ARE HIGHER YIELDS POSSIBLE IN ANNUAL RYEGRASS SEED CROPS? (YEAR 2)

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Introduction

Forage grass seed crops, including annual ryegrass (*Lolium multiflorum* L.), are a vital part of seed production enterprises in Oregon. Like other cool-season grasses, annual ryegrass produces only 15–33% of its potential seed yield. Lodging of the crop during flowering is one of the major factors limiting seed yield. Making better use of management practices that reduce stem length and decrease lodging is one area that should be further explored to address seed yield losses.

Seed yield is reduced by lodging during anthesis and early seed fill as a result of self-shading in the canopy and reduction in pollination. While trinexapac-ethyl (TE) has been shown to increase yield in perennial ryegrass, its use patterns and potential effects on the seed yield of annual ryegrass are relatively understudied, especially in Oregon. Previous work in the northern hemisphere suggests that seed yield responses of annual ryegrass to TE are generally small (Mellbye et al., 2007; Rijckaert, 2010; Macháč, 2012). However, new studies conducted in New Zealand report seed yield increases of 30–50% when TE is applied (Trethewey et al., 2016).

In addition to plant growth regulator (PGR) use, defoliation by grazing or mechanical cutting is also used to reduce stem length, decrease lodging, and increase seed yield in annual ryegrass seed crops across the globe. Historically, final defoliation by grazing or mowing is carried out at the appearance of the first node on reproductive stems (BBCH 30–31), although new research has demonstrated higher seed yields when defoliation occurs slightly later (BBCH 32–33) (Rolston et al., 2010). Effects of spring grazing on annual ryegrass seed crops were evaluated in Oregon during the late 1970s (Young et al., 1996), but no work has been done since the introduction of PGRs.

Recent research shows that even greater seed yield increases in annual ryegrass crops are possible when TE applications are strategically timed with spring defoliation. For example, Rolston et al. (2012) reported seed yields of 3,015 lb/acre when 200 g ai TE/ha was applied to annual ryegrass that had been defoliated at BBCH 32–33. This represents a 35% increase over the treatment with the same TE rate applied to annual ryegrass defoliated once at BBCH 30–31 and a 123% increase over the zero TE treatment. This response to TE and later-timed defoliation was related to delayed lodging and better light interception by the standing crop.

Current prices of TE are relatively low, and many annual ryegrass growers are accustomed to grazing fields. If we could better understand how these two lodging reduction strategies can best work together in the Oregon environment, there is strong potential for economic benefit to the grower. The objectives of this work are to define optimum treatment applications of TE across multiple defoliation timings for annual ryegrass seed crops and to determine whether interaction between TE and defoliation will further reduce lodging and increase seed yield. The work presented in this article represents information from year 2 of a 2-year project. Data from year 1 can be found in OSU's *2018 Seed Production Research Report*.

Materials and Methods

A field trial with Oregon 'Gulf' and New Zealand 'Winterstar II' annual ryegrass varieties was established in September 2018 at OSU's Hyslop Research Farm. The experimental design for the trial is a randomized complete block with a split-plot arrangement of treatments and four replications. Plot size is 11 feet x 45 feet. Plots were established with conventional tillage during fall. Spring nitrogen (N) was applied as urea (46-0-0) at 130 lb N/acre. Routine herbicide sprays were applied to manage weeds as needed. Defoliation by grazing was simulated using a flail mower. Main plots were defoliation timings, and subplots were TE rate. Subplots were randomly allocated within defoliation main plots.

Defoliation main plots included the following timings:

- Untreated control (no defoliation)
- Single cutting at BBCH growth stage 31 (appearance of first node)
- Triple cutting: once at BBCH growth stage 31 and twice when regrowth was at BBCH 32–33

TE subplots included the following application rates and timings:

- Untreated control (no PGR)
- Trinexapac-ethyl (Palisade EC): 1.4 pt/acre at BBCH 32
- Trinexapac-ethyl: 2.8 pt/acre at BBCH 32
- Trinexapac-ethyl: 4.2 pt/acre at BBCH 32

Defoliation by flail mowing occurred on March 20, 2019 for the single cutting and on March 20, March 31, and April 18, 2019 for the triple cutting. The TE treatments were applied at the two-node stage (BBCH 32) using a bicycle-type boom sprayer operated at 20 psi delivering 20 gpa with XR Teejet 8003VS nozzles. Above-ground biomass samples were taken from each annual ryegrass plot near crop maturity, and dry weight was determined. The crop height of annual ryegrass was also measured for each treatment at harvest maturity. Lodging ratings were recorded weekly from the start of anthesis until harvest.

Seed was harvested by a small-plot swather and combine, and seed was cleaned to determine 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

In year 2, the triple-mow treatment increased seed yield in ‘Gulf’ (Table 1), and both the single- and triple-mow treatments increased seed yield in ‘Winterstar II’ (Table 2). For ‘Gulf’, maximum seed yield was attained with a triple mowing, which resulted in a 45% seed yield increase (Table 1). This contrasts with data from year 1 of the project, when the maximum seed yield with ‘Gulf’ was obtained with a single mowing. In year 2, there was no advantage or disadvantage to the single-mow over the no-mow treatment with ‘Gulf’. For ‘Winterstar II’, maximum seed yield was also attained with the addition of mowing, with a 23.1% and 31.2% increase with single- and triple-mowing treatments, respectively. Both mowing treatments also increased seed number and decreased lodging (data not shown), fertile tiller length, and spike length in both varieties. There were no effects on biomass for either variety.

