SPRING MOWING AND PLANT GROWTH REGULATOR EFFECTS ON FIRST- AND SECOND-YEAR FINE FESCUE SEED CROPS

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Introduction

Fine fescues (*Festuca rubra* L.) comprise a group of three cool-season grass species, including strong creeping red fescue (*F. rubra* ssp. *rubra*), slender creeping red fescue (*F. rubra* ssp. *littoralis*), and Chewings fescue (*F. rubra* ssp. *commutata*). While fine fescues are morphologically similar in many vegetative and reproductive characteristics, strong creeping red fescue and slender creeping red fescue produce rhizomes, while Chewings fescue does not. Their extensive geographic distribution as turfgrasses is due to their wide adaptation to many environmental and management conditions. However, Oregon is the leading producer of fine fescue seed in the United States, with nearly 22,500 acres valued at $23.3 million in 2019 (Anderson, 2020).

Open-field burning has been an important management tool in Oregon fine fescue seed production fields because removal of postharvest residue maintains high seed yield and quality. The use of the plant growth regulator (PGR) trinexapac-ethyl (TE; Palisade EC) was evaluated over 4 years as a potential alternative to open-field burning for maximizing yield in creeping red fescue (Zapiola et al., 2014). Results of that study indicated that fall-applied TE has no effect on seed yield or seed yield components and cannot be used as a substitute for open-field burning. However, Gingrich and Mellbye (2001) reported a 32–48% increase in fine fescue seed yields from spring-applied TE in a series of on-farm trials conducted in the Silverton Hills.

Clormequat chloride (CCC; Adjust) is another stem-shortening PGR that has been used in other seed-producing areas worldwide, but it has not been examined in Oregon grass seed production until recently. These two PGRs act at different locations in the gibberellin (GA) biosynthesis pathway (Rademacher, 2015). CCC is an onium-type compound, and a label is currently being pursued by the registrant for its use in grass grown for seed. The effect of CCC and TE + CCC mixtures has not been previously examined in fine fescue seed crops grown under Oregon conditions.

Field observations have shown that inflorescence emergence can begin very early in the spring (February–March), and there is concern that early-emerging inflorescences do not make meaningful contributions to seed yield. Spring mowing, with and without combinations of TE and CCC PGRs, was identified as a key research priority in a series of Oregon State University (OSU) focus group meetings held with fine fescue seed growers during the 2017–2018 growing season. There have been no studies to address the effect of spring mowing on seed yield, components of yield, and above-ground biomass production in fine fescues.

The objective of this research is to determine whether a smaller window of inflorescence emergence can be created by mowing in the spring, which could result in more uniform flowering and increased seed yield. We also investigated effects of combining spring mowing with TE, CCC, and TE + CCC PGR applications.

Materials and Methods

Two years of field trials were conducted on ‘Survivor’ Chewings fescue and ‘Wendy Jean’ creeping red fescue at OSU’s Hyslop Research Farm near Corvallis, OR, from 2018–2020. The soil type at the site is a Woodburn silt loam. Plot size was approximately 11 feet x 45 feet. Plots were established with conventional tillage during spring of 2018. Routine fertilizer and herbicide applications were made as needed to manage fertility and weed pests. Mowing treatments were implemented using a standard flail mower set to a cutting height of 2–3 inches. Postharvest residue was managed by straw removal and flailing (no field burning). The experimental design was a randomized complete block with a split-plot arrangement of treatments and four replications. Main plots were spring mowing timings, and subplots were PGR treatments. Subplots were randomly allocated within spring mowing main plots. All PGR treatments were applied at BBCH 32 growth stage (two-node).

