EFFECTS OF TRINEXAPAC-ETHYL ON KENTUCKY BLUEGRASS IN THE GRANDE RONDE VALLEY OF NORTHEASTERN OREGON (2019)

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Introduction

A 3-year study was initiated in the spring of 2018 to evaluate the effects of trinexapac-ethyl (TE, Palisade EC) plant growth regulator (PGR) on seed yield of Kentucky bluegrass (KBG). 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 stem internodes. PGRs are widely utilized in grass seed production around the world to increase seed yield potential via reduced lodging, improved pollination and fertilization, and improved harvestability.

PGR research in 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., 2014, 2015; Silberstein et al., 2002). Results from these studies showed 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 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 in first-, second-, third-, and fourth-year harvest stands. Classes of KBG 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 data presented in this article reflect only the second-year results. The results of the first year were evaluated but delayed until seed cleaning equipment and technical assistance became available in March 2019. The final year of the study will be conducted in 2020.

Materials and Methods

The second year of the study was initiated in spring 2019 in the Grande Ronde Valley of northeastern Oregon by establishing three trials in the same irrigated, commercial KBG seed production fields utilized in study year 1. The experimental design at each site was a randomized complete block with three replications. Plot sizes were 29 feet x 300 feet. Standard crop management practices were provided by cooperator growers, with the exception of the PGR application, which was applied by the researcher using a tractor-mounted R&D research sprayer with a 27-foot boom delivering 16 gal/acre. Crop growth stage, stand planting date, and environmental conditions at application time are provided in Table 1. Trinexapac-ethyl (TE) treatments included an untreated control (no TE) and 0.8, 1.4, and 2.8 pt product/acre.

Above-ground biomass samples were collected (two 1 ft^2 quadrats/plot) in June after anthesis but prior to mature seed development (BBCH 70–80) to determine biomass dry weight/acre, tiller height, panicle density, and ergot infection levels. Twenty-five panicles/plot were collected from windrows after swathing to further evaluate ergot infection levels. Seed was harvested with

Table 1. Crop growth stage and environmental conditions at time of TE application.

	Baron KBG	Skye KBG	Gaelic KBG
Application date	May 4, 2019	May 4, 2019	May 7, 2019
KBG growth stage	1–2 node (BBCH 31–32)	1–2 node (BBCH 31–32)	1–2 node (BBCH 31–32)
Stand planted	Spring 2017	Spring 2016	Spring 2017
Air temperature (°F)	75	81	58
Relative humidity (%)	44	29	56
Cloud cover (%)	5	0	5
Wind velocity (mph)	0–3 from NE	1–3 from NE	0–3 from SE
Soil temperature, surface (°F)	64	85	55
Soil temperature, 1 inch (°F)	64	75	55
Soil temperature, 2 inch (°F)	62	60	53
Soil temperature, 4 inch (°F)	62	57	49

grower-owned equipment, and a Brent weigh wagon was used to measure dirt weight seed yield/plot in the field. Subsamples of seed were collected from each plot and cleaned 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 (International Marketing & Design Model U).

Seed quality samples for each treatment/site were collected by combining 50 g of seed from each replicated treatment at each site to determine seed germination and vigor (three reps x 50 g/rep = 150 g clean seed/treatment/site). A total of 12 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 daily temperature/light cycles of 68°F (16 hours dark) and 86°F (8 hours light) for 2 weeks. Tetrazolium (TZ) testing was performed on two replications of 100 seeds/rep by soaking seed in TZ solution overnight and then counting viable seeds. Accelerated aging tests (AAT) were performed on 4 replications of 50 seeds/rep. These seeds were subjected to stress at 105.8°F for 48 hours before germination, using the same daily temperature/light cycle as was used in the germination test protocol.

Results and Discussion

Seed yield and lodging

'Baron' KBG: Seed yield was not affected by any TE treatments. The 2.8 pt/acre treatment reduced biomass and panicle number by 28% and 38%, respectively (Table 2). Lodging did not occur in any of the treatments. Tiller height was reduced in all treatments, with a notable height reduction of 4–6 inches with the 2.8 pt/acre TE rate. No differences were observed for percent cleanout or seed weight. The difference in purity is attributed to the mechanical seed cleaning process, not to TE application.

'Skye' KBG: Seed yield was increased (32%) across all TE treatments (Table 3). Lodging was reduced at the 1.4 and 2.8 pt/acre TE rates by 48% and 100%, respectively. Tiller height was reduced by 3 inches at the 2.8 pt/acre rate. There were no effects on above-ground biomass, panicle number, seed weight, or purity.

'Gaelic' KBG: Seed yields across all TE treatments were not statistically significant (Table 4). Across all TE treatments, lodging was reduced significantly (63%), but the level of reduction depended on TE rate. The 0.8 and 1.4 pt/acre TE rates did not provide adequate lodging control and resulted in 72% and 40% lodging, respectively. The high TE rate of 2.8 pt/acre resulted in complete lodging control. Tiller height was significantly reduced by all TE treatments, with a notable 10.8-inch height reduction at the 2.8 pt/acre TE rate. There were no effects on percent cleanout, above-ground biomass, panicle number, seed weight, or purity.

Spikelets/panicle and ergot infection

Differences were measured for the number of spikelets/panicle and ergot infection levels between varieties, but no interactions between variety and TE treatment were observed (Table 5). Ergot infection was detected in two of three sites, but frequency and severity levels were low (Table 5). All three varieties began anthesis during the first week of June and ended by mid-June. The flowering stage for 'Gaelic' KBG occurred during

Table 2. Effect of TE on seed yield, yield components, and growth characteristics of second-year harvest 'Baron' Kentucky bluegrass, 2019 (Site 1).[1]

TE treatment	Seed yield	Cleanout	Biomass	Tiller height	Panicle number	1,000-seed weight	Purity	Lodging
(pt/a)	(lb/a)	(%)	(ton/a)	(in)	(no./ft^2)	(g)	(%)	(%)
Control	960	17.3	6.1 a	22.9 a	388 a	0.416	99.0 a	0
0.8	912	16.7	5.3 ab	21.0 b	309 bc	0.418	97.4 b	0
1.4	945	18.3	6.1 a	21.2 b	378 ab	0.412	98.9 a	0
2.8	708	20.7	4.4 b	16.6 c	241 c	0.417	98.7 a	0
LSD (0.05)	NS	NS	0.9	1.6	78	NS	1.0	NS

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

Table 3. Effect of TE on seed yield, yield components, and growth characteristics of third-year harvest 'Skye' Kentucky bluegrass, 2019 (Site 2).[1]

TE treatment	Seed yield[2]	Biomass	Tiller height	Panicle number	1,000-seed weight	Purity	Lodging
(pt/a)	(lb/a)	(ton/a)	(in)	(no./ft^2)	(g)	(%)	(%)
Control	512 c	6.8	25.7 a	259	0.418	97.9	100 a
0.8	612 b	6.6	25.7 a	246	0.408	97.5	100 a
1.4	758 a	6.3	26.0 a	232	0.427	96.4	52 b
2.8	666 b	5.8	22.7 b	222	0.421	97.4	0 c
LSD (0.05)	91	NS	1.2	NS	NS	NS	16

[1]Values followed by the same letters are not significantly different at LSD (*P* = 0.05).
[2]Clean seed yield based on 18% percent cleanout for seed subsamples (dirt weights not available).

Table 4. Effect of TE on seed yield, yield components, and growth characteristics of second-year harvest 'Gaelic' Kentucky bluegrass, 2019 (Site 3).[1]

TE treatment	Seed yield	Cleanout	Biomass	Tiller height	Panicle number	1,000-seed weight	Purity	Lodging
(pt/a)	(lb/a)	(%)	(ton/a)	(in)	(no./ft^2)	(g)	(%)	(%)
Control	1,046	46.4	7.3	31.6 a	367	0.406	95.8	99 a
0.8	1,357	36.0	6.4	29.0 b	333	0.417	98.8	72 b
1.4	1,337	40.0	6.3	28.2 b	313	0.393	98.3	40 c
2.8	1,155	40.4	6.4	20.8 c	336	0.411	98.1	0 d
LSD (0.05)	NS	NS	NS	1.4	NS	NS	NS	17

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

Table 5. Average number of spikelets/panicle and ergot infection frequency/severity by Kentucky bluegrass variety across all trinexapac-ethyl treatments, 2019.[1]

KBG variety	Spikelets/panicle	Ergot-infected panicles	Ergot sclerotia/panicle
	(average no.)	(%)	(average no.)
Baron	128 b	2.2 ab	0.03 ab
Skye	96 c	4.6 a	0.06 a
Gaelic	176 a	0.0 b	0.0 b
LSD (0.05)	14	2.8	0.04
Variety	*P* = 0.00	*P* = 0.009	*P* = 0.007
Treatment	NS	NS	NS
Variety x treatment	NS	NS	NS

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

a period of very low airborne ergot spore activity following peak spore activity in mid- to late May (data not shown), and ergot infection was not detected. Ergot infection did occur at the 'Baron' and 'Skye' sites, but neither the quantity nor temporal dynamics of airborne ascospores is known since monitoring was not performed at those sites.

Seed quality

Seed quality was not affected by TE at any application rate, and there were no significant interactions between variety and TE treatment (Table 6). Slight differences were observed between varieties for TZ and AAT levels, but differences are not attributed to TE application. Slowed germination in the AAT is attributed to a varietal response to high temperatures and relative humidity.

Table 6. Kentucky bluegrass seed viability and vigor by variety across all trinexapac-ethyl treatments, 2019.

KBG variety	Standard germination test	Tetrazolium test	Accelerated aging test
	(%)	(% viable seed)	(% germination, 2 weeks)
Baron	85	91.0 a	57.4 c
Skye	84	86.2 b	68.6 b
Gaelic	84	92.7 a	81.0 a
LSD (0.05)	NS	2.6	4.6
Variety	NS	*P* = 0.0006	*P* = 0.00
Treatment	NS	NS	NS
Variety x treatment	NS	NS	NS

Conclusion

Overall, results from the second year of the study did not show an interaction ($P = 0.0529$) between variety and TE application rate effect on seed yield. A varietal response to TE application was observed for improved seed yield only in 'Skye', where the 0.8 and 2.8 pt/acre TE rates resulted in statistically similar seed yields, both of which were lower than the 1.4 pt/acre rate. An interaction did occur between variety and TE application rate ($P = 0.00$) for lodging, which indicates that 'Skye' and 'Gaelic' were more susceptible to lodging than 'Baron' at the 0.8 and 1.4 pt/acre TE rates.

Year 1 results (data not shown) were similar to year 2 results, with no observed differences in above-ground biomass. Panicle emergence was delayed approximately 7 days at the 2.8 pt/acre TE rate, with reduced tiller height and lodging at the 1.4 and 2.8 pt/acre TE rates. In first-harvest stands of 'Baron' and 'Gaelic', the 2.8 pt/acre TE rate resulted in fewer panicles/ft^2; however, neither seed weight nor yield was reduced. 'Baron' responded similarly in the second harvest year, with a reduced number of panicles/ft^2. In contrast, no differences were observed for 'Skye' or 'Gaelic'.

Further investigation is needed to examine optimal TE application rates for KBG varieties. This project will be repeated in 2020 to investigate effects of TE on third- and fourth-year seed crop stands in the same fields.

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