed weight among PGR treatments in 'Spyder' for 2017 or 2018
- There was no significant difference in seed weight among PGR treatments in 'Fawn' for 2018.

Figure 1. Effect of PGR and PGR mixtures on lodging in 'Spyder' turf-type tall fescue in spring 2017 .

TE 1X = 210 g ai/ha, TE 1/2X = 105 g ai/ha, CCC 1X = 1500 g ai/ha, CCC 1/2X = 750 g ai/ha

Figure 2. Effect of PGR and PGR mixtures on lodging in 'Fawn' turf-type tall fescue in spring 2017





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