Spring mowing main plots included the following timings:

Untreated control (no mowing)		
Early mow	Year 1: March 31	Year 2: February 12
Late mow	Year 1: April 18	Year 2: March 5

PGR subplots include the following active ingredients and application rates:

- Untreated control (no PGR)
- Trinexapac-ethyl (TE): 1.4 pt/acre (Chewings) or 2.8 pt/acre (creeping red)
- Clormequat chloride (CCC): 1.34 lb/acre
- TE: 1.4 pt/acre (Chewings) or 2.8 pt/acre (creeping red) + CCC: 1.34 lb/acre

At peak flowering (BBCH 65), three 0.1 m^{-2} samples were harvested (cut to 2 cm above ground level) at random from each plot to determine inflorescences m^{-2}, tillers m^{-2}, stem length cm^{-2}, and above-ground biomass. Inflorescences m^{-2} were determined by counting all inflorescences within each sample, and stem length was determined by measuring ten stems chosen randomly from each sample. Samples were placed in a dryer at 65°C for approximately 48 hours and were then weighed to determine the above-ground biomass.

Plots were swathed with a modified John Deere 2280 swather and combined with a Hege 180 plot combine. Subsamples of harvested seed were collected from each plot and cleaned using a Clipper M2B cleaner to determine cleanout percentage and 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 quantified.

Results and Discussion

Results from the first year of the study (2019) indicate that both early- and late-spring mowing treatments decreased seed yield in first-year stands of both Chewings fescue (Table 1) and creeping red fescue (Table 2). The decrease in seed yield can likely be attributed to a reduction in fertile tillers and seed number. There was an increase in seed weight from both the early and late mowing in both fine fescue varieties. There were mixed effects on HI among varieties. Above-ground biomass and tiller height were reduced with both mowing treatments in both varieties.

In the second year of the study (2020), mowing treatments were applied approximately 1 month earlier, and the seed yield response differed from year 1. Results indicated no difference in seed yield between mowing treatments for either Chewings fescue (Table 3) or creeping red fescue (Table 4) when PGRs were not applied. However, seed yield increased in Chewings fescue with early mowing when TE + CCC was applied and for late mowing when both TE and TE + CCC were applied (Table 3). Conversly, seed yield in creeping red fescue was negatively affected when late mowing and TE + CCC were combined, but all other treatments were the same (Table 4). There were no differences in fertile tiller number, above-ground biomass, or HI between mowing treatments for either variety in year 2. Unlike year 1, neither mowing treatment reduced fertile tiller height in either variety.

In the first year, PGR effects on seed yield differed between the two fine fescue species and mowing treatments. In Chewings fescue, all PGR treatments increased seed yield with no mow and early mow but remained unchanged with late mow (Table 1). PGRs increased creeping red fescue seed yield only with the no-mow treatment (Table 2). PGR treatments containing CCC increased seed weight with no-mow and early-mow treatments in Chewings fescue (Table 1). In creeping red fescue, effects of PGR on seed weight varied, with an increase in seed weight with all PGR treatments in the no-mow treatment and a decrease in seed weight when TE + CCC and late-mow treatments were combined (Table 2). PGR treatments did not affect fertile tiller number in either variety, but the TE and CCC treatments decreased tiller height when combined with early mowing in creeping red fescue. There were mixed effects on biomass but no effects from any of the PGR treatments on HI in Chewings fescue (Table 1). All CCC PGR treatments decreased above-ground biomass in creeping red fescue with no-mow and early-mow treatments (Table 2). The TE + CCC PGR treatment increased HI across all mowing treatments.

PGR effects on seed yield differed between the two fine fescue species in year 2. All PGR treatments, except CCC combined with early mow, increased seed yield in Chewings fescue (Table 3). In creeping red fescue, TE and TE + CCC treatments increased seed yield, except for TE + CCC with late mow (Table 4). Seed weight was often, but not always, increased in both varieties when TE-containing PGR treatments were applied. The TE + CCC PGR treatment decreased tiller number in no-mow Chewings fescue (Table 3) and with all mowing treatments in creeping red fescue. All PGR treatments decreased tiller height and above-ground biomass across all mowing treatments in Chewings fescue (Table 3), but only TE-containing PGR treatments decreased tiller height in creeping red fescue (Table 4). The TE + CCC PGR treatment decreased above-ground biomass in creeping red fescue across all mowing treatments (Table 4). TE and TE + CCC also

