Endophytes in Summer Dormant Tall Fescue: Are There Benefits?

Erin Hubbard, Ginger Swoboda, William Krogman, Carolyn Young and Michael Trammell

Introduction

Continental or summer active (SA) tall fescue is a successful forage grass, widely utilized in the eastern USA where its persistence is attributed to a beneficial endophytic fungus. However, much of this region is planted with endophyte-infected tall fescue that is toxic to grazing livestock, known as common toxic endophyte (CTE). Naturally occurring endophyte strains (selected endophytes) have been identified that retain the host benefits while eliminating livestock toxicity. These new endophyte strains are now commercially available within SA tall fescue cultivars as a value-added trait that aids host persistence. Mediterranean or summer dormant (SD) tall fescue has a survival strategy by going dormant during summer, thus offering multi-year persistence in the hot, water limited environments typical of the southern Great Plains. SD tall fescue can potentially complement or replace traditional, annual small grains graze-out systems in the southern Great Plains, providing high quality forage from fall through spring, thereby reducing livestock costs for producers by reducing the need to plant winter annuals.

Objective

The objective of this study is to evaluate the role of endophytes (CTE and selected) as a value added trait in SD tall fescue using clonal pairs (endophyte-infected, E+ and endophyte-free, E-) that have been generated from ten host lines, two SA and eight SD, representing 15 unique genotypes per population.

Materials and Methods

- The study was conducted over two years at the Noble Research Institute's (Noble) Research Park located in Ardmore, OK (34°11'N, 97°5'W) on a Heiden clay and Dupy farm located near Gene Autrey, OK (34°17'N, 96°59'W) on a Renfrow silt loam.
- Clonal pairs (endophyte-infected and endophyte-free) were generated from ten host lines, two SA and eight SD, representing 15 unique genotypes per population.
- Each clonal pair population was planted in a block of either E+ or E- with individual genotypes planted in a row of six space plants.
- The E+ and E- blocks were allowed to openly cross pollinate in the field and were separated from other crossing blocks by a pollen screen of triticale.
- In autumn 2014, NFTF 1730, PDF, and Texoma MaxQ II clonal pair populations were planted and seed was produced in 2015-2017.
- Additional clonal pair populations were transplanted in autumn 2015 and seed was produced in 2016 and 2017.
- Seed was hand harvested and cleaned from individual plants to limit potential cross contamination between plants (Figure 1). Rough and clean weight, percentage change after cleaning, and total annual seed weight (g) was determined for all seed lots (Figure 2). Seed produced was used for field evaluation.
- Sward plots were established at Noble's Unit 3 farm in Ardmore, OK (34°10'N, 97°5'W) on Windthorst fine sandy loam in 2015 and 2016 to evaluate the persistence of E+ and E- clone pairs under intensive grazing (Figure 4).
- Another series of sward plots were established in 2016 at Vashti, TX (33°33'N, 98°2'W) on an Anocon loam to evaluate the persistence of E+ and E- clone pairs under intensive grazing and mechanical harvesting for yield.
- Individual clones representing each population and endophyte status were also evaluated for tiller number and plant height under growth chamber conditions (10hr light, 22°C, and well watered) (Table 1).

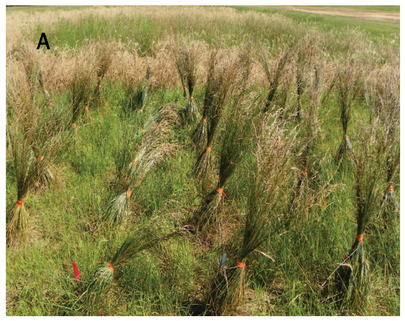

Figure 1. Seed harvest for tall fescue clonal pairs (A) Seed was harvested from individual plants to reduce potential cross contamination. A tall fescue plot with ripe seed, ready for hand-harvesting. **(B)** Harvested tall fescue plants hang-drying prior to the cleaning process. **(C)** Rubbing board and grain dockage sieve used to separate fescue seed from the panicle. Once removed from the panicle, a wall blower was used to remove chaff and obtain cleaned seed.

