

Summary Report of the
SERAIEG-8
Tall Fescue Toxicosis/Endophyte Workshop
Natchez Trace State Park Wildersville, TN
October 17- 19, 2004

Edited by D.J. Lang
Mississippi State University

ARKANSAS

Annual Progress Report
SERAIEG 8

CONTRIBUTING STATION: USDA-ARS, Dale Bumpers Small Farms Research Center, Booneville, AR

PROJECT PERSONNEL: M. L. Looper, C. F. Rosenkrans, Jr., T. S. Edrington, C. L. Schultz, T. R. Callaway, R. Flores, and G. E. Aiken

TITLE: Effects of the ergot alkaloids dihydroergotamine, ergonovine, and ergotamine on growth of *Escherichia coli* O157:H7 and *Salmonella in vitro*

ACCOMPLISHMENTS: Numerous ergot alkaloids are contained within tall fescue. Three of the more commonly occurring, commercially available ergot alkaloids were utilized in this study. Ergot alkaloids, at the various concentrations used in the current study should include the range of concentrations that occur in the rumen of cattle grazing endophyte-infected tall fescue. There was minimal, if any, affect on the growth of *E. coli* O157:H7 and *Salmonella*.

IMPACTS: Factors such as ergot alkaloids (i.e., ergovaline), exposure to a combination of alkaloids, characteristics of the grazed forage, or management strategies that influence the incidence of fecal shedding of *Escherichia coli* O157:H7 in cattle grazing endophyte-infected tall fescue may help identify times when on-farm pathogen control would be the most effective and increase overall food safety.

CONTRIBUTING STATION: USDA-ARS, Dale Bumpers Small Farms Research Center, Booneville, AR

PROJECT PERSONNEL: M. L. Looper, G. E. Aiken, R. Flores, C. F. Rosenkrans, Jr., and D. K. Brauer

TITLE: Supplementation influences milk yield and milk components of cows grazing stockpiled tall fescue

ACCOMPLISHMENTS: The nutritive content of the stockpiled fescue in the current study was 66% digestible and 12% crude protein, indicating that if dry matter intake is adequate, forage alone could meet the nutritional requirements of cows. Concentrations of ergovaline (mean = 344 ppb) were below the quantity of published values that may induce clinical fescue toxicosis in cattle (M. Craig). Although milk yield and percent milk fat was increased in cows supplemented with SH and grazing stockpiled fescue, adjusted 205-d weaning weights of calves from SH-supplemented cows were not increased. Furthermore, body weights and body condition of cows were not affected by supplementation.

IMPACTS: Extension of the grazing season with stockpiled forages can decrease dependence on stored or purchased feeds reducing feed costs. If availability of stockpiled fescue is adequate, supplementation of cows may not be nutritionally or economically necessary.

PUBLICATIONS:

Looper, M. L., T. S. Edrington, C. F. Rosenkrans, Jr., C. L. Schultz, T. R. Callaway, G. E. Aiken, R. Flores, and D. K. Brauer. 2004. Effects of the ergot alkaloids dihydroergotamine, ergonovine, and ergotamine on the growth of *Escherichia coli* O157:H7 and *Salmonella in vitro*. Proc. 5th Int. Symp. *Neotyphodium*/Grass Inter. 503.

Looper, M. L., G.E. Aiken, R. Flores, C.F. Rosenkrans, Jr., and D.K. Brauer. 2004. Supplementation influences milk yield and milk components of cows grazing stockpiled tall fescue. Proc. 5th Int. Symp. *Neotyphodium*/Grass Inter. 502.

Aiken, G. E., S. F. Tabler, M. L. Looper, D. K. Brauer, and J. R. Strickland. 2004. Management of beef cattle to alleviate fescue toxicosis. Proc. 5th Int. Symp. *Neotyphodium*/Grass Inter. 410.

Looper, M. L., G. E. Aiken, R. Flores, and C. F. Rosenkrans, Jr. 2004. Effects of diet on performance, reproduction, and economics of market cows grazing stockpiled fescue. J. Anim. Sci. 82 (Suppl. 2):4.

Aiken, G. E., M.L. Looper, S. F. Tabler, and J. R. Strickland. 2004. Recovery of yearling calves from fescue toxicosis. XX Int. Graz. Con., Dublin, Ireland.

Burke, J. M., D. K. Brauer, and M. L. Looper. 2004. Use of novel endophyte-infected tall fescue for cow-calf production in Arkansas. J. Anim. Sci. 82 (Suppl. 1):91.

Burke, J. M., D. K. Brauer, and M. L. Looper. 2004. Calving rate and production responses of long-term exposure to endophyte-infected tall fescue. J. Anim. Sci. 82 (Suppl. 1):90.

Looper, M. L., G. E. Aiken, S. F. Tabler, R. Flores, and C. F. Rosenkrans, Jr. 2004. Performance of market cows grazing stockpiled tall fescue. AR Agr. Exp. Sta. Rep. (In press).

Annual Progress Report
SERAIEG 8

January 1, 2004 – December 31, 2004

CONTRIBUTING STATION: University of Arkansas, Fayetteville

PROJECT PERSONNEL: Wayne Coblenz, Ken Coffey, Chris Golden, Zelpha Johnson, David Kreider, Michael Looper, Jordan May, Kenneth May, Ali Moubarak, Mike Nihsen, Rick Rorie, Charles Rosenkrans, Jr., Chuck West, Tom Yazwinski

TITLE: Relationships between serum constituents at weaning and subsequent carcass characteristics of beef calves

ACCOMPLISHMENTS: Baseline information about the effects of calf gender and serum metabolites for grazing animals and their subsequent carcass composition has been established. We have demonstrated that ivermectin can help alleviate the toxicity of tall fescue and association with diminished steer gains.

IMPACTS: Steer gains are critical for profitable stocker operations and tall fescue is a key forage in year round cattle operations. Ivermectin is one method of maintaining acceptable steer gains while grazing toxic tall fescue.