Table 1. Effects of spring mowing and plant growth regulators on seed yield, yield components, and above-ground biomass of first-year 'Survivor' Chewings fescue, 2019.[1]

		Seed yield	Cleanout	Seed weight	Seed no.	Biomass	Tiller no.	Tiller height	HI[2]
		($lb\ a^{-1}$)	(%)	(mg)	($no\ m^{-2}$)	($kg\ ha^{-1}$)	($no\ m^{-2}$)	(cm)	(%)
No mow	No PGR	785 c	5.61 e	0.8865 a	99,673 cd	8,223 ef	325 cd	77.9 e	10.8 bc
	TE	865 cd	5.57 e	0.8820 a	110,132 de	9,849 g	350 cd	77.5 e	10.0 b
	CCC	907 de	4.65 d	0.9150 b	111,172 de	8,811 fg	320 c	74.4 e	11.7 bc
	TE + CCC	1,007 e	3.71 ab	0.9132 b	123,807 e	9,654 g	375 d	70.6 de	11.0 bc
Early mow	No PGR	554 b	4.25 bcd	0.9817 c	63,409 b	5,578 abc	161 b	57.5 bc	11.4 bc
	TE	714 c	3.71 bc	0.9947 c	80,486 c	7,588 def	205 b	61.1 bcd	10.9 bc
	CCC	729 c	2.97 a	1.0025 cd	81,901 c	6,188 bcd	166 b	62.1 cd	13.4 c
	TE + CCC	739 c	3.70 ab	1.0032 cd	82,573 c	6,775 cde	192 b	51.8 ab	12.6 bc
Late mow	No PGR	157 a	4.09 bcd	1.0295 def	17,128 a	5,104 abc	62 a	47.3 a	3.6 a
	TE	172 a	4.57 d	1.0485 f	18,472 a	3,879 a	58 a	44.2 a	5.4 a
	CCC	162 a	4.46 cd	1.0310 ef	17,699 a	4,211 a	69 a	43.4 a	4.6 a
	TE + CCC	174 a	4.79 d	1.0240 de	19,081 a	4,651 ab	85 a	43.6 a	4.3 a
	SE =	62	0.49	0.0136	7,799	607	19	3.4	1.2

[1]Numbers followed by the same letter are not significantly different at LSD (P = 0.05).
[2]Harvest index (HI) is the ratio of seed yield to above-ground biomass.

Table 2. Effects of spring mowing and plant growth regulators on seed yield, yield components, and above-ground biomass of first-year 'Wendy Jean' creeping red fescue, 2019.[1]

		Seed yield	Cleanout	Seed weight	Seed no.	Biomass	Tiller no.	Tiller height	HI[2]
		($lb\ a^{-1}$)	(%)	(mg)	($no\ m^{-2}$)	($kg\ ha^{-1}$)	($no\ m^{-2}$)	(cm)	(%)
No mow	No PGR	1,187 d	3.61 abc	1.0496 a	124,215 d	10,371 e	389 g	68.0 h	13.1 abc
	TE	1,416 f	3.19 ab	1.0960 bc	144,786 f	8,977 d	378 g	61.3 g	18.0 de
	CCC	1,297 e	3.23 ab	1.0997 bc	132,249 de	9,852 de	391 g	67.9 h	15.1 bcd
	TE + CCC	1,370 ef	2.99 a	1.1387 d	134,787 ef	7,057 c	358 g	49.8 ef	21.9 f
Early mow	No PGR	872 c	4.53 cd	1.1387 d	85,663 bc	7,272 c	234 f	53.1 f	13.7 abc
	TE	904 c	4.23 bcd	1.1381 d	88,975 c	4,866 b	180 de	40.7 bc	21.7 ef
	CCC	826 bc	4.54 cd	1.1320 cd	81,705 bc	6,409 c	171 cde	48.4 de	15.7 bcd
	TE + CCC	769 b	4.94 d	1.1148 bcd	77,028 b	4,886 b	187 ef	33.2 a	17.5 d
Late mow	No PGR	445 a	6.62 e	1.1268 cd	44,108 a	4,218 b	103 ab	44.5 cd	11.7 ab
	TE	441 a	7.18 ef	1.0851 ab	45,237 a	4,057 b	126 bcd	38.7 b	12.1 ab
	CCC	395 a	7.14 ef	1.1097 bcd	39,722 a	4,242 b	117 abc	43.1 bc	10.6 a
	TE + CCC	426 a	8.06 f	1.0887 b	43,870 a	2,803 a	75 a	31.0 a	16.7 cd
	SE =	68	0.46	0.0165	6,519	553	20	1.6	1.8