Results

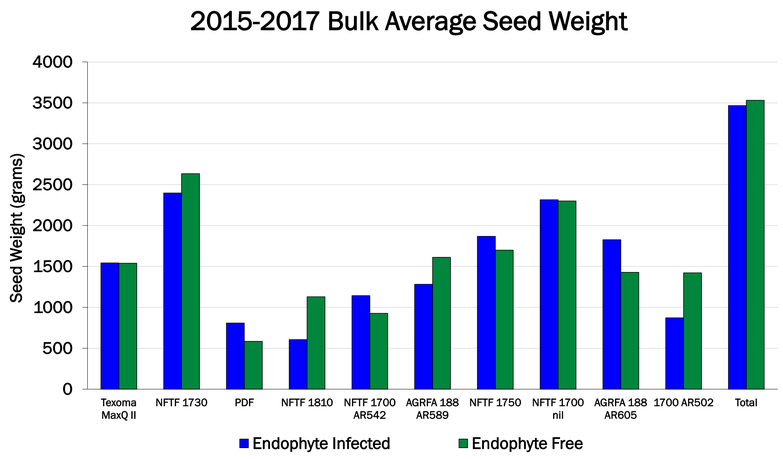

Figure 2. Average bulk seed weight of clonal pairs from the years 2015-2017. NFTF 1730, Texoma MaxQ II, and PDF were produced 2015-2017 while the remaining lines were produced from 2016-2017. The total is the average of endophyte-infected and endophyte-free over the three years.

Table 1. Effect of endophyte on tiller number and plant height at 4, 8, and 12 week intervals across all clonal pair genotypes under growth chamber conditions.

Endophyte Status	Tiller Number			Plant Height (cm)		
	4 week	8 week	12 week	4 week	8 week	12 week#
Endophyte Infected	7.2 a*	20.3 a	30.5 a	33.3 a	42.1 a	42.3 b
Endophyte Free	7.9 a	21.2 a	30.6 a	35.1 a	42.2 a	48.4 a
Mean	7.6	20.7	30.5	34.2	42.1	44.7

- # 12 week represents regrowth after cutback at 8 week.
- Data with the same letter within a column are not significantly different at the $p \geq 0.05$.

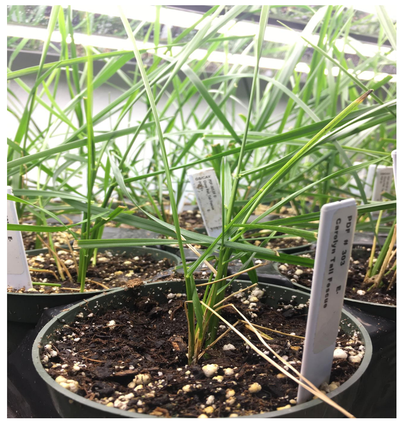

Figure 3. PDF clonal pairs being prepared for transplant into the field for the 2017 growing season.

Table 2. Percent stands of clonal pair sward plots under intensive grazing at the Unit 3 farm in Ardmore, OK. Sward plots were established in the fall of 2015.

Clonal Isolation	Endophyte Status	Average % Stand			
		20-Mar-16	24-Aug-16	8-Mar-17	3-Oct-17
NFTF 1730	Infected	94 a*	98 a	100 a	86 b
	50/50 Mix	95 a	98 a	96 a	86 b
	Nil	100 a	98 a	99 a	7 b
PDF	50/50 Mix	100 a	98 a	99 a	81 b
Texoma MaxQ II	Infected	96 a	97 a	100 a	75 b
	50/50 Mix	96 a	100 a	100 a	47 b
	Nil	93 a	90 a	93 a	79 b

* Data with the same letter within a column are not significantly different at the $p \geq 0.05$

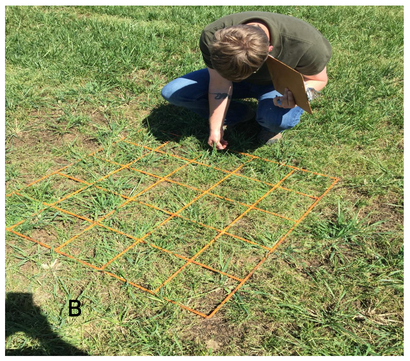

Figure 4. (A) Cattle grazing sward plots established with E+ and E- clonal pair seed. **(B)** Stand counts were taken using a grid method as described by Hopkins (2005).

Table 3. Percent stands of clonal pair sward plots under both intensive grazing and mechanical harvesting (clipping) at the Unit 3 farm in Ardmore, OK and at Vashti, TX.

	Location	Vashti, TX	Vashti, TX	Ardmore, OK	Vashti, TX	Vashti, TX	Ardmore, OK
	Trial Type	Clipping	Grazing	Grazing	Clipping	Grazing	Grazing
Clonal Isolation	Endophyte Status	Average % Stand	Average % Stand	Average % Stand	Average % Stand	Average % Stand	Average % Stand
		27-Apr-17	27-Apr-17	3-Apr-17	9-Oct-17	3-Oct-17	3-Oct-17
NFTF 1730	Infected	51	30	100	27	5	22
	Nil	42	61	12	26	13	29
	50/50	36	3	100	33	2	28
Texoma MaxQ II	Infected	100	48	58	100	47	100
	Nil	100	2	6	98	16	93
	50/50	100	61	10	99	36	100
PDF	Infected	100	4	12	100	49	100
	Nil	100	19	52	100	70	95
	50/50	100	43	76	100	47	98
NFTF 1750	Infected	27	28	78	35	10	45
	Nil	28	25	100	37	1	45
	50/50	35	21	20	43	2	32
AGRFA 188 AR605	Infected	22	25	6	17	0	13
	Nil	17	31	18	9	0	10
	50/50	32	5	8	18	1	28
NFTF 1810	Infected	29	0	18	34	1	28
	Nil	70	91	20	78	10	43
	50/50	63	58	30	76	8	54
AGRFA 188 AR589	Infected	25	26	90	18	0	35
	Nil	43	34	12	60	3	47
	50/50	42	27	28	29	3	39
NFTF 1700 AR542	Infected	44	2	100	44	0	47
	Nil	15	3	100	15	2	20
	50/50	42	7	14	41	1	42
NFTF 1700 nil	FT*	42	28	66	36	1	20
	Nil	36	29	100	22	1	31
	50/50	24	13	38	19	1	27

*FT was fungicide treated with the fungicide Proline at 300g active/ha per application

- Bulk average seed weight did not differ between endophyte-infected or endophyte-free tall fescue lines (Figure 2).
- Endophyte status does not seem to affect the number of tall fescue tillers over a 12 week period, but may affect plant height since there was a difference between endophyte-infected and endophyte-free at 12 weeks (Table 1).
- Stand data collected from sward plots under grazing (Table 2) indicated a significant decline in stand frequency after 2-years of grazing. However, stands were similar across populations regardless of endophyte infection.
- Initial stand data from the sward plots planted in 2016 were very low (Table 3). Texoma MaxQ II and PDF, both SA tall fescues, had higher stand percentages across all locations (Table 3).

Conclusions

- A difference between the height of endophyte-infected and endophyte-free clonal pairs was observed under growth chamber conditions at 12 weeks (Table 1).
- Initial stand data was >90% for clonal pair populations established in 2015 (Table 2). Stands had declined after 2-years of intensive grazing, but were similar across all populations regardless of endophyte status.
- Poor establishment of SD tall fescue plots in 2016 was a result of poor cold tolerance (Table 3), typical of Mediterranean germplasm. The greater cold tolerance of the SA tall fescue germplasm is reflected in the higher initial stand data (Table 3).
- More work is needed to determine if there are benefits of endophyte in summer dormant tall fescue.

Future Studies

- Establish an east-west gradient of plot trials across Oklahoma and Texas and plot trials along a north-south gradient in California to assess the value of endophyte in SD clonal pairs on productivity under various irrigation and harvesting treatments (Figure 3).

Literature Cited

Hopkins, A.A. 2005. Grazing tolerance of cool-season grasses planted as seeded sward plots and spaced plants. Crop Sci. 45: 1559-1564