Response of Summer-dormant and Summer-active- Types Tall Fescue With and Without Fungal Endophyte Infection to Plant Parasitic Nematode Exposure

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Abstract

Summer-active (continental) tall fescue (*Schedonorus arundinaceus*) is well adapted to the southeast and Midwest where annual precipitation is in excess of 35 inches. Continental types possess drought avoidance mechanisms, but will re-grow with summer rains which reduces their persistence in continental climates such as the Southern Plains. Mediterranean Basin origin summer-dormant tall fescue (Mediterranean) avoids extended moisture and heat stress periods by invoking dormancy in response to increasing day length and temperature. Mediterranean tall fescues may expand the tall fescue adaptation zone due to their summer dormancy. Persistence of continental types is enhanced by the presence of an ergot-alkaloid-producing endophyte, *Neotyphodium coenophialum* (wild), conferring resistance to insects, drought and grazing. Ergot alkaloids cause fescue toxicosis in livestock. Non-ergot-alkaloid-producing strains of *N. coenophialum* (novel) endophytes have been identified and placed into tall fescue selections. Some novel strains in continental tall fescue confer resistance to plant parasitic nematodes while others do not. Resistance to nematodes by novel endophytes in Mediterranean tall fescues is uncertain.

This study sought to compare the effects of four nematode types on wild endophyte-infected continental tall fescue and novel endophytes in continental or Mediterranean tall fescue. This greenhouse study was conducted with two continental varieties: Kentucky 31 (wild) and Texoma MaxQ II (novel); and the Mediterranean variety Flecha AR542 (novel). Endophyte-free plants of each variety were controls. Plants were established from seed; endophyte presence was verified then plants were transplanted to 7.5 inch pots. Pots were inoculated with two levels of stunt (*Tylenchorhynchus spp.*) low 90, high 270; ring (*Criconemella spp.*) low 250, high 800; spiral (*Helicotylenchus spp.*) low 75, high 225; and lesion (*Pratylenchus spp.*) low 20, high 55 nematodes. Study length was six months, then nematode soil populations were determined. Lesion (an endoparasitic nematode) soil populations were near zero across all plants. Ectoparasitic nematode populations were higher for Flecha AR542 and lower for Kentucky 31 (wild) than other variety-by-endophyte combinations. The novel endophyte MaxQ II had no effect on ectoparasitic nematode populations compared to endophyte- free Texoma. Results indicate that the novel endophyte AR542 increases host suitability of Flecha summer-dormant tall fescue to ectoparasitic nematodes.

Introduction

Tall fescue is a cool-season perennial forage grass that covers over 35 million acres, the majority of which are in regions where annual precipitation is 35 inches or greater (Burns et al., 1979). In regions that have a continental climate such as the Southern Plains, annual cool-season forages are relied upon to supply quality forage for stocker cattle production. Annual grasses have a yearly establishment cost that can be eliminated if they can be replaced by a persistent perennial cool-season forage such as tall fescue. The persistence of tall fescue is enhanced by infection of an ergot-alkaloid-producing endophyte (Malinowski and Belesky, 2000). Ergot-producing endophytes (wild) cause tall fescue toxicosis which costs United States livestock producers up to $1 billion annually (Roberts, et al., 2011). Non-ergot-producing endophytes (novel) do not cause tall fescue toxicosis, but still enhance plant persistence and have been identified and placed in tall fescue selections (Bouton et al., 2002).

Long-term persistence of novel or wild endophyte-infected tall fescue has been limited because most tall fescue cultivars are summer-active and can have high tiller mortality during extreme Southern Plains summers (Malinowski et al., 2009). Tall fescue selections from the Mediterranean Basin are summer-dormant and could prove to be more persistent in the Southern Plains. A benefit to ergot-producing endophytes is resistance to insect feeding. In a recent stockpile study (Rogers unpublished data) with novel and wild summer-active and novel summer-dormant tall fescue, stand thinning began in year one of a three-year study. Soil testS revealed the presence of stunt nematodes. The objective of this study was to determine if novel endophytes in summer-active or summer-dormant tall fescue confer nematode resistance equal to that of a wild endophyte.

Methods

Three cultivars of tall fescue were tested in two sequential greenhouse experiments in 2011 at the Noble Foundation in Ardmore, OK. The cultivars were Kentucky 31+, a summer-active continental type, infected with a wild endophyte; Texoma MaxQ II, a summer-active continental type, infected with a novel (MaxQ II) endophyte; and Flecha AR542, a summer-dormant Mediterranean type, infected with a novel (AR542) endophyte. Endophyte-free plants of each variety served as controls. Tall fescue plants were established from seed by placing one seed per cell in a 36-cell tray containing Metro-mix 830 potting soil (Sun Gro Horticulture, Vancouver, British Columbia, Canada). Two 36-cell trays each were established for endophyte-infected and-free Kentucky 31 and Texoma. Three 36-cell trays each were established for endophyte- infected and-free Flecha. Trays were placed in a starter room in the greenhouse facility at 73.4oF constant temperature and 60% relative humidity. At seven weeks after emergence, a tiller was collected from each plant and submitted for endophyte testing using a polymerase chain reaction (PCR) screen. The PCR-based screen verified the presence or absence of the endophyte and distinguished the novel endophyte from the common toxic endophyte and thereby verified the endophyte-plant associations.

Following endophyte verification, plants were transferred to 7.5” X 7.125” 1-gallon pots containing a 50:50 mixture of a Renfrow silt loam soil (Fine, mixed, thermic Udertic Paleustolls) and an Illite calcined clay (Profile Products, Buffalo Creek, IL). A liner was placed in the bottom of each pot to prevent soil from sifting out of the pot. Prior to potting, the Renfrow soil was steam-autoclaved.

Methods (*cont.*)

Pots were then placed into the greenhouse where the experiments were conducted. On June 3, pots were inoculated with three treatment levels (high, low and 0 control) of a mixed culture of stunt (*Tylenchorhynchus spp.*) low 90, high 225; ring (*Criconemella spp.*)low 250, high 800; spiral (*Helicotylenchus spp.*) low 75, high 225; and lesion (*Pratylenchus spp.*) low 20, high 55 nematodes. Stunt, ring and spiral nematodes are ectoparasitic and migratory, living on the outside of the plant root and feeding on root tips, thus, inhibiting root elongation. Lesion nematodes are endoparasitic and live within the plant’s roots, feeding on plant root tissue. The experimental design was a randomized complete block factorial with five replications. Each sequential experiment contained 95 plants (3 varieties X 2 (presence or absence of endophyte) X 3 nematode levels (0, low, high) X 5 replications). The experiments ran for a six month period. Individual pots were watered twice per week and were fertilized once per week with 20-10-20 fertilizer solution.

At the termination of the experiment, plants were removed from the pots, soil shaken from the roots and the entire soil contents of the pot were bagged, individually identified and sent directly to Oklahoma State University, Stillwater, OK., for nematode analysis. Plant roots and tops were separated, individually identified and placed into a freezer for future analysis. For nematode assays, a 100-cc soil subsample was taken for each pot and nematodes recovered by wet sieving/sugar flotation and identified to genus using a compound microscope. Nematode population numbers were transformed to log10 and analyzed using the MIXED procedure of SAS. Experiment and replication were considered to be random effects and treatments as fixed effects. Ls means were declared significant at $P \leq 0.05$. Ectoparasitic nematodes were analyzed together in one analysis and the endoparasitic lesion nematode population was analyzed separately.

Conclusions

- The novel endophyte AR542 increased ectoparasitic nematode host suitability of the summer-dormant tall fescue variety Flecha.
- The novel endophyte MaxQ II had no effect on ectoparasitic nematode host suitability of the summer-active tall fescue variety Texoma.
- The ectoparasitic nematode host suitability of Texoma MaxQ II is similar to endophyte-free Kentucky 31, Texoma and Flecha.
- The novel endophytes tested in this study support higher ectoparasitic nematode populations than the wild-type endophyte.
- Increased host suitability of novel-endophyte infected tall fescue to ectoparasitic nematodes could be contributing to reduced persistence of novel-endophyte-infected tall fescue in the western edge of tall fescue adaptability.

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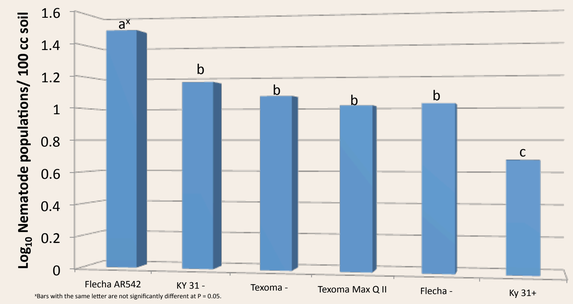
Fig. 1. Tall fescue variety effect on ectoparasitic nematode populations



*Bars with the same letter are not significantly different at P = 0.05.

Lesion nematode (*Pratylenchus spp.*)
Oklahoma State University photo

Stunt nematode (*Tylenchorhynchus spp.*)
Oklahoma State University photo

Ring nematode (*Criconemella spp.*)
Oklahoma State University photo

Spiral nematode (*Helicotylenchus spp.*)
Oklahoma State University photo

Results

Variety effect on ectoparasitic nematode populations was significant ($P < 0.01$) with no variety-by-nematode interaction. Flecha containing the novel endophyte AR542 supported higher ectoparasitic nematode populations than other variety-endophyte combinations and Kentucky 31 infected with a wild-type endophyte the lowest. The MaxQ II novel endophyte infecting the variety Texoma did not reduce ectoparasitic nematode populations compared to endophyte-free Texoma (Fig. 1). There were no treatment effects on lesion nematode soil populations. However, lesion nematodes are endoparasitic, and soil populations do not reflect lesion nematode populations that have moved from the soil into the plant roots. To truly measure the effect of lesion nematodes, additional testing and analysis will be required and were not available at the time of poster publication.

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