INTERACTION OF TRINEXAPAC-ETHYL AND APPLIED NITROGEN INCREASES SEED YIELD IN PERENNIAL RYEGRASS AND TALL FESCUE

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Introduction

Trinexapac-ethyl (TE) is a plant growth regulator (PGR) which has been widely adopted for use as a lodging control agent in grass seed production. Under certain growing conditions especially accompanied with high nitrogen (N) availability in spring, the structure of the stem cannot support the increasing weight of the developing inflorescence and seed. As a result, the tiller together with the inflorescence that it supports lodges or falls to the ground under its own weight. Lodging affects pollination and seed development, and consequently, seed yield is reduced.

Previous studies have found that an earlier PGR used for lodging control - paclobutrazol, increased seed yield of perennial ryegrass regardless of N application rate (Hampton et al., 1983). In other words, there was no interaction of the PGR and applied N for seed yield evident in this study. Young et al. (1999) found interactions of paclobutrazol and N in Chewing's fescue and tall fescue but not in orchardgrass under conditions in the Willamette Valley. In more recent studies with TE, Borm and van den Berg (2008) similarly found no interaction of TE PGR and applied N for seed yield in perennial ryegrass.

Since lodging is exacerbated in the high N environment present in grass seed production systems, further work was needed to determine the possibility of interactions of TE PGRfor lodging control and spring-applied N under Oregon conditions. The objectives of this study were to determine how TE and spring-applied N treatment affects seed production characteristics and seed yield in perennial ryegrass and tall fescue.

Methods

Field trials were conducted at Hyslop Crop Science Research Farm near Corvallis, OR, to characterize the effects of TE and spring-applied N on seed yield and other seed production characteristics in 'Evening Shade' perennial ryegrass and 'Falcon IV' tall fescue. The trials were conducted over three harvest years, 2010 to 2012.

The trials were designed to manipulate partitioning within the crop through the following management treatments:

1. Spring applied N (160 lbs/acre – perennial ryegrass, 120 lbs/acre – tall fescue)
2. TE PGR (1.5 pts/acre)
3. Control (no spring N, no PGR)

Spring N was applied in March of each of the three years with an orbit air spreader system. The TE PGR treatment (Palisade®) was applied at BBCH stage 32-33 to control lodging. Above-ground dry weight and fertile tiller number were determined on samples collected from each plot near peak anthesis of perennial ryegrass and tall fescue in June. The seed crops were cut with a small-plot swather and threshed by a small-plot combine in July of each of the study years. The seed was cleaned, and seed yield and seed weight were determined. Harvest index was determined as the proportion of total above-ground dry matter represented by seed yield.

Results and Discussion

Interactions of TE PGR and spring-applied N governed seed yield of perennial ryegrass in all three harvest years and was evident in tall fescue in two of the three harvest years, but the responses differed among the two species. For perennial ryegrass, the PGR had no positive effect on seed yield unless N was applied (Figure 1). Perennial ryegrass seed yields were greatest with the combination of TE and N in each of the three harvest years. In tall fescue, there was no interaction of TE and N for seed yield in 2010, but seed yield interactions were evident in both 2011 and 2012 where the combination of N and TE PGR produced the greatest seed yields (Figure 2).

There were no interactions of TE and N for the seed yield components, fertile tillers and seed weight, in any of the harvest years for both perennial ryegrass

and tall fescue. Likewise, there were no interactions of TE and N for above-ground dry weight or for harvest index in both perennial ryegrass and tall fescue. The influence of TE and N on seed yield components and other seed production characteristics were independent of one another.

The application of spring N consistently increased the above-ground dry weight observed in both seed crop species over the life of the study (Table 1). An increase in the number of fertile tillers resulting from N application accompanied the increased dry weight in perennial ryegrass, but increased fertile tiller production was observed in only one of three years in tall fescue as a result of N application. Nitrogen increased seed weight for both perennial ryegrass and tall fescue. Mixed effects of N on harvest index were noted for both perennial ryegrass and tall fescue. Harvest index was most often reduced by N application, but was also increased or not affected by N. Spring-applied N increased the size of the crop canopy (above-ground dry weight) in both species thereby enabling greater solar energy capture and partitioning of carbon (derived from atmospheric CO_2) to the seed (seed weight) increasing seed yield.