TITLE: Impact of weaning date on long-term growth performance by fall-born calves grazing *Neotyphodium coenophialum* – infected tall fescue pastures

Ken Coffey, Wayne Coblenz, Michael Looper, Charles Rosenkrans, Jr., Elizabeth Kegley, and John Jennings
University of Arkansas Division of Agriculture and Dale Bumpers Small Farms Research Center, USDA-ARS, Booneville, AR

ACCOMPLISHMENTS: Initial phases of the first year of a multiyear trial were completed in which timing of spring weaning dates of fall-borne calves were compared for animal stress and growth. As was noted in a previous 3-yr. study, weaning fall-born calves in mid-April appears to have negative impacts on their long-term growth and development compared with weaning later in the spring. Delaying weaning until at least mid-May may improve subsequent animal gains and thereby reduce discrimination against "fescue" cattle.

IMPACT: Calving and weaning can possibly be timed to minimize endophyte toxin effects on stress and growth of beef calves born on *N. coenophialum*-infested tall fescue pastures. Biochemical Responses to Endophyte Infection and Water Deficit in Tall Fescue

TITLE: Biochemical Responses to Endophyte Infection and Water Deficit in Tall Fescue

PROJECT PERSONEL: Charles P. West, Rachel D. Carson, and Claudia Guerber
Department of Crop, Soil & Environmental Sciences
University of Arkansas

ACCOMPLISHMENTS: We provided further evidences of a link between endophyte presence and enhanced superoxide dismutase activity and dehydrin expression as possible biochemical mechanisms of endophyte-enhanced tiller survival during drought.

IMPACTS: The results may lead to a better understanding of the biochemical mechanisms of stress signal transduction and subsequent plant responses associated with enhanced stress tolerance. The endophyte's involvement in boosting host stress tolerance may be through signals that amplify the production of membrane-protecting dehydrins. These results form the basis for further work on identifying biochemical or molecular markers to aid in selecting endophytes that substantially enhance host drought tolerance.

PUBLICATIONS:

Belesky, D.P., and C.P. West. 2004. Abiotic stresses and endophyte effects. *In* Tall Fescue Information System. <http://forages.oregonstate.edu/>.

Carson, R.D., C.P. West, B. de los Reyes, S. Rajguru, and C.A. Guerber. 2004. Endophyte effects on dehydrin protein expression and membrane leakage in tall fescue. *In* R.L. Kallenbach, C.F. Rosenkrans, Jr., and T.R. Lock (eds.). Paper # 202. Abstracts and Proc. of 5th International Symposium on *Neotyphodium*/Grass Interactions.

Coblentz, W.K., K.P. Coffey, D.A. Scarbrough, T.F. Smith, K.F. Harrison, J.B. Humphry, B.C. McGinley, D.S. Hubbell III, J.E. Turner, and C.P. West. 2004. Using orchardgrass and endophyte-free fescue versus endophyte-infected fescue overseeded on bermudagrass for cow herds: Four-year summary. *In* R.L. Kallenbach, C.F. Rosenkrans, Jr., and T.R. Lock (eds.). Paper # 414. Abstracts and Proc. of 5th International Symposium on *Neotyphodium*/Grass Interactions.

Coffey, K.P., W.K. Coblentz, T.F. Smith, J.E. Turner, D.S. Hubbell, III, D.A. Scarbrough, B.C. McGinley, C.F. Rosenkrans, Jr. 2004. Weaning date and pasture rotation frequency effects on forage measurements and performance by fall-born calves grazing tall fescue pastures. *J. Anim. Sci.* 82(Suppl. 2):24

Coblentz, W.K., K.P. Coffey, D.A. Scarbrough, T.F. Smith, D.S. Hubbell, III, K.F. Harrison, B.C. McGinley, J.E. Turner, and J.B. Humphry. 2004. Using orchardgrass and endophyte-free fescue versus endophyte-infected fescue overseeded on bermudagrass for cow herds: four-year summary of cattle performance. *J. Anim. Sci.* 82(Suppl. 1):91.

Coblentz, W.K., K.P. Coffey, D.A. Scarbrough, T.F. Smith, K.F. Harrison, D.S. Hubbell, III, B.C. McGinley, J.E. Turner, and J.B. Humphry. 2004. Using orchardgrass and

endophyte-free fescue versus endophyte-infected fescue overseeded on bermudagrass for cow herds: four-year summary of forage characteristics. *J. Anim. Sci.* 82(Suppl. 1):92.

Gunter, S.A., P.A. Beck, K.S. Lusby, C.P. West, and D.S. Hubbell III. 2004. Comparison of three tall fescues containing novel endophytes for stocker cattle weight gain. *In* R.L. Kallenbach, C.F. Rosenkrans, Jr., and T.R. Lock (eds.). Paper #418. Abstracts and Proc. of 5th International Symposium on *Neotyphodium*/Grass Interactions.

Jennings, J.A., C.P. West, A.S. Moubarak, C.R. Rosenkrans, Jr., D.E. Kratz, M.S. Gadberry, and T.R. Troxel. 2004. Endophyte Status of Stockpiled Fescue Demonstrations in Arkansas. *In* R.L. Kallenbach, C.F. Rosenkrans, Jr., and T.R. Lock (eds.). Paper # 516. Abstracts and Proc. of 5th International Symposium on *Neotyphodium*/Grass Interactions.

Nihsen, M.E., E.L. Piper, C.P. West, R.J. Crawford, T.M. Denard, Z.B. Johnson, C.A. Roberts, D.A. Spiers, and C.F. Rosenkrans, Jr. 2004. Growth rate and physiology of steers grazing tall fescue inoculated with novel endophytes. *J. Anim. Sci.* 82:878-883.

Reynolds, J.L., R.K. Ogden, K.P. Coffey, W.K. Coblenz, C.V. Maxwell, and K. VanDevender. 2004. In situ digestibility of tall fescue fertilized with different swine manure treatments and harvested on four dates. *J. Anim. Sci.* 82(Suppl. 1):90.