Seed yield was also increased by PGR treatments for both varieties (Tables 1 and 2). For ‘Gulf’, maximum seed yield was attained with the 2.8 pt TE/acre rate applied at BBCH 32 (two-node stage), although there was also a significant increase at 1.4 pt TE/acre. For ‘Winterstar II’, maximum seed yield was attained with the 1.4 pt TE/acre rate applied at BBCH 32. All PGR treatments increased seed number, while decreasing lodging (data not shown), 1,000-seed weight, tiller length, and spike length in both varieties. There were

Table 1. Interaction of spring mowing and plant growth regulators (PGRs) on seed yield, yield components, and growth characteristics of Oregon ‘Gulf’ annual ryegrass.[1]

TE treatment	Mowing treatment	Seed yield	Cleanout	Seed weight	Fertile tillers	Tiller length	Biomass	Seed number	Harvest index
(pt/a)		(lb/a)	(%)	(g)	(no./ft^2)	(cm)	(kg/ha)	(no./m^2)	(%)
Untreated	0x	772 ab	2.2	3.345 h	54.6	164.9 g	15,402	25,956 ab	11.8
1.4	0x	1,052 abcd	1.9	3.286 h	73.9	153.3 f	16,939	36,111 abcd	7.6
2.8	0x	1,070 cde	2.1	3.188 g	76.1	145.6 e	18,159	37,728 cde	8.0
4.2	0x	1,268 de	2.2	3.043 ef	78.6	125.3 d	14,077	46,936 de	8.5
Untreated	1x	1,074 bcd	1.6	3.096 fg	86.4	145.3 e	11,909	38,922 bcd	13.7
1.4	1x	920 abc	1.8	2.987 de	96.6	140.5 e	12,258	34,578 abc	10.5
2.8	1x	1,334 def	1.6	2.862 c	94.4	122.8 d	11,446	52,217 def	16.0
4.2	1x	1,402 ef	1.5	2.750 b	99.4	110.1 c	12,396	57,240 ef	10.2
Untreated	3x	732 a	1.4	2.923 cd	103.5	112.6 c	9,512	28,129 a	15.2
1.4	3x	1,653 fg	1.2	2.664 b	117.8	99.9 b	10,120	69,578 fg	16.1
2.8	3x	1,785 gh	1.2	2.531 a	108.9	88.2 a	8,369	79,008 gh	15.2
4.2	3x	1,956 h	1.2	2.546 a	124.4	83.1 a	9,428	86,082 h	18.0
P-value		0.0002	0.5560	0.0202	0.9099	0.0335	0.4562	0.0000	0.6309

[1]Means followed by the same letters are not significantly different at LSD ($P = 0.05$).

no PGR effects on biomass, spikelet number, or HI for either variety.

An interaction of spring mowing and PGR for seed yield, seed number, and lodging was evident in both varieties in year 2. The combined effects of these two management practices further increased seed yield and seed number over individual treatment (spring mowing or PGR) effects. While seed weight was reduced with the combination of spring mowing and PGRs, the increase in seed number still allowed for a greater overall seed yield.

Conclusion

The results of this 2-year project indicate that spring mowing (single or triple) combined with at least 2.8–4.2 pt TE/acre applied at BBCH 32 can increase annual ryegrass seed yield by as much as 151–215% and 72–185% in 'Gulf' and 'Winterstar II', respectively. The combination of these spring management practices should be evaluated on a large scale in growers' fields to further validate what appear to be promising results for achieving higher seed yields in annual ryegrass seed crops in Oregon.

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Table 2. Interaction of spring mowing and plant growth regulators (PGRs) on seed yield, yield components, and growth characteristics of New Zealand 'Winterstar II' annual ryegrass.[1]

TE treatment	Mowing treatment	Seed yield	Cleanout	Seed weight	Fertile tillers	Tiller length	Biomass	Seed number	Harvest index
(pt/a)		(lb/a)	(%)	(g)	(no./ft^2)	(cm)	(kg/ha)	(no./m^2)	(%)
Untreated	0x	1,191 ab	2.1	4.340 de	46.2	158.1	13,251	30,395 ab	14.9
1.4	0x	1,577 cd	1.9	4.342 d	45.0	142.4	12,463	40,828 cd	15.0
2.8	0x	1,119 a	1.8	4.397 de	53.8	133.2	15,005	28,522 a	13.2
4.2	0x	1,526 bcd	1.9	4.196 c	54.3	125.5	13,388	40,875 cd	13.9
Untreated	1x	1,210 ab	1.5	4.455 e	75.4	142.4	13,434	30,404 ab	12.1
1.4	1x	1,535 bcd	1.6	4.354 d	75.6	131.4	12,909	39,510 bc	13.8
2.8	1x	2,007 e	1.4	4.183 c	72.1	116.5	12,200	53,751 e	15.0
4.2	1x	1,948 e	1.4	4.055 ab	89.3	106.7	14,348	53,849 e	13.7
Untreated	3x	1,337 abc	1.5	4.332 d	79.5	111.7	10,043	34,535 abc	15.4
1.4	3x	1,856 de	1.5	4.131 bc	81.8	98.5	10,042	50,401 de	18.9
2.8	3x	2,068 e	1.3	4.058 b	92.5	97.9	10,367	57,261 e	17.0
4.2	3x	1,880 de	1.5	3.960 a	88.5	90.7	8,920	53,261 e	22.0
P-value		0.0040	0.6666	0.0007	0.7789	0.4805	0.7804	0.0023	0.5924

[1]Means followed by the same letters are not significantly different at LSD ($P = 0.05$).

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