SPRING-APPLIED NITROGEN AND PLANT GROWTH REGULATOR EFFECTS ON ORCHARDGRASS SEED YIELD

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Introduction

Forage grass seed crops, including orchardgrass (*Dactylis glomerata* L.), are a vital part of seed production enterprises in Oregon. Like other cool-season grasses, orchardgrass produces only a fraction of its potential seed yield. Lodging of the crop during flowering is one of the major factors limiting maximum seed yield. A recent decline in orchardgrass growers and acreage, coupled with relatively strong market demand, makes it important to maximize production on the remaining orchardgrass acreage. Making better use of nitrogen (N) and plant growth regulators (PGRs) is a way to achieve that objective.

Two stem-shortening PGRs, chlormequate chloride (CCC, trade name Cyclocel) and trinexapac-ethyl (TE, trade name Palisade EC), enhance seed yield in forage grasses by blocking gibberellic acid (GA) biosynthesis. Prior to the development of TE, CCC was used commercially in perennial ryegrass (*Lolium perenne* L.) seed crops in New Zealand, where it produced 34–44% seed yield increases (Hampton, 1986). The greater seed yield response to TE in comparison to CCC resulted in rapid grower adoption of TE globally. Recent studies in western Oregon have shown 46–62% reductions in lodging, a result of stem shortening, when TE was applied to tall fescue (*Schedonorus phoenix* [Scop.] Holub) crops at 1.5 pt/acre and 3 pt/acre, respectively (Chastain et al., 2015). In perennial ryegrass, seed yield increased 14 lb/acre for every 0.4-inch reduction in stem length (Chynoweth et al., 2014).

In comparison with tall fescue and perennial ryegrass, seed yield response to PGRs in orchardgrass is relatively understudied. Gingrich and Mellbye (2002) reported seed yield increases ranging between 6 and 19% when TE was applied at flag leaf to early head emergence. A recent study conducted by Rolston et al. (2014) in New Zealand indicated that orchardgrass seed yield increases of 30–37% are possible when TE is applied earlier, at the two-node stage. In this same study, a mixture of TE + CCC was more effective at increasing seed yield across four orchardgrass cultivars than either CCC or TE applied alone.

Although CCC and TE are both GA inhibitors, CCC acts in the early steps of GA biosynthesis, while TE acts late in the pathway. Combinations of PGRs that act at separate locations in the GA pathway may produce additive effects on seed yield. Positive outcomes have resulted from such combinations. For example, when a tank-mix of CCC and TE was applied to orchardgrass, seed yields increased by 84% across five New Zealand experiments (Rolston et al., 2014).

Since lodging is exacerbated in the high-nitrogen environments present in grass seed production systems, additional work is needed to determine possible interactions between PGRs and spring-applied N under western Oregon conditions. Recommendations for application rates of N fertilizer in orchardgrass have not been revised and have not appeared in the international seed production literature since PGRs were introduced in this important forage seed crop. In Oregon, OSU fertilizer recommendations for orchardgrass seed crops (Doerge et al., 2000) are more than 15 years old, and new information is needed to evaluate whether N rate recommendations should be adjusted to further increase seed yield in current management environments.

The objectives of this multiyear study were (1) to measure the effects of multiple N fertilizer rates in the presence and absence of TE and TE + CCC plant growth regulators and (2) to define optimum treatment and timing applications of TE and TE + CCC plant growth regulators for orchardgrass seed crops.

Materials and Methods

A field trial with 'Persist' orchardgrass was established in October, 2015 at OSU's Hyslop Research Farm. Plot size is 11 feet x 38 feet. Fungicide and insecticide treatments were applied to manage pests as needed. Fall N was applied to all plots at a rate of 40 lb N/acre during 2015 and 2016. The first harvest year following the establishment period was 2017. The experimental design for the trial was a randomized complete block with a split-plot arrangement of treatments and three replications. Main plots received spring-applied N at rates of:

- 0 lb N/acre
- 100 lb N/acre
- 140 lb N/acre
- 180 lb N/acre

PGR subplots included the following treatments and application rates:

- Untreated control (No PGR)
- 1.5 pt/acre TE applied at BBCH 32 (2 nodes)
- 1.5 lb/acre TE applied at BBCH 51 (panicles 10% emerged)
- 0.75 pt/acre TE + 1.34 lb/acre CCC (2 nodes)

Spring N was applied on March 16, 2017 using a tractor-mounted orbit-air spreader system with appropriate amounts of 46-0-0. The PGR treatments were applied at the two-node stage (BBCH 32) and when panicles were 10% emerged (BBCH 51) 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 plot near crop maturity, and dry weight of the standing crop was determined. Total tissue N content was measured from the above-ground biomass samples. Tiller height was measured for each treatment at harvest maturity. Lodging ratings were determined just prior to swathing.

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

All treatments containing spring-applied N increased seed yield in orchardgrass, in comparison with the untreated control (Table 1). Maximum seed yield was attained with 100 lb N/acre, and there was no additional benefit from higher N rates. Nitrogen also increased seed number and biomass, but had no effect on percent cleanout, seed weight, fertile tiller number, or HI. Total tissue N concentration did not increase when rates above 100 lb/N acre were applied (data not shown); thus, it is not surprising that seed yield did not further increase with higher N rates. Spring-applied N had no effect on lodging in the first-year orchardgrass crop.

Seed yield was also significantly increased by PGR treatments (55%). However, there were no differences among PGR timings or between TE and the TE + CCC mixture (Table 2). All PGR treatments increased seed number and HI, but there were no effects on seed

Table 1. Effect of nitrogen (N) on seed yield, yield components, and growth characteristics of first-year orchardgrass.[1]

N treatment	Yield	Cleanout	Seed wt.	Seed no.	Biomass	Fertile tillers	Tiller height	Harvest index	Lodging
(lb/a)	(lb/a)	(%)	(mg/seed)	(seeds/m^2)	(kg/ha)	(no./ft^2)	(cm)	(%)	(%)
0	608 a	8.3 a	0.921 a	73,912 a	10,351 a	48.9 a	119 a	6.6 a	6.5 a
100	726 b	8.3 a	0.914 a	89,196 b	11,815 b	41.6 a	117 a	7.1 a	4.4 a
140	729 b	7.9 a	0.931 a	88,217 b	11,008 ab	41.4 a	116 a	7.6 a	4.7 a
180	796 b	8.4 a	0.921 a	96,934 b	13,323 c	44.0 a	115 a	6.8 a	5.9 a

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

Table 2. Effect of plant growth regulators (PGRs) on seed yield, yield components, and growth characteristics of first-year orchardgrass.[1]

PGR treatment	Yield	Cleanout	Seed wt.	Seed no.	Biomass	Fertile tillers	Tiller height	Harvest index	Lodging
	(lb/a)	(%)	(mg/seed)	(seeds/m^2)	(kg/ha)	(no/ft^2)	(cm)	(%)	(%)
Control (No PGR)	504 a	8.9 b	0.921 ab	61,402 a	11,624 a	43.7 a	133 c	4.8 a	13.7 c
Palisade 1.5 pt/a (BBCH 32)	785 b	7.8 a	0.929 b	94,922 bc	11,669 a	42.9 a	118 b	7.6 b	4.7 b
Palisade 1.5 pt/a (BBCH 51)	780 b	7.4 a	0.935 b	93,654 b	12,652 a	50.4 a	115 b	7.1 b	3.1 b
Palisade 0.75 pt/a + CCC 1.34 lb ai/a	790 b	8.6 b	0.902 a	98,282 c	10,552 a	38.9 a	100 a	8.6 c	0.0 a

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

weight, biomass, or fertile tiller number. Lodging was significantly reduced with PGRs, compared to the untreated control, and no lodging was observed in the TE + CCC mixture treatment. Reduction in lodging from PGRs was made possible by a reduction in tiller height.

An interaction of spring-applied N and PGR for seed yield was evident in this first-year study (Figure 1). The combination of spring-applied N and PGRs produced the greatest seed yields. One interesting finding is that, despite this positive interaction, seed yield was enhanced by PGRs even when no spring N was applied. In other grass seed crops, such as tall fescue and perennial ryegrass, increased seed yield from PGR applications have not been found when no spring N is applied.

The results of this first-year study indicate that applying a combination of spring-applied N and PGRs can increase orchardgrass seed yield in western Oregon conditions, even when lodging is minimal. This work will be repeated in 2018 to examine the effects of these treatments on a second-year stand.

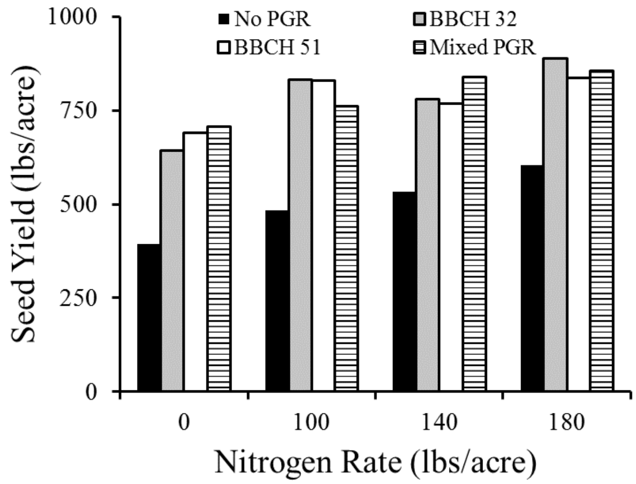

Figure 1. Interaction of spring-applied nitrogen (N) and plant growth regulators (PGRs) on seed yield in first-year orchardgrass.

References

Chastain, T.G., W.C. Young III, C.J. Garbacik, and T.B. Silberstein. 2015. Trinexapac-ethyl rate and application timing effects on seed yield and yield components in tall fescue. Field Crops Res. 173:8–13.

Chynoweth, R.J., J.A.K. Trethewey, M.P. Rolston, and B.L. McCloy. 2014. Reduced stem length increases perennial ryegrass seed yield. Agron. N.Z. 44:61–70.

Doerge, T., H. Gardner, T.L. Jackson, and H. Youngberg. 2000. *Fertilizer Guide: Orchardgrass Seed (Western Oregon)*. Oregon State University, FG 45.

Gingrich G.A. and M.E. Mellbye. 2002. The effect of plant growth regulators on seed yields of tall fescue and orchardgrass. In W.C. Young (ed.). *2001 Seed Production Research Report.* Oregon State University, Ext/CrS 121.

Hampton, J.G. 1986. The effect of chlormequat chloride application on seed yield in perennial ryegrass (*Lolium perenne* L.). J. of Appl. Seed Prod. 4:9–13.

Rolston, M.P., R.J. Chynoweth, M. Kelley, B.L. McCloy, and J.A.K. Threthewy. 2014. Seed yield response of four cocksfoot (*Dactylis glomerata* L.) cultivars following the application of stem-shortening plant growth regulators. N.Z. J. of Ag. Res. 57(4):332–341.

Acknowledgments

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