Secks, M.E., M.D. Richardson, C.P. West, and J.B. Murphy. 2004. Carbohydrate profiles of *Neotyphodium coenophialum*. *In* R.L. Kallenbach, C.F. Rosenkrans, Jr., and T.R. Lock (eds.). Paper #214. Abstracts and Proc. of 5th International Symposium on *Neotyphodium*/Grass Interactions.

Secks, M.E., M.D. Richardson, and C.P. West. 2004. Field performance of novel endophyte/tall fescue combinations under water deficit. *In* R.L. Kallenbach, C.F. Rosenkrans, Jr., and T.R. Lock (eds.). Paper # 405. Abstracts and Proc. of 5th International Symposium on *Neotyphodium*/Grass Interactions.

West, C.P., and S.A. Gunter. 2004. Persistence of HiMag tall fescue inoculated with nontoxic endophytes. *In* R.L. Kallenbach, C.F. Rosenkrans, Jr., and T.R. Lock (eds.). *In* R.L. Kallenbach, C.F. Rosenkrans, Jr., and T.R. Lock (eds.). Paper #518. Abstracts and Proc. of 5th International Symposium on *Neotyphodium*/Grass Interactions.

GEORGIA

SERAIEG-8 Report 2004

PROJECT PERSONNEL: Patricia Timper and Joe Bouton USDA-ARS, Tifton, GA and University of Georgia, Athens, GA (now with The Samuel Roberts Noble Foundation, Ardmore, OK)

TITLE: Screening Non-Ergot-Producing Strains of *Neotyphodium coenophialum* for Resistance to the Lesion Nematode

ACCOMPLISHMENTS: The presence of the endemic strain of *Neotyphodium coenophialum* confers resistance to some plant-parasitic nematodes, notably the lesion nematode *Pratylenchus scribneri* and the root-knot nematode *Meloidogyne marylandi* in tall fescue. However, we recently found that the non-ergot-alkaloid producing strain (AR542) in MaxQ tall fescue does not confer resistance to the lesion nematode (resistance to the root-knot nematode was not tested). Because both low mammalian toxicity and nematode resistance are important traits in tall fescue, our objective was to determine whether other non-ergot producing strains of *N. coenophialum* confer resistance to the lesion nematode.

IMPACT: In summary, we have identified three non-ergot producing endophyte strains which confer a high level of resistance to the lesion nematode *P. scribneri*, and two non-ergot strains which confer moderate resistance. We are currently retesting these resistant strains of *N. coenophialum* to confirm their ergot alkaloid status and their ability to suppress reproduction of the lesion nematode.

PUBLICATIONS:

Timper, P. and J.H. Bouton. 2004. Effect of endophyte status and tall fescue cultivar on reproduction of lesion and stubby root nematodes. Proceedings of the 5th International Symposium on *Neotyphodium*/Grass Interactions, R. Kallenbach, C. Rosenkrans, Jr., and T.R. Lock (eds.). University of Arkansas Press #406.

Timper, P., R.N. Gates, and J.H. Bouton. 2005. Reproduction of *Pratylenchus* spp. in tall fescue infected with different strains of the fungal endophyte *Neotyphodium coenophialum*. *Nematology* 7: submitted.

TITLE: Endophyte Survival in Seed Under Field Conditions

PROJECT PERSONNEL: N.S. Hill and J. Andrae, Dept. Crop and Soil Sciences, UGA, Athens

ACCOMPLISHMENTS: Initial viable endophyte content of the seed increased with seed maturity (ie. later harvest dates had higher endophyte infection) (Table 1). Similarly, germination of seed exposed to field conditions increased with seed maturity. Germination and initial endophyte infection levels were similar for MaxQ, Jesup-wild type endophyte, or Kentucky-31 (data not shown). Regardless of when the seed was harvested, seedling plants from all field-exposed seeds had 97% viable endophyte infection.

PUBLICATIONS:

Hill, N.S., J.H. Bouton, E.E. Hiatt, III and B. Kittle. 2004. Seed maturity, germination, and endophyte relationships in tall fescue. *Crop Sci.* (In press)

C.E. Realini, S.K. Duckett, N.S. Hill, C.S. Hoveland, B.G. Lyon, J.R. Sackman and M.H. Gillis. 2004 Effect of endophyte type on carcass traits, meat quality, and fatty acid composition of beef cattle grazing tall fescue. *J. of Anim. Sci.* (In Press)

R. C. Youngblood, N. M. Filipov, B. J. Rude, D. L. Christiansen, R. M. Hopper, P. D. Gerard, N. S. Hill, B. P. Fitzgerald and P. L. Ryan. 2004. Effects of short-term exposure to endophyte-infected tall fescue diets on the plasma catecholamine metabolite (DOPAC) in mares during early gestation. *J. of Animal Sci.* (In Press)

Franzluebers, A.J. and N.S. Hill. 2004. Soil carbon, nitrogen, and ergot alkaloids with short- and long-term exposure to endophyte-infected and -free tall fescue. *SSSA* (In press)

C.A. Roberts, H.R. Benedict, N.S. Hill, R.L. Kallenbach, and G.E. Rottinghaus. 2004. Determination of ergot alkaloid content in tall fescue by near-infrared spectroscopy. *Crop Science* (in press).

TITLE: Fall Herbicide Applications to Replace Toxic Tall Fescue with Novel Endophyte-Infected Cultivars.

