EFFECTS OF TRINEXAPAC-ETHYL ON KENTUCKY BLUEGRASS IN THE GRANDE RONDE VALLEY OF NORTHEASTERN OREGON (YEAR 3)

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Introduction

A 3-year study was initiated in the spring of 2018 to evaluate the effects of trinexapac-ethyl (Palisade EC) plant growth regulator (PGR) on seed yield of Kentucky bluegrass. Trinexapac-ethyl (TE) is a stem-shortening PGR that inhibits the action of a key enzyme in the gibberellic acid biosynthesis pathway, thereby preventing cell elongation and resulting in shortened internodes. PGRs are widely utilized in grass seed production systems worldwide to increase seed yield potential via reduced lodging, improved pollination and fertilization, and improved swathing.

Plant growth regulator research in Kentucky bluegrass (KBG) seed production is limited (Butler and Simmons, 2012), whereas extensive research has been conducted in perennial ryegrass, tall fescue, and fine fescue (Chastain et al., 2015; Silberstein et al., 2002). Results from these previous studies show that crop response to PGR application rates and timing varies among grass seed species. However, there is overwhelming evidence that TE effectively increases seed yield in grass seed crops under Oregon conditions.

The objective of this multiyear study is to evaluate the effect of TE application on seed yield of three different classes of KBG cultivars during first- through fourth-year harvest stands. Classes of Kentucky bluegrass include a BVMG type ('Baron'), a Midnight type ('Skye'), and a Shamrock type ('Gaelic'). The classes are based on pedigree, turf performance, and morphological (PTM) attributes (Shortell et al., 2009). The 2020 results presented in this article reflect the third and final year of the study.

Materials and Methods

The final year of the study was initiated in spring 2020 in the Grande Ronde Valley of northeastern Oregon by establishing trials in irrigated, commercial Kentucky bluegrass seed production fields previously utilized for each variety in each year of the study. The experimental design at each site was a randomized complete block with three replications. Plot dimensions were 29 feet x 300 feet. Standard crop management practices were provided by grower cooperators with the exception of the TE application, which was applied by the investigator using a tractor-mounted R&D research sprayer with a 27-foot boom delivering 16 gal/acre spray volume. Crop growth stage, stand planting date, and environmental conditions at application time are shown in Table 1. Trinexapac-ethyl PGR treatments included an untreated control (no TE), 0.8, 1.4, and 2.8 pt TE/acre.

Two 1-square-foot above-ground biomass samples were collected from each plot in late June prior to mature seed development (BBCH 80–87) to determine above-ground biomass dry weight/acre, tiller height, panicle number, and ergot infection levels. Twenty-five panicles/plot were collected from swathed windrows to further evaluate ergot infection levels. Seed was harvested with grower-owned equipment, and a weigh

Table 1. Crop growth stage and environmental conditions at time of trinexapac-ethyl (TE) plant growth regulator (PGR) application on three varieties of Kentucky bluegrass grown for seed.

	Baron KBG	Skye KBG	Gaelic KBG
Application date	May 7, 2020	May 7, 2020	May 4, 2020
KBG growth stage	two-node (BBCH 32)	two-node (BBCH 32)	two-node (BBCH 32)
Stand planted	Spring 2017	Spring 2016	Spring 2017
Air temperature (°F)	68	60	64
Relative humidity (%)	38	55	31
Cloud cover (%)	Clear	Clear	40
Wind velocity (mph)	0–4 from NW-W	0–5 from NW	3–7 from SE
Soil temperature, surface (°F)	70	59	68
Soil temperature, 1 inch (°F)	68	52	63
Soil temperature, 2 inch (°F)	62	52	60
Soil temperature, 4 inch (°F)	54	44	57

wagon was used to measure dirt weights in the field. Subsamples of seed were collected from each plot and were cleaned twice with a small-capacity three-screen cleaner (Westrup LA-LS) to determine clean seed yield. Purity of clean seed was determined with a seed blower (Hoffman model 67HMC-LK). Other crop/weed seeds and inert matter were not quantified. Seed weight was determined by weighing two 1,000-seed samples with an electronic seed counter located at the Oregon State University Agriculture and Natural Resource Program at Eastern Oregon University, La Grande, OR.

Seed quality samples for each treatment/site were collected by combining 50 grams of seed from each replicated treatment at each site to determine seed germination and vigor. Twelve bulked seed samples were submitted to the OSU Seed Lab for viability and vigor testing. A standard germination test was conducted with 4 replications of 100 seeds/rep for each treatment. Seeds were chilled at 50°F for 7 days, then transferred to a growth chamber set for alternating daily temperature and illumination cycles consisting of 16 hours dark at 59°F and 8 hours light at 77°F for 2 weeks. Tetrazolium tests (TZ) were performed to determine viable seeds on 2 replications of 100 seeds/rep with seeds moistened for 16 hours. Pierced seeds were soaked in 1% TZ solution overnight and then microscopically examined to determine number of normal seedlings. Accelerated aging tests (AAT) were performed on 4 replications of 50 seeds/rep. These seeds were subjected to stress at 106°F for 48 hours. They were then allowed to germinate at 59–77°F for 2 weeks to assess seed vigor based on the number of normal seedlings that emerged after exposure to stress.

