

# SEED YIELD OF THREE TALL FESCUE CULTIVARS AS AFFECTED BY ENDOPHYTE INFECTION

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## ABSTRACT

Endophyte-infected (E+) tall fescue (*Festuca arundinacea* Schreb.) has enhanced fitness in some environments. The objectives were to measure the effects of the endophyte *Acremonium coenophialum* on seed yield traits and to determine the transmission rate of the endophyte from infected maternal plants into seed. Twenty infected and noninfected (E-) seedlings of each of three tall fescue cultivars were transplanted to the field in May, 1993. In 1994, there were significant differences between E+ and E- plants for panicle number and seed weight per panicle. In the second year, there were no differences between E+ and E- for the measured traits. Cultivar effects were larger than endophyte effects in both years. Endophyte transmission was very high in both years.

## KEYWORDS

Tall fescue, endophyte, seed yield

## INTRODUCTION

Invasive and agronomically important cool season grasses (Poaceae) are often infected with seed-disseminated Clavicipitaceous fungal endophytes (Leuchtman, 1992). Grasses such as tall fescue (*Festuca arundinacea* Schreb.) do not exhibit symptoms of infection by *Acremonium coenophialum* Morgan-Jones and Gams, yet the symbiotic association greatly affects host persistence and ecological fitness (Clay, 1990). Enhanced host fitness factors include tolerance to biotic (insect and mammalian herbivores) and abiotic (drought) stresses. Additionally, *A. coenophialum*-infected (E+) tall fescue may have improved plant growth and fecundity.

Reports of endophyte effects on seed germination and seedling establishment have varied. Clay (1987) found 10% better germination of E+ seed than E- seed, while Bacon (1993) found that seedlings from E+ seed were not as drought tolerant as seedlings from E- seed.

In this study, we compared the effect of the endophyte on seed yield traits of three tall fescue cultivars, and determined the transmission success of the endophyte from infected maternal plants to their progeny.

## METHODS

Seed of three tall fescue cultivars used in this study were 'Georgia Jesup Improved' (GA-JI, Dr. Joe Bouton, Univ. of Georgia), 'Kentucky 31' (KY 31, International Seeds, Halsey, OR) and 'Johnstone' (Univ. of KY forage breeding program). Seed of E+ and E- GA-JI and KY 31 were from genetically near-identical populations (isofrequent or isogenetic populations). Johnstone was available only as E-, so E+ Johnstone was produced by introducing *A. coenophialum*, isolated from an E+ KY 31 plant into meristems of E- Johnstone seedlings (Latch and Christensen, 1985). Twenty E+ and E- plants of each cultivar grown in 10 cm pots (ca. 6-8 months) were transplanted to the field in May 1993 in randomized complete block design at 0.9 m spacing, with cultivars being isolated by a border of triticale to prevent cross-cultivar pollination. Seed was harvested from each plant in late June-early July 1994 and 1995. Seed was threshed, cleaned, weighed and stored at -20°C. Ten seeds per plant for each of the two harvest years were tested for infectivity by the tissue print immunoblot assay (Gwinn *et al.*, 1991). Data were analyzed by using the General Linear Models procedure of SAS (1988).

## RESULTS AND DISCUSSION

1994 season. In the first year of harvesting the spaced plants, panicle numbers were significantly different ( $P < 0.01$ ) among cultivars and between infected and noninfected plants (Table 1). There was also a significant interaction between cultivar and endophyte status. Johnstone produced the fewest panicles with a mean of 210, followed by KY 31 with 310 panicles per plant, and GA-JI with 317. The endophyte infected plants produced significantly more panicles than the noninfected ones (310 vs. 248). Both GA-JI and Johnstone produced significantly more panicles when infected, but there was no difference in panicle numbers between E+ and E- KY 31.

Seed yields were different among the three cultivars, but the endophyte effect was not significant (E+ plants yielded an average of 80 g plant<sup>-1</sup> while E- plants yielded 86 g plant<sup>-1</sup>). Seed yield per panicle was significantly different among cultivars and between E+ and E- plants. KY 31 had the lowest seed yield per panicle with 27 mg panicle<sup>-1</sup>. Johnstone had the highest with 38 mg panicle<sup>-1</sup>. We have observed that seed harvested from E- plants are approximately 10-15% heavier (in terms of 1000 seed weight) than seed harvested from E+ plants grown in the same environment. Tall fescue may compensate for fewer reproductive tillers by producing more seeds per panicle, and seeds with greater mass. Conversely, E+ plants with greater panicle numbers may not produce sufficient photosynthate to develop as many seed per panicle, or seed mass as E- plants.