The application of TE tended to reduce above-ground dry weight, but these effects were neither consistent nor were they always statistically significant (Table 2). Effects of the TE application were largely not evident in fertile tiller numbers as has been noted in previous studies. Applications of TE mostly increased harvest index in perennial ryegrass and tall fescue, and even when not significant, the trend was for increased harvest index with the PGR application. Mixed effects of the TE PGR were observed for seed weight; application of the PGR reduced seed weight, increased seed weight, or had no effect on seed weight.

The results of this study increases our understanding of how TE and applied spring N work in affecting seed yield in perennial ryegrass and tall fescue and this information can be used to improve the economic and biological efficiency of TE applications. Spring N applications greatly increased lodging in perennial ryegrass and to a lesser extent in tall fescue. Nitrogen-induced lodging was mitigated by the application of the TE PGR in both species. For best results in increasing seed yield when using TE in perennial ryegrass and tall fescue, the PGR should be applied in conjunction with the recommended rates of spring N for these crops.

References

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Table 1. Spring-applied N effects on harvest characteristics in perennial ryegrass and tall fescue seed crops.

Crop and Year	Treatment	Dry weight	Fertile tillers	Harvest index	Seed weight
		kg ha^{-1}	no m^{-2}		mg
Perennial Ryegrass					
2010	No N	6485a†	1927a	13.2b	--
	Spring N	16405b	3100b	10.2a	--
2011	No N	4723a	1841a	10.0a	1.80a
	Spring N	10303b	2487b	11.1b	1.93b
2012	No N	4221a	1765a	15.4b	1.72a
	Spring N	10659b	2454b	13.3a	2.82b
Tall Fescue					
2010	No N	19734a	1281a	3.7a	--
	Spring N	20626b	1281a	3.2a	--
2011	No N	7953a	743a	11.8a	2.49a
	Spring N	12663b	872a	12.1a	2.59b
2012	No N	4304a	474a	19.6b	2.47a
	Spring N	10959b	710b	11.6a	2.69b

†Means within columns and years that are followed by the same letter are not significantly different (P = 0.05)

Table 2. Trinexapac-ethyl PGR treatment effects on harvest characteristics in perennial ryegrass and tall fescue seed crops.

Crop and Year	Treatment	Dry weight	Fertile tillers	Harvest index	Seed weight
		kg ha^{-1}	no m^{-2}		mg
Perennial Ryegrass					
2010	No PGR	11650a†	2551a	11.2a	--
	PGR	11240a	2487a	12.2a	--
2011	No PGR	8376b	2306b	9.4a	1.79a
	PGR	6649a	2034a	11.8b	1.93b
2012	No PGR	7715a	2099a	13.3a	1.79a
	PGR	7167a	2121a	15.4b	1.76a
Tall Fescue					
2010	No PGR	20261a	1302a	2.6a	--
	PGR	20098a	1259a	4.3b	--
2011	No PGR	12031b	883b	10.5a	2.62b
	PGR	8586a	732a	13.4a	2.46a
2012	No PGR	7865a	549a	11.7a	2.61b
	PGR	7398a	635a	19.8b	2.56a

†Means within columns and years that are followed by the same letter are not significantly different (P = 0.05)