[1]Numbers followed by the same letter are not significantly different at LSD (P = 0.05).
[2]Harvest index (HI) is the ratio of seed yield to above-ground biomass.

Table 3. Effects of spring mowing and plant growth regulators on seed yield, yield components, and above-ground biomass of second-year 'Survivor' Chewings fescue, 2020.[1]

		Seed yield	Cleanout	Seed weight	Seed no.	Biomass	Tiller no.	Tiller height	HI[2]
		(lb a^{-1})	(%)	(mg)	(no m^{-2})	(kg ha^{-1})	(no m^{-2})	(cm)	(%)
No mow	No PGR	897 ab	14.67 cd	0.8755 b	114,878 ab	10,967 c	330 bcd	76.0 ef	9.5 a
	TE	1,155 cd	14.04 abcd	0.8763 b	147,769 de	9,814 bc	308 abcd	62.9 d	13.7 ab
	CCC	1,026 bc	14.30 bcd	0.8910 bcd	129,183 bc	8,990 abc	258 abc	63.4 d	13.2 ab
	TE + CCC	1,517 e	13.84 abcd	0.9040 cde	188,092 f	8,315 ab	252 a	49.7 ab	20.8 c
Early mow	No PGR	880 a	15.30 d	0.8553 a	115,436 ab	10,030 bc	302 abcd	84.4 g	10.6 a
	TE	1,276 d	14.13 bcd	0.9098 def	157,196 e	9,589 abc	304 abcd	73.3 e	15.2 b
	CCC	1,101 c	14.70 cd	0.8880 cb	138,863 cd	10,822 c	347 d	77.4 ef	11.4 ab
	TE + CCC	1,789 f	13.09 abc	0.9148 efg	219,299 g	9,176 abc	308 abcd	52.5 bc	22.3 c
Late mow	No PGR	838 a	14.16 bcd	0.9011 cde	106,265 a	9,773 bc	326 abcd	82.6 fg	9.9 a
	TE	1,487 e	12.92 abc	0.9305 g	179,028 f	8,175 ab	284 abcd	59.0 cd	21.0 c
	CCC	1,059 c	12.27 ab	0.9030 cde	131,413 bcd	9,823 bc	337 cd	74.1 e	12.1 ab
	TE + CCC	1,543 e	11.99 a	0.9263 fg	186,788 f	7,207 a	256 ab	44.0 a	24.3 c
	SE =	46	0.49	0.0065	5,784	607	28	2.4	1.5

[1]Numbers followed by the same letter are not significantly different at LSD (P = 0.05).
[2]Harvest index (HI) is the ratio of seed yield to above-ground biomass.

Table 4. Effects of spring mowing and plant growth regulators on seed yield, yield components, and above-ground biomass of second-year 'Wendy Jean' creeping red fescue, 2020.[1]

		Seed yield	Cleanout	Seed weight	Seed no.	Biomass	Tiller no.	Tiller height	HI[2]
		(lb a^{-1})	(%)	(mg)	(no m^{-2})	(kg ha^{-1})	(no m^{-2})	(cm)	(%)
No mow	No PGR	1,015 abc	17.29 ab	0.9886 ab	115,007 abc	8,249 ef	315 e	58.2 d	14.2 a
	TE	1,187 de	17.97 ab	1.0198 cde	130,846 de	6,506 bcde	255 bcde	48.4 bc	22.8 cd
	CCC	1,002 ab	17.54 ab	0.9761 a	115,294 abc	7,182 cdef	288 cde	55.2 d	16.4 ab
	TE + CCC	1,156 d	18.70 bc	0.9943 abcd	130,228 de	5,418 abc	208 ab	38.1 a	24.7 de
Early mow	No PGR	1,022 abc	17.53 ab	1.0091 bcde	114,299 abc	8,652 f	304 de	55.7 d	13.4 a
	TE	1,277 e	16.81 ab	1.0369 ef	138,626 e	6,463 bcde	240 abcd	44.0 b	22.7 cd
	CCC	1,073 bcd	17.06 ab	0.9925 abc	120,488 bcd	8,171 ef	291 cde	53.0 cd	15.2 a
	TE + CCC	1,175 de	17.40 ab	1.0361 ef	127,143 cde	4,616 ab	169 a	35.6 a	29.3 e
Late mow	No PGR	931 a	16.78 ab	1.0079 bcde	103,629 a	7,383 def	319 e	56.0 d	14.7 a
	TE	1,127 cd	16.46 a	1.0661 f	122,182 bcd	5,777 abcd	230 abc	43.5 b	22.1 bcd
	CCC	1,015 ab	16.32 a	1.0021 abcd	113,408 abc	6,570 cde	260 bcde	53.6 cd	17.4 abc
	TE + CCC	1,008 ab	20.79 c	1.0232 de	110,506 ab	4,160 a	225 abc	33.9 a	27.8 de
	SE =	45	0.92	0.0101	5,279	729	30	2.0	2.2

[1]Numbers followed by the same letter are not significantly different at LSD (P = 0.05).
[2]Harvest index (HI) is the ratio of seed yield to above-ground biomass.

had the greatest effect on HI in both varieties. Overall, PGR treatments appear to have had similar effects in first- and second-year stands.

The differences in seed yield response to mowing treatments between years 1 and 2 can likely be attributed to differences in mowing timing in relation to growing degree day (GDD) accumulation. In year 1, early and late mowing treatments were carried out at 461 GDD and 648 GDD, respectively. Due to the negative effect of spring mowing on seed yield in the first year, mowing treatments were applied at 291 GDD (early) and 423 GDD (late) in the second year. The differences in the resulting seed yield response are an indication that components of seed yield are being set prior to the accumulation of 399 GDDs; therefore, any spring mowing practices should occur before that time. Results also suggest that only an early-spring mowing treatment should be considered in both species because a late mowing is likely to be detrimental to achieving high seed yields.

These data reinforce results from previous studies indicating that TE PGR use in fine fescue seed crops increases seed yield. This was evident in both Chewings and creeping red fescue in both the first- and second-year stands. Interestingly, CCC had a positive effect on seed yield, both alone and in combination with TE, in Chewings fescue but not in creeping red fescue. If this product receives a grass-grown-for-seed label, its use should be considered in Chewings fescue seed crops.

References

Anderson, N.P. 2020. Extension estimates for Oregon legume seed crop acreage and production, 2019. https://cropandsoil.oregonstate.edu/seed-crops/oregon-grass-and-legume-seed-production

Gingrich, G.A. and M.E. Mellbye. 2001. The effect of plant growth regulators on seed yields of grass crops. In W.C. Young Ill (ed.). *2000 Seed Production Research Report*. Oregon State University, Ext/CrS 115.

Rademacher, W. 2015. Plant growth regulators: Backgrounds and uses in plant production. J. Plant Growth Regul. 34:845–872.

Zapiola, M.L., T.G. Chastain, C.J. Garbacik, and W.C. Young III. 2014. Trinexapac-ethyl and burning effects on seed yield components in strong creeping red fescue. Agron. J. 106(4):1371–1378.

Acknowledgments

USDA-NIFA, the Agricultural Research Foundation, and Taminco US LLC provided funding for this work. The authors thank Syngenta Crop Protection and Taminco US LLC for providing PGR products. We are also appreciative of the fine fescue growers and field representatives who provided input when this project was being developed.