Results and Discussion

Seed yield and lodging

'Baron' Kentucky bluegrass: TE did not increase seed yield, and seed yield was suppressed at the 2.8 pt TE/acre rate (Table 2). Lodging did not occur in any of the treatments and was consistent with observations made for 'Baron' in 2019 (Walenta and Anderson, 2020). Differences were observed for biomass but did not correspond with TE rate. TE applied at 1.4 and 2.8 pt/acre reduced tiller height by 15 and 33%, respectively. No differences were observed for seed weight, panicle number, or clean seed purity.

'Skye' Kentucky bluegrass: Seed yield was not increased with TE; however, the lowest seed yield was observed at the 2.8 pt TE/acre rate (Table 3). Lodging was reduced by 46% and 100% at the 1.4 and 2.8 pt TE/acre rates, respectively. The 0.8 pt TE/acre rate did not reduce lodging. Tiller height was reduced by 3.6 inches at the 2.8 pt TE/acre rate. TE did not affect above-ground biomass, panicle number, seed weight, or seed purity.

'Gaelic' Kentucky bluegrass: Seed yield was not increased with TE application, and yield was suppressed at the 2.8 pt TE/acre rate (Table 4). Lodging was reduced at all TE application rates. Tiller height was reduced by TE and was dependent upon application rate. TE did not affect above-ground biomass, panicle number, seed weight, or purity.

The number of spikelets per panicle differed by variety (Table 5). 'Gaelic' KBG was the only variety in which TE rate affected the number of spikelets/panicle. There

Table 2. Effect of trinexapac-ethyl (TE) plant growth regulator (PGR) on seed yield, yield components, and growth characteristics of third-year-harvest Kentucky bluegrass var. 'Baron'.[1]

PGR treatment	Seed yield	Cleanout	Biomass	Tiller height	Panicles	1,000-seed weight	Purity	Lodging
(pt TE/a)	(lb/a)	(%)	(ton/a)	(in)	(no./ft^2)	(g)	(%)	(%)
Control	439 a	51.5 b	5.4 ab	22.1 a	365	0.372	97.1	0
0.8	387 a	53.3 ab	5.0 b	21.3 a	364	0.358	95.1	0
1.4	375 ab	53.2 ab	6.0 a	18.7 b	497	0.357	95.1	0
2.8	252 b	58.9 a	5.4 ab	14.9 c	339	0.360	95.8	0
LSD (0.05)	134	7.1	0.9	1.9	NS	NS	NS	NS

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

was an 18% reduction in spikelet number at 2.8 pt TE/acre, compared to the untreated control.

Ergot infection

Ergot infection was detected at all sites in 2020, with the highest infection level recorded in 'Skye' (Table 5). Ergot incidence and severity levels were low in 'Baron' and 'Gaelic' varieties. Ergot spore monitoring utilized both Burkhard and roto-rod spore traps at the 'Gaelic' trial site. Spore trap results indicate peak airborne spore activity occurred early- to mid-May 2020, which was approximately 9 days prior to the start of flowering for 'Gaelic' (data not shown). Thus, less disease inoculum was available for initial infection as the 'Gaelic' flowering stage advanced. Ergot spore trap results from the 'Skye' site indicate peak spore activity occurred early- to mid-June, which directly coincided with flowering period (June 5–25). Thus, the high levels of airborne spores led to high infection levels.

Seed viability and vigor

Standard germination and TZ test procedures showed no effect of TE on seed viability (Table 6). Varying levels of dormancy existed for all three KBG varieties, as indicated by the TZ test results being higher than those of germination. The AAT results were very low for the three varieties, even after 2 weeks of germination. However, 'Skye' and 'Gaelic' exhibited better seedling vigor compared to 'Baron'. This result can be attributed to the physiological quality of each variety and the varieties' responses to stress conditions (high temperature and high humidity) in the AAT test.

The low vigor results observed in all three varieties are not attributed to TE applications but rather to the tolerance of each variety to the stress conditions of the AAT test. Overall, TE application at any rate did not affect seed viability or vigor measurements.