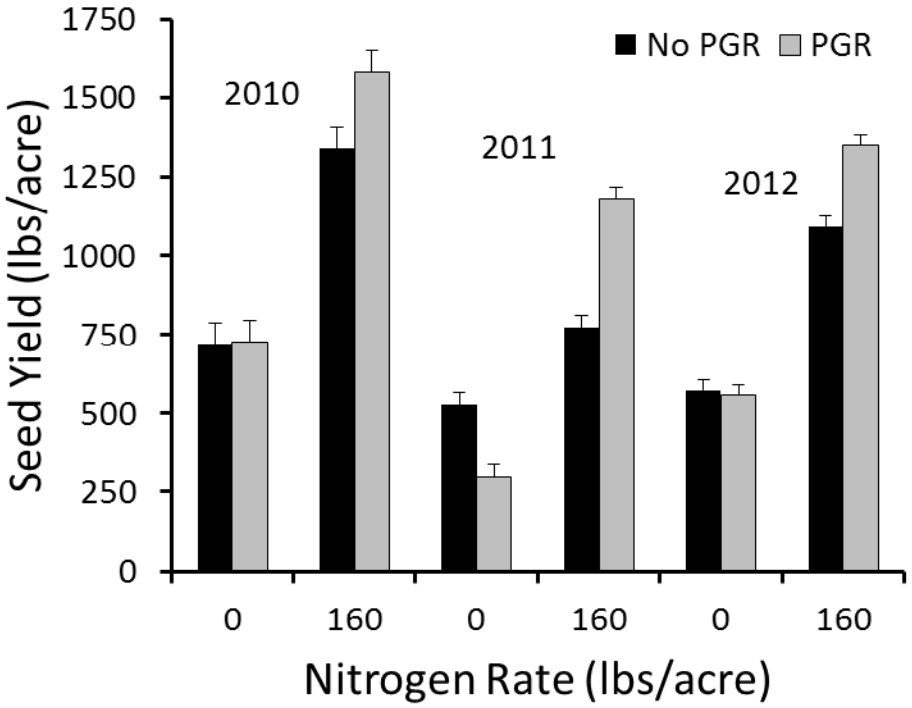

Figure 1. Interaction effects of trinexapac-ethyl PGR and spring-applied nitrogen on seed yield of perennial ryegrass over a three-year period. Bars represent standard error of the mean difference values for comparing means within years (P = 0.05)

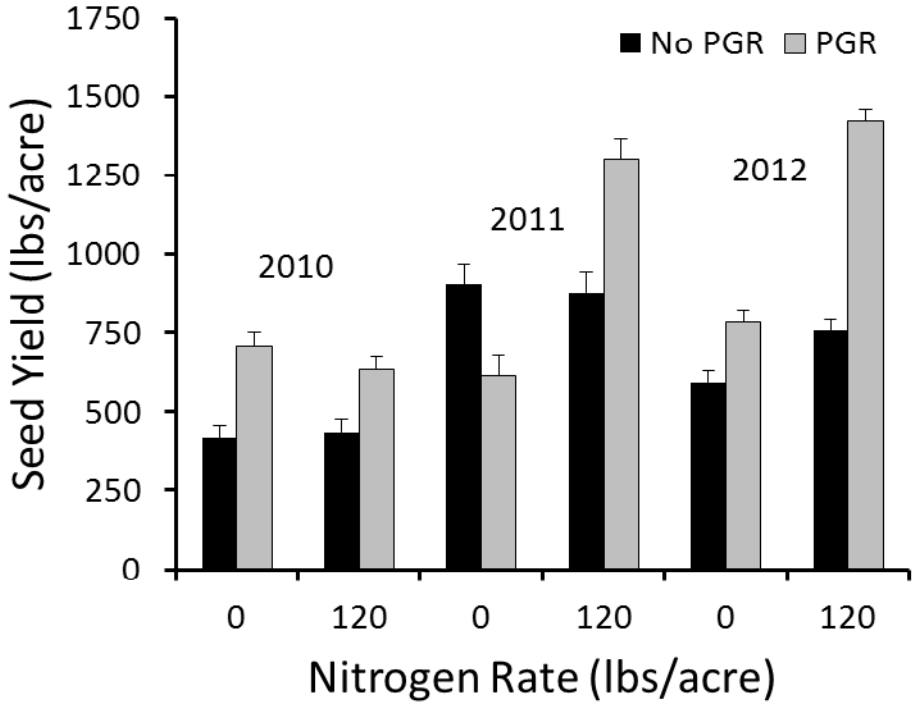

Figure 2. Interaction effects of trinexapac-ethyl PGR and spring-applied nitrogen on seed yield in tall fescue over a three-year period. Bars represent standard error of the mean difference values for comparing means within years (P = 0.05)