ARE HIGHER YIELDS POSSIBLE IN ANNUAL RYEGRASS SEED CROPS? (YEAR 1)

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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.

Materials and Methods

A field trial with Oregon ‘Gulf’ and New Zealand ‘Winterstar II’ annual ryegrass varieties was established in September 2017 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 three 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. The experimental design was a randomized complete block with a split-plot arrangement of treatments and four replications. 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: 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 19, 2018 for the single cutting and on March 19, April 2, and April 13, 2018 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

Both the single- and triple-mow treatments significantly increased seed yield in 'Gulf' (Table 1), but there were no effects of mowing 'Winterstar II' annual ryegrass (Table 2). Maximum seed yield with 'Gulf' was attained with a single mowing, which resulted in a 74.5% seed yield increase (Table 1). There was no advantage or disadvantage to the triple-mow over the single-mow treatment. Both mowing treatments also increased seed number and HI and decreased percent cleanout, biomass, fertile tiller length, and spike length.

Seed yield was also significantly increased by PGR treatments for both varieties (Tables 1 and 2). Maximum seed yield was attained with the 4.2 pt TE/acre rate applied at BBCH 32 (two-node stage), although there were also significant increases at lower treatment rates. All PGR treatments increased seed number and HI, while decreasing thousand-seed weight, tiller length, and spike length in both varieties. There were no PGR effects on biomass.

An interaction of spring mowing and PGR for seed yield and seed number was evident in 'Gulf' but not in 'Winterstar II'.

Conclusion

The results of this work indicate that a combination of spring mowing (single or triple) combined with at least 2.8 to 4.2 pt TE/acre can increase seed yield by as much as 173%. It is noted that overall seed yields were low in this trial. This work will be repeated in the 2018–2019 crop season.

References

Macháč, R. 2012. Effects of trinexapac-ethyl (Moddus) on seed yields and quality of eleven temperate grass species. In S. Barth and D. Milbourne (eds.). *Breeding Strategies for Sustainable Forage and Turf Grass Improvements.* Dordrecht, New York: Springer Science Business Media.

Mellbye, M.E., G.A. Gingrich, and T.B. Silberstein. 2007. Use of plant growth regulators on annual ryegrass: The Oregon experience. In *Proceedings of the 6th International Herbage Seed Conference*, Gjennestad, Norway, Bioforsk Fokus.

Rijckaert, G.A. 2010. Effects of plant growth regulation in seed crops of Italian ryegrass (*Lolium multiflorum* L.). In *Proceedings of the International Herbage Seed Conference*, Dallas, TX.

Rolston, M.P., B.L. McCloy, J.A.K. Trethewey, and R.J. Chynoweth. 2010. Removing early spring emerged reproductive growing points enhances seed yield of Italian ryegrass. Agron. N.Z. 40:33–40.

Rolston, M.P., J.A.K. Trethewey, R.J. Chynoweth, and B.L. McCloy. 2012. Italian ryegrass seed yield: Trinexapac-ethyl and closing date interaction. Agron. N.Z. 42:119–127.

Trethewey, J.A.K., M.P. Rolston, B.L. McCloy, and R.J. Chynoweth. 2016. The plant growth regulator, trinexapac-ethyl, increases seed yield in annual ryegrass (*Lolium multiflorum* Lam.). N.Z. J. of Agric. Res. 59(2):1–9.

Young III, W.C., D.O. Chilcote, and H.W. Youngberg. 1996. Annual ryegrass seed yield response to grazing during stem elongation. Agron. J. 88:211–215.

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

TE treatment	Mowing treatment	Yield[1]	Cleanout	Seed weight	Fertile tillers	Tiller length	Biomass	Seed no.	Harvest index
		(lb/a)	(%)	(g)	(no./ft^2)	(cm)	(kg/ha)	(no./m^2)	(%)
Untreated	0x	693 a	11.9	3.176	52.5	150.0	12,806	24,693	6.38
1.4 pt/a	0x	736 a	12.7	3.027	78.5	149.2	16,835	27,339	4.85
2.8 pt/a	0x	950 a	11.7	2.854	70.5	137.3	14,994	37,703	7.45
4.2 pt/a	0x	1,414 bc	10.8	2.753	86.8	127.8	18,035	58,167	9.58
Untreated	1x	1,108 ab	9.9	3.017	84.3	125.2	10,947	41,647	11.73
1.4 pt/a	1x	1,450 bc	8.8	2.841	88.0	110.8	11,181	57,153	16.23
2.8 pt/a	1x	1,892 de	9.1	2.747	78.3	105.2	10,629	77,181	23.05
4.2 pt/a	1x	2,169 e	9.0	2.741	84.5	100.0	10,699	88,832	24.28
Untreated	3x	873 a	11.4	2.840	82.5	114.6	8,818	34,577	11.63
1.4 pt/a	3x	1,683 cd	9.9	2.641	90.8	104.6	9,308	71,435	21.38
2.8 pt/a	3x	1,978 de	9.3	2.611	108.5	95.9	10,605	84,895	23.65
4.2 pt/a	3x	2,185 e	9.9	2.591	101.8	90.2	9,023	94,591	29.77

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

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.

TE treatment	Mowing treatment	Yield	Cleanout	Seed weight	Fertile tillers	Tiller length	Biomass	Seed no.	Harvest index
		(lb/a)	(%)	(g)	(no./ft^2)	(cm)	(kg/ha)	(no./m^2)	(%)
Untreated	0x	660	8.2	4.545	53.0	136.1	16,867	16,281	6.38
1.4 pt/a	0x	875	5.7	4.412	74.8	144.0	16,146	22,220	4.85
2.8 pt/a	0x	1,060	5.8	4.232	71.0	116.1	14,946	28,054	7.45
4.2 pt/a	0x	1,550	5.1	4.061	84.0	120.8	16,189	42,936	9.58
Untreated	1x	691	8.1	3.967	37.3	121.5	7,575	19,537	11.73
1.4 pt/a	1x	1,140	7.2	3.633	67.0	107.2	9,728	35,411	16.23
2.8 pt/a	1x	1,378	8.2	3.601	70.5	102.2	10,880	42,862	23.05
4.2 pt/a	1x	1,649	7.1	3.500	68.8	96.1	9,542	52,905	24.28
Untreated	3x	868	7.3	3.982	59.0	106.3	7,387	24,423	11.63
1.4 pt/a	3x	1,251	5.6	3.794	85.0	98.7	9,152	36,859	21.38
2.8 pt/a	3x	1,725	5.3	3.608	84.8	91.1	8,743	53,692	23.65
4.2 pt/a	3x	1,885	7.5	3.648	83.5	85.2	7,785	57,915	29.77