Table 3. Effect of trinexapac-ethyl (TE) plant growth regulator (PGR) on seed yield, yield components, and growth characteristics of fourth-year-harvest Kentucky bluegrass var. 'Skye'.[1]

PGR treatment	Seed yield	Cleanout	Biomass	Tiller height	Panicles	1,000-seed weight	Purity	Lodging
(pt TE/a)	(lb/a)	(%)	(ton/a)	(in)	(no./ft^2)	(g)	(%)	(%)
Control	584	46.5	6.3	29.6 a	256	0.430	99.3	99 a
0.8	620	49.7	6.2	28.5 b	242	0.436	99.5	95 a
1.4	662	45.2	6.6	27.6 ab	229	0.428	99.4	53 b
2.8	545	43.5	6.3	26.0 b	240	0.424	99.6	0 c
LSD (0.05)	NS	NS	NS	2.2	NS	NS	NS	16

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

Table 4. Effect of trinexapac-ethyl (TE) plant growth regulator (PGR) on seed yield, yield components, and growth characteristics of third-year-harvest Kentucky bluegrass var. 'Gaelic'.[1]

PGR treatment	Seed yield	Cleanout	Biomass	Tiller height	Panicles	1,000-seed weight	Purity	Lodging
(pt TE/a)	(lb/a)	(%)	(ton/a)	(in)	(no./ft^2)	(g)	(%)	(%)
Control	1,290	30.8	5.8	30.3 a	329	0.381	96.0	78 a
0.8	1,242	31.9	5.6	26.3 b	413	0.384	97.7	7 b
1.4	1,372	26.5	5.3	23.5 c	428	0.379	94.1	0 b
2.8	950	41.1	5.3	20.1 d	457	0.399	96.8	0 b
LSD (0.05)	NS	NS	NS	2.0	NS	NS	NS	33

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

Table 5. Effect of trinexapac-ethyl (TE) plant growth regulator (PGR) on spikelet number and ergot infection frequency/severity of three Kentucky bluegrass varieties.[1]

PGR treatment	Spikelets/panicle	Ergot-infected panicles	Ergot sclerotia/panicle
(pt TE/a)	(no.)	(%)	(no.)
		var. Baron	
Control	147	11 a	1.6 a
0.8	146	8 ab	1.0 a
1.4	141	0 b	0.0 b
2.8	132	0 b	0.0 b
LSD (0.05)	NS	11	0.7
		var. Skye	
Control	188	42	2.6
0.8	187	40	1.9
1.4	177	31	3.6
2.8	173	50	2.2
LSD (0.05)	NS	NS	NS
		var. Gaelic	
Control	215 a	0	0
0.8	192 a	4	1
1.4	221 ab	0	0
2.8	175 b	2	1
LSD (0.05)	35	NS	NS

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

Table 6. Effect of trinexapac-ethyl (TE) plant growth regulator (PGR) on seed viability and vigor of three Kentucky bluegrass varieties.[1]

PGR treatment	Standard germination test	Tetrazolium test	Accelerated aging test
(pt TE/a)	(%)	(% viable seed)	(% germination at 2 weeks)
		var. Baron	
Control	77.5	84.6	9.0
0.8	72.0	83.2	6.5
1.4	70.0	83.7	5.5
2.8	66.0	81.4	5.0
LSD (0.05)	NS	NS	NS
		var. Skye	
Control	87.0	95.2	23.0 ab
0.8	87.0	96.2	34.0 a
1.4	86.0	96.2	22.5 ab
2.8	86.5	95.7	18.0 b
LSD (0.05)	NS	NS	12.7
		var. Gaelic	
Control	78.5 a	90.0	24.0 b
0.8	79.8 a	86.2	10.5 c
1.4	59.8 b	82.4	16.5 bc
2.8	84.8 a	89.1	47.5 a
LSD (0.05)	8.2	NS	9.9

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

Overall, results for the third year of the study indicate that TE application did not increase seed yields for any of the three varieties. The 2.8 pt TE/acre rate resulted in the lowest seed yield for each variety and is consistent with year 2 results. Seed viability and vigor were not affected by any TE treatments. Cleanout percentages were extremely high due to cleaning seed samples twice to achieve adequate purity levels.

Kentucky bluegrass varieties differ in susceptibility to lodging as stands age. For example, 'Baron' lodged in the first harvest year without application of TE but did not lodge in the second or third years of the study. 'Skye' experienced severe lodging at zero, 0.8, and 1.4 pt/acre TE rates in all 3 years of the study. 'Gaelic' lodged at 0, 0.8, and 1.4 pt TE/acre rates in the first 2 years of the study, but lodging was not observed in the third year. The 2.8 pt TE/acre rate eliminated lodging in each of the three varieties in all 3 years. However, no benefit can be realized since this treatment resulted in decreased seed yield.

The results of this study will be investigated further to identify any interactions and trends between stand age, variety, and TE rate. In addition, efforts will continue to determine optimal TE application rates for Kentucky bluegrass varieties grown in the Grande Ronde Valley.

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