1995 season. The second harvest year again saw more panicles produced by GA-JI and KY 31 than for Johnstone. No significant differences were found among the three cultivars for seed weight. Seed weight per panicle was significantly lower for KY 31 than for the other two cultivars, as in 1994. Seed yields and yield per panicle in 1995 were about half the yields in 1994. This may have resulted from sub-optimal nitrogen availability, winter damage, or crowding of tillers in the spaced plants. There was no endophyte effect on panicle number, seed weight, or seed weight per panicle in the second harvest year.

Transmission of the endophyte from infected maternal plants to seed was very high in both years (98-100%). A few E+ plants lost the endophyte and were dropped from the study, but 57 out of 60 E+ plants produced nearly 100% infected seed.

In the first year, the endophyte resulted in greater panicle production, but less seed weight per panicle. KY 31 produced the least seed per panicle, but relatively many panicles. In the second harvest year, the only significant difference were among cultivars. Thus, the endophyte effect may be important in some years, but generally the differences among cultivars are greater for panicle number, seed yield, and seed weight per panicle.

## REFERENCES

- Bacon, C.W. 1993. Abiotic stress tolerance (moisture, nutrients) and photosynthesis in endophyte-infected tall fescue. *Agric., Ecosyst. and Environ.* **44**(1993): 123-141.
- Clay K. 1987. Effects of fungal endophytes on the seed and seedling biology of *Lolium perenne* and *Festuca arundinacea*. *Oecologia* **73**: 358-362.

Clay, K. 1990. Fungal endophytes of grasses. *Ann. Rev. Ecol. Systems* **21**: 275-295.

Gwinn, K.D., M.H. Shepherd-Collins, and B.B. Reddick. 1991. Tissue print-immunoblot: an accurate method for the detection of *Acremonium coenophialum* in tall fescue. *Crop Sci.* **31**: 185-195.

Latch, G.C.M., and M.J. Christensen. 1985. Artificial infections of grasses with endophytes. *Ann. Appl. Biol.* **107**: 17-24.

Leuchtman, A. 1992. Systematics, distribution, and host specificity of grass endophytes. *Nat. Toxins* **1**: 150-162.

SAS Institute Inc. 1988. SAS/STAT User's guide, Release 6.03 Edition. Cary, NC: SAS Institute, Inc.

**Table 1**

Means of seed yield traits from three tall fescue cultivars infected with an endophyte (E+) and noninfected (E-) for 1994.

	Panicle no. plant <sup>-1</sup> -----#-----	Seed yield plant <sup>-1</sup> -----g-----	Seed yield panicle <sup>-1</sup> -----mg-----
GA-JI	317.2 a*	93.53 a	32.11 ab
Johnstone	210.1 b	73.31 b	38.03 a
KY 31	309.6 a	81.71 ab	27.09 b
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E+	309.5 a	80.15 a	27.72 a
E-	248.4 b	85.54 a	37.10 b
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GA-JI E+	373.9 a	90.03 ab	25.48 c
GA-JI E-	260.4 bc	97.02 a	38.75 ab
Johnstone E+	245.4 c	75.35 ab	32.84 bc
Johnstone E-	174.8 d	71.27 b	43.22 a
KY 31 E+	309.2 b	75.07 ab	24.84 c
KY 31 E-	309.9 b	88.33 ab	29.33 bc

\* Values in the same column-group followed by different letters are significantly different, P<0.05.

**Table 2**

Means of seed yield traits from three tall fescue cultivars infected with an endophyte (E+) and noninfected (E-) for 1995.

	Panicle no. plant <sup>-1</sup> -----#-----	Seed yield plant <sup>-1</sup> -----g-----	Seed yield panicle <sup>-1</sup> -----mg-----
GA-JI	337.6 a	48.74 a	15.33 a
Johnstone	282.6 b	39.96 a	14.72 a
KY 31	363.2 a	40.22 a	11.64 b
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E+	345.4 a	43.61 a	14.76 a
E-	310.2 a	42.34 a	13.03 a
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GA-JI E+	341.8 a	47.35 ab	14.38 ab
GA-JI E-	333.4 a	50.12 a	16.29 a
Johnstone E+	319.6 a	44.27 ab	14.15 ab
Johnstone E-	245.6 b	35.66 b	15.28 a
KY 31 E+	374.8 a	39.20 ab	10.56 b
KY 31 E-	351.4 a	41.25 ab	12.72 ab

\* Values in the same column-group followed by different letters are significantly different, P<0.05.