PERSONNEL: J.G. Andrae, N.S. Hill, and T. Murphy

ACCOMPLISHMENTS: The traditionally recommended spray-smother-spray method for converting toxic tall fescue pastures to nontoxic cultivars is likely limiting adoption of novel endophyte-infected cultivars. A three year study is currently underway to determine the effectiveness of various fall application intervals of glyphosate (2,4 and 6 weeks) versus a single application or the traditional spray-smother-spray method. Year 1 data indicate that mowing to prevent seed production coupled with two fall glyphosate applications applied 6 weeks apart results in similar toxic tall fescue “escapes” as the spray-smother-spray method. However, excessive residue from pearl millet in the spray smother spray treatment resulted in significantly lower seedling row occupancy and forage yield during the spring following establishment. Ergot alkaloid concentrations of these plots will be monitored over the next several years to determine long-term stability of toxic and MaxQ mixtures. Year two herbicide applications and planting are complete.

IMPACT: If multiple fall herbicide applications effectively eradicate toxic tall fescue, the adoption of novel endophyte-infected tall fescue should improve. The ability to graze spring and summer tall fescue production during the replacement year decreases costs and increases flexibility by allowing producers to defer replacement decisions until fall months when they can evaluate if weather and hay stores are favorable.

PUBLICATIONS:

Andrae, J.G. 2004. Replacing endophyte-infected tall fescue stands. Vol 13. American Forage and Grassland Council Proceedings. Roanoke, VA. Pg 131-137.

Barker, David J., Nicholas S. Hill, and John G. Andrae. 2003 Measuring endophyte in tall fescue- plants, fields and farms. Chapter VI Tall Fescue Information System. *In review*.

Lacy, Curt, John D. Anderson, and John Andrae. 2003. "Economic analysis of replacing wild-type endophyte infected tall fescue with novel endophyte-infected tall fescue." Selected paper prepared for presentation at Southern Agricultural Economics Association Annual Meeting, Mobile AL, February 1-5 2003. Posted at <http://www.agecon.lib.umn.edu/>. 17 pgs.

Roberts, C. and J. Andrae. 2004. Chapter 18: Public Education on Tall Fescue Toxicosis. In: Neotyphodium/Grass Interactions. *In press*.

Roberts, C.A., and J.G. Andrae. 2004. Tall Fescue Toxicosis and Management. Crop Management doi:10.1094/CM-2004-0427-01-MG. *Online*. Posted at: <http://www.plantmanagementnetwork.org/sub/cm/management/2004/toxicosis/Roberts.pdf>

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January 1, 2004- December 31, 2004

Contributing Station: USDA-ARS, Watkinsville GA

PROJECT PERSONNEL: Alan Franzluebbbers, John Stuedemann, Nick Hill

TITLE: Seasonal distribution of stocking rate and heifer performance in response to three tall fescue-endophyte associations (E-free, endophyte-free; E-MaxQ, nonergot-alkaloid producing endophyte; E-wild, wild-type endophyte).

ACCOMPLISHMENTS: Tall fescue-endophyte association seasonally affected cattle performance and stocking rate. During the first 2.5 years of exposure, heifer performance was greater with nonergot-alkaloid producing endophyte than with wild-type endophyte during all four season, but less dramatically in summer. Heifers grazing all three different tall fescue-endophyte associations performed relatively poorly in summer. Since our objective was to equalize forage availability among all treatments at any one point in time, stocking rate was allowed to fluctuate throughout the year. Stocking rate on wild-type endophyte was greater throughout the year compared with nonergot-alkaloid producing endophyte.

IMPACT: Depending upon a producer's management options available, this research shows (1) that the negative effect of wild-type endophyte on cattle performance can be avoided with establishment of nonergot-alkaloid producing endophyte and (2) that the negative effect of wild-type endophyte on cattle production can be partly overcome with higher stocking rate, especially during spring and summer seasons.

PUBLICATIONS:

Stuedemann JA, Seman DH. 2004. Integrating genetics, environment, and management to minimize animal toxicoses. In: Roberts CA, Spiers DA (Editors), *Neotyphodium* in Cool-Season Grasses, ASA Monogr. (in press).

Franzluebbers AJ, Hill NS, Jenkins MB, Zuberer DA, Humayoun SB, Stuedemann JA. 2004. How does soil respond to wild-type endophyte infection? Paper #310. Proc. 5th Int. Symp. Neotyphodium/Grass Interaction, 23-26 May 2004, Fayetteville AR.

Stuedemann JA, Seman DH. 2004. Integrating genetics, environment, and management to minimize animal toxicoses. Proc. 5th Int. Symp. Neotyphodium/Grass Interaction, 23-26 May 2004, Fayetteville AR.

ILLINOIS

2004 SERAIEG Report

Contributing Station: Southern Illinois University Carbondale, Department of Animal Science, Food and Nutrition, MC 4417, Carbondale, IL

PROJECT PERSONNEL: K.L. Jones, S.S. King, C.R. McCleary

TITLE: Bulls Fed Wild-Type Endophytic Fescue Have Impaired Semen Quality

ACCOMPLISHMENTS: The authors documented potential detrimental effects to bull reproduction after consuming wild-type fescue.

IMPACTS: Bull reproductive performance may be disrupted after ingesting toxic fescue.

PUBLICATIONS:

Jones, K.L., C.R. McCleary, S.S. King, G.A. Apgar, K.E. Griswold. 2004. Consumption of toxic fescue impairs bull reproductive parameters. Prof Anim Sci. 20:1-6.

KENTUCKY

Annual Progress Report
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January 1 2004-December 31 2004

University of Kentucky
Kentucky Agricultural Experiment Station
Kentucky Cooperative Extension Service
Tall Fescue Grassland Diversity (SIPM)

PROJECT PERSONNEL: C. T. Dougherty (cdougher@uky.edu), Chengjun Huo, and James Roberts. Department of Agronomy, University of Kentucky, Lexington.

ACCOMPLISHMENTS: The use of fungicides to suppress endophytes and toxicant synthesis in established tall fescue pastures shows promise but needs more research on fungicide formulations and rates and times of application.

TITLE: Ergovaline + Ergovalinine and Tall fescue Content of Central Kentucky Horse Pastures

PROJECT PERSONNEL: P. W. Long (pwlong@uky.edu), J. C. Henning, and L. P. Bush
Department of Agronomy, University of Kentucky, Lexington

ACCOMPLISHMENTS: E+E in herbage samples from tall fescue plants and from multispecies pastures increased from near zero in late April, peaked in mid May followed by secondary peak in late June. In herbage from pastures with less than 20% tall fescue, the E+E exceeded 0.3 ppm, an accepted threshold for animal response. Environment (precipitation and temperature) and farm management practices play a role in E+E levels and tall fescue content of pastures

PUBLICATIONS:

Long, W., J. C. Henning, B. Coleman, L. Lawrence, C. Peterson, and A. Reinowski. 2002. Overview of the mare reproductive loss syndrome monitoring program for 2002. in Proc. First Workshop on Mare Reproductive Loss Syndrome, 2003; 102-112. Univ Kentucky, AES, SR-2003-1

Schultz, C. and L. P. Bush. 2002. The potential role of ergot alkaloids in mare reproductive loss syndrome. in Proc. First Workshop on Mare Reproductive Loss Syndrome, 2003; 60-63 Univ Kentucky, AES, SR-2003-1

TITLE: Tall Fescue Breeding and Cultivar Development

PROJECT PERSONNEL: Timothy D. Phillips (tphillip@uky.edu)
Department of Agronomy University of Kentucky, Lexington

TITLE: Effects of Ingestion of Endophyte-infected Tall Fescue Seed on Serum, Fecal and Urine levels of Ergovaline and Lysergic Acid in Mature Geldings

PROJECT PERSONNEL: C. L. Schultz, S. L. Lodge-Ivey, A. M. Craig, J. R. Strickland, and L. P. Bush (lpbush@uky.edu) University of Kentucky, Oregon State University and USDA/ARS/FAPRU, Lexington, KY 40546

TITLE: Ergot alkaloid and loline alkaloid biosynthesis genes

PROJECT PERSONNEL: Christopher L. Schardl. This work was conducted in collaboration with Robert B. Grossman (Department of Chemistry, University of Kentucky), Lowell P. Bush, Timothy D. Phillips (Department of Agronomy, University of Kentucky), and Daniel G. Panaccione (Plant and Soil Science Department, West Virginia University).

MISSISSIPPI

Annual Progress Report
SERAIEG 8 2004

PROJECT PERSONNEL: D.J. Lang¹, S.P. Wang², A. Tokilita¹, R. Given¹, M. Salem¹ and R. Elmore¹ ¹*Dept. of Plant and Soil Sciences, Mississippi State University, Mississippi, MS 39762-9555* ²*Laboratory of Quantitative Vegetation Ecology, Institute of Botany, Chinese Academy of Sciences, Beijing, 100093, China. Email: dlang@pss.MsState.edu*

TITLE: Persistence of tall fescue and cattle grazing preference as affected by endophyte status

ACCOMPLISHMENTS: Stand persistence of novel non-toxic endophyte infected tall fescue was similar to toxic E+ tall fescue. Cattle preferred to graze E- tall fescue plots indicating that they could detect and avoid grazing tall fescue that was toxic E+ infected while their preference for NE+ tall fescue was generally intermediate.

IMPACT: Novel, non ergot alkaloid producing endophyte infected tall fescue has persisted as well as toxic endophyte tall fescue. Animals prefer to consume endophyte free tall fescue compared with toxic endophyte infected tall fescue.

PUBLICATIONS: Submitted to XX International Grassland Congress, Dublin, Ireland

TITLE: Steer Grazing of Novel and Infected Fescues for Post-Weaning Gain on Heavy Clay Soils

PROJECT PERSONEL: T.F. Best and R.R. Evans Prairie Research Unit

TITLE: A Novel Approach to Alleviate Ergot Alkaloid Toxicosis in Mares Consuming Endophyte-infected Tall Fescue

PROJECT PERSONEL: P. L. Ryan^{1,2} A. I. Orr¹, B. J. Rude¹, D. L. Christiansen² R. M. Hopper², N. M. Filipov², N. S. Hill³, B. P. Fitzgerald⁴. ¹Department of Animal and Dairy Sciences and College of Veterinary Medicine², Mississippi State University, MS, ³Department of Crop and Soil Sciences, University of Georgia, Athens, GA, ⁴Gluck Equine Research Center, University of Kentucky, Lexington, KY

TITLE: Animal and Forage Responses on Novel Endophyte Fescue Compared to Ryegrass Pastures

CONTRIBUTING STATION: Central Mississippi Research and Extension Center, Brown Loam Branch Experiment Station, Raymond, MS 39154

PROJECT PERSONNEL: B. Macoon, R.C. Vann, and J.D. Perkins III.

PROGRESS OF WORK:

ACCOMPLISHMENTS: The results from this 3-yr study suggest that animal performance on tall fescue pastures, though less than ryegrass, appear to be acceptable for sustainable animal production in an area south of the traditional tall fescue zone of adaptation. The success of tall fescue in pasture-based cattle production this region, however, will depend on its persistence in pastures.

IMPACT: Based on the results from this study, a future study is currently being established to examine the potential of novel endophyte tall fescue in year-round pasture systems with bermudagrass [*Cynodon dactylon* (L.) Pers.] as the summer forage. Within that study, grazing management to evaluate various levels of grazing intensity will be done. Also, in another study planned for this winter will evaluate supplementation management vs. sole pasture of tall fescue. Further, advanced breeding lines of tall fescue infected with novel endophyte will be evaluated in mob grazing studies to determine plant persistence under conditions of harsh grazing.

PUBLICATIONS:

Macoon, B., R.C. Vann, B.J. Boyd, S.E. Howell, and F.T. Withers, Jr. 2002. Forage production and animal performance on non-toxic endophyte tall fescue. *In* Annual Meetings Abstracts [CD-ROM]. ASA, CSSA, SSSA, Madison, WI.

Macoon, B., R.C. Vann, B. Boyd, S. Howell, and F.T. Withers, Jr. 2003. Evaluation of novel-endophyte tall fescue under grazing conditions. *MAFES Information Bull.* 399:34.
Macoon, B., R.C. Vann, B. Boyd, and F.T. Withers, Jr. 2002. Evaluation of novel-endophyte tall fescue under grazing conditions. *MAFES MSU-ES Information Bull.* 387:31.

Macoon, B., R.C. Vann, J.D. Perkins III, and F.T. Withers, Jr. 2004. Steer performance and forage production on novel-endophyte fescue compared to ryegrass pastures. p. 504. *In* R. Kallenbach, C. Rosenkrans, and T. Ryan Lock (eds.). *Proc. 5th Int. Symp. on Neotyphodium/Grass Interactions*. Fayetteville, AR., 23-26 May 2004. University of Arkansas, Fayetteville.

Macoon, B., R.C. Vann, J.D. Perkins III, and F.T. Withers, Jr. 2004. Evaluation of novel-endophyte tall fescue under grazing conditions. *MAFES Information Bull.* 406:37.

MISSOURI

Annual Progress Report
SERAIEG 8
January 1, 2004- December 31, 2004

Contributing Station: University of Missouri

PROJECT PERSONNEL: Don Spiers, Jim Williams, George Rottinghaus, Tim Evans, Peggy Ann Eichen, Laura Wax, Raja Settivari

TITLE: Growth and Core Temperature Responses of Rats to Different Ergovaline Doses Administered During Heat Stress.

TITLE: Contribution of Ergovaline to the Fescue Toxicosis Response in Rats

TITLE: Fescue Toxicosis Affects Reproduction and Thermoregulatory Systems of Male Rats Exposed to Heat Stress

TITLE: Differential Expression of Genes in Rat Liver Due to Fescue Toxicosis at Thermoneutrality

TITLE: Effects of fescue toxicosis on CYP3A4 in rats at thermoneutrality in vivo

TITLE: Dose Response of Whole Seed Administration of Endophyte-Infected Tall Fescue on Heat Stress in Cattle

TITLE: Effectiveness of Ground Endophyte-Infected Tall Fescue Seed in Production of Fescue Toxicosis in Cattle

TITLE: The Influence of Nitrogen Rate and Pasture Composition on the Toxicity, Quality and Yield of Stockpiled Tall Fescue Rob Kallenbach

TITLE: Ergot Alkaloid Concentration as affected by Storage and Preservation
Craig Roberts, Rob Kallenbach, Matt Massie, Nick Hill

TITLE: Ergot Alkaloid Concentration as affected by Hay Moisture and Hay Storage Time
Craig Roberts, Rob Kallenbach, Matt Massie

TITLE: Determination of Ergot Alkaloid Content in Tall Fescue by NIR Spectroscopy
Craig Roberts, Heather Benedict, Nick Hill, Rob Kallenbach, and George Rottinghaus

TITLE: Tall Fescue Toxicosis Management Workshop
Craig Roberts and Richard Crawford

PUBLICATIONS:

Roberts, C.A., H.R. Benedict, N.S Hill, R.L. Kallenbach, and G.E. Rottinghaus. 2005. Determination of ergot alkaloid content in tall fescue by near-infrared spectroscopy. *Crop Sci.* 45:(in press).

Roberts, C.A., and J.A. Andrae. 2004. Tall fescue toxicosis and management. Online. *Crop Managm.* doi. 10:1094/CM-2004-0427-01-MG.

Roberts, C.A., C.P. West, and D.A. Spiers (eds.) 2005. *Neotyphodium* in Cool-Season Grasses. 392 p. Blackwell Publishing Professional, Ames, IA. (in press)

Roberts, C.A., and J.A. Andrae. 2005. Public education in tall fescue toxicosis. p. 359-377. In C.A. Roberts, et al. (eds.) *Neotyphodium* in Cool-Season Grasses. Blackwell Publishing Professional, Ames, IA. (in press)

Wen, L., J.E. Williams, R.L. Kallenbach, C.A. Roberts, P.R. Beuselinck, and R.L. McGraw. 2004. Cattle preferentially select birdsfoot trefoil from mixtures of tall fescue and birdsfoot trefoil. Online. *Forage and Grazinglands* doi:10.1094/FG-2004-0924-01-RS.

Lock, T. R., R.L. Kallenbach, D.G. Blevins, T.M. Reinbott, G.J. Bishop-Hurley, R.J. Crawford, Jr., M.D. Massie, and J.W. Tyler. 2004. Phosphorus fertilization of tall fescue pastures may protect beef cows from hypomagnesaemia and improve gain of nursing calves. Online. *Forage and Grazinglands* doi:10.1094/FG-2004-0608-01-RS.

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NEW ZEALAND

2004 SERAIEG Report

PROJECT PERSONNEL: Syd Easton sydney.easton@agresearch.co.nz

PROJECT TITLE: Endophyte Research at AgResearch, New Zealand in 2004

NOBLE FOUNDATION

Annual Progress Report
SERAIEG 8

January 1, 2004- December 31, 2004

PROJECT PERSONNEL: Andy Hopkins and Joe Bouton, The Noble Foundation, Inc. Ardmore, OK.

PROGRESS OF WORK:

1. Development of non-toxic tall fescue cultivars.
2. Performance of steers grazing various tall fescue – endophyte combinations.

Our objectives are to compare persistence, under moderate grazing, of tall fescue containing novel, wild type, and no endophyte, and to compare weight gain of animals grazing these various tall fescue – endophyte combinations.

ACCOMPLISHMENTS:

1 Evaluation and deployment of novel endophytes in tall fescue. Sufficient seed of the eight tall fescue –endophyte combinations was produced to allow additional grazing tolerance trials to be planted at three locations (Lubbock, Overton, and Iowa Park, Texas) in 2004. Enough seed is on hand so that grazing trials involving steers can be established in fall, 2005.

2. Performance of steers grazing various tall fescue – endophyte combinations.

Data for agronomic and animal performance were collected for a third year. All entries have persisted well at this site, which has a fertile soil with very good moisture holding capacity. Steers gains in spring were greatest for GA-5 MaxQ and Dovey, intermediate for GA-5 E- and GA-5 E+, and least for KY-31 E+. Weight gain did not differ in fall. Body temperatures followed similar patterns, with steers on KY-31 E+ having elevated temperatures in spring. Available forage differed only slightly in spring. Endophyte type and infection levels did not shift over time, with all entries having greater than 80% stands at the conclusion of the study. Thus, tall fescue can persist in the Southern Plains, under moderate grazing pressure, on soils with very good moisture holding capacity

NORTH DAKOTA

PROJECT PERSONEL: N.W. Shappell and D.J. Smith Biosciences Research Laboratory, USDA-ARS, Fargo ND 58102 shappeln@fargo.ars.usda.gov

ACCOMPLISHMENTS: No further research on ergopeptides was completed during the October 2003 to October 2004 period.

PUBLICATIONS:

N.W. Shappell and D.J. Smith. Ergovaline transport across human gastrointestinal cells (Caco-2). J. Animal Science Vol. 82, Suppl.1, p. 181,T71.

N.W. Shappell and L.O. Billey. Assessment of Tasco and YCWP on Ergovaline Toxicity in Caco-2 Cells. J. Animal Science Vol. 82, Suppl.1, p. 181,T72.

OHIO

SERAIEG-8 2004 Report

Contributing station: Ohio State University (OSU), Ohio Agricultural Research and Development Center (OARDC)

PROJECT PERSONNEL: Dr David Barker (Hort & Crop Sci), Dr Landon Rhodes (Plant Pathology), Dr Mark Sulc (Hort & Crop Sci), John McCormick (Hort & Crop Sci), Kristin Mack (HCS, graduate student), Caroline Brown (undergrad. hons., Univ. Melb.)

TITLE: *Population Stability in Endophyte-Free Novel-Endophyte Tall Fescue Pastures (completed)*

ACCOMPLISHMENTS: We found that observed endophyte levels for E- at Jackson were 77, 118, and 143% greater than expected in autumn 2001, spring 2002 and autumn 2002, respectively. Observed endophyte levels for E- at Belle Valley were 32, 70, and 39% greater than expected in autumn 2001, spring 2002 and autumn 2002, respectively. Observed endophyte levels in Nontoxic-E at all sites were consistent with the endophyte levels in the seed that was planted, and plants had a negligible concentration of toxic alkaloids. We concluded that, where mechanisms for contamination exist, E- tall fescue stands can be readily contaminated by wild tall fescue and its toxic endophyte. Also, Nontoxic-E tall fescue appears less susceptible to contamination by wild tall fescue.

TITLE: *Occurrence and Control of the Fescue and Ryegrass Toxicosis Endophytes in Ohio Dairy Pastures (in progress)*

TITLE: *Financial Implications of Non-toxic Endophyte-infected Fescue Pasture: Establishment Costs and Livestock Returns (in progress)*

TITLE: *The effect of spatial variation in endophyte distribution on the grazing pattern of cattle (in progress)*

IMPACTS: presentations to 8 industry meetings in north-east USA (OH, PA) in which results from endophyte studies were presented (total audience 520)
presentations at 5 pasture walks in Ohio 1 Oct 2003 – 1 Oct 2004 in which results from endophyte studies were presented (total audience 350); 4 articles in farming journals and websites; 6 research publications; 5 demonstration sites throughout Ohio planted by Pennington Seeds.

PUBLICATIONS:

Barker, D. J., R. M. Sulc, T. L. Bultemeier, J. McCormick, R. Little, C. D. Penrose, D. Samples. 2004. Contrasting toxic-endophyte contamination between endophyte-free and nontoxic-endophyte tall fescue pastures. Crop Science (accepted)

Barker, D.J., L. Rhodes, M. Burgess, R. Lewandowski, T. Noyes, D. Slates. 2004. Factors affecting the occurrence of endophyte in perennial ryegrass and tall fescue in Ohio dairy pastures. Proceedings of the American Forage and Grasslands Congress 13: 505.

Hume D.E. and Barker D.J. 2005. Growth and Management of Endophytic Grasses in Pastoral Agriculture. p. 199-225. *In* C.A. Roberts, C.P. West, and D.E. Spiers (eds.) *Neotyphodium* in cool-season grasses. Blackwell Publishing, Ames, IA. Proceedings of the Fifth International Symposium on Neotyphodium/Grass Interactions, Fayetteville, Arkansas, USA. 23-26 May 2004.

Barker, D.J., N.S. Hill, and J.G. Andrae. 2004. Measuring endophyte in tall fescue - plants, fields and farms. Chapter 6 in the online e-book "Tall Fescue Information System" <http://forages.oregonstate.edu/is/tfis/>

Barker, D.J., Penrose, C.; Sulc, R.M.; Little, R.; Samples, D. 2003. Persistence of non-toxic endophyte fescue in S.E. Ohio. Proceedings of the National Assoc of County Ag Agents (NACAA) 88:38-39.

Sulc, R.M., McCormick, J.S., Rhodes, L.H., Barker, D.J., Hammond, R.B. 2003. Ohio Forage Performance Trials 2003.

OREGON

SERAIEG-8 2004 Report

CONTRIBUTING STATION – Oregon State University

PROJECT PERSONNEL – Drs. A. Morrie Craig, Linda L. Blythe

ACCOMPLISHMENTS: Several research projects further defined the digestive kinetics of tall fescue and perennial ryegrass endophyte alkaloids. Several feeding studies examined the ruminal digestion kinetics of ergovaline and lysergic acid in sheep and cattle. In two trials, sheep and beef steers were fed differing levels of E+ tall fescue. The possible effects of endophyte-infected fescue straw on rumen kinetics were studied as well as the potential role of rumen microbes in the metabolism of ergovaline, lysergic acid, and lolines. Animals on E+ diets showed depressed blood prolactin levels. The appearance of lysergic acid in the feces implies that ergot alkaloids in the feed were degraded to lysergic acid by rumen microbial digestion and degradation in the lower gastrointestinal tract. From this research an HPLC assay for lysergic acid was developed. The results of the sheep project were published in the 2004 Proceedings of the Western resectional, American Society of Animal Science (DeLorme M et al., Vol 55:393-396). Further results from the project will be published and manuscripts describing the results of the other studies and assay development are in process.

PUBLICATIONS:

Blythe L, Craig AM, Pielstick L. Outbreak of fescue foot in Eastern Oregon cattle: A case study. Proceedings of the 11th International Symposium of the World Association of Veterinary Laboratory Diagnosticians, Bangkok, Thailand. November 9-13, 2003.

Lehner AF, Craig AM, Blythe LL, Tobin T. Fescue toxicosis originating from minor peptide alkaloids. Proceedings of the 11th International Symposium of the World Association of Veterinary Laboratory Diagnosticians, Bangkok, Thailand. November 9-13, 2003.

Aldrich-Markham S, Pirelli G, Craig AM. Endophyte Toxins in Grass Seed Fields and Straw Effects on Livestock. Extension Communication EM 8598. Oregon State University Extension Service. August 2003.

Fisher MJ, Bohnert DW, Ackerman CJ, Schauer CS, DelCurto T, Craig AM, Vanzant ES, Harmon DL, Schrick FN. Evaluation of Perennial Ryegrass Straw as a Forage Source for Ruminants. Journal of Animal Science. 2004; 82:2175-2184.

Hermes JC, Nakaue HS, Craig AM, The Effect of Feeding Endophyte-Infected Feed and Bedding on the Performance of Broilers. Journal of Applied Poultry Research. 2004; 13:71-76.

DeLorme M, Lodge-Ivey SL, Craig AM. Effects of feeding *Neotyphodium coenophialum*-infected tall fescue straw on lamb performance. Proceedings of the Western Sectional, American Society of Animal Science Vol 45:393-396 and Poster. Corvallis, OR. June 16-18, 2004.

TENNESSEE

SERAIEG-8 2004 Report

TITLE: Performance and semen parameters of yearling beef bulls and growth of steers grazing different tall fescue cultivars

PROJECT PERSONEL: G. M. Schuenemann¹, J. C. Waller¹, F. N. Schrick¹, F. M. Hopkins¹, J. C. Riggins², W. D. Pitt², H. A. Fribourg³, G. E. Bates³, G.M. Pighetti¹, J. L. Edwards¹, J. W. Oliver⁴, K. D. Gwinn⁵, and B. D. Sims² ¹Animal Science Department, ²Highland Rim Experiment Station, ³Plant Sciences Department, ⁴Comparative Medicine Department, and ⁵Entomology and Plant Pathology Department

TITLE: Influence of tall fescue pastures differing in endophyte status on rumen parameters and in situ degradation of selected substrates

PROJECT PERSONEL: A. M. Corrigan¹, J. C. Waller¹, A. M. Saxton¹, L. C. Miller¹,

K. D. Gwinn², and C. J. Richards¹ ¹ Animal Science Department, and ²Entomology and Plant Pathology Department

TITLE: Effects of purified fiber energy supplementation on total tract disappearance and nitrogen retention of sheep fed E+ tall fescue hay

PROJECT PERSONEL: C. J. Richards and H. M. Blalock Animal Science Department

TITLE: Animal performance and forage productivity from cool-season forages with and without clovers at Ames Plantation

PROJECT PERSONEL: J. C. Waller¹, F. N. Schrick¹, G. E. Bates², M. C. Dixon³, M. C. Smith³, K. D. Gwinn⁴, and R. J. Carlisle³ ¹Animal Science Department, ²Plant Sciences Department, ³Ames Plantation, and ⁴Entomology and Plant Pathology Department

TITLE: Steer performance and forage productivity from tall fescue pastures with different endophyte/fescue combinations, with and without at Knoxville

PROJECT PERSONEL: J. C. Waller¹, J. W. Oliver², F. N. Schrick¹, G. E. Bates³, D. Rose⁴, B. McKee⁴, M. A. Mueller³, K. D. Gwinn⁵, and R. B. Simpson⁴ ¹Animal Science Department, ²Comparative Medicine Department, ³Plant Sciences Department, ⁴Knoxville Experiment Station, and ⁵Entomology and Plant Pathology Department

TITLE: Forage systems for stocker cattle

PROJECT PERSONEL: J. C. Waller¹, G. E. Bates², C. J. Richards¹, J. C. Riggins³, K. D. Gwinn⁴ ¹Animal Science Department, ²Plant Sciences Department, ³Highland Rim Experiment Station, and ⁴Entomology and Plant Pathology Department

TITLE: Evaluation under grazing of tall fescue cultivars infected with different endophytes at Grand Junction, Springfield, and Knoxville

PROJECT PERSONEL: J. C. Waller¹, H. A. Fribourg², and G. E. Bates²
¹Animal Science Department and ²Plant Sciences Department

PUBLICATIONS

Blalock, H.M., and C.J. Richards. 2004. Effects of purified fiber energy supplementation on digestion and ruminal parameters of steers fed cool season grass hay. *J. Anim. Sci.* 82(Suppl. 1):293.

Baublits, R.T., J. Brown, F.W. Pohlman, Z.B. Johnson, D.O. Onks, H.D. Loveday, R.E. Morrow, B.A. Sandelin, W.K. Coblenz, C.J. Richards, and R.B. Pugh. 2004. Carcass and beef color characteristics of three biological types of cattle grazing cool-season forages supplemented with soyhulls. *Meat Science* 68:297-303.

Bates, G. 2004. Novel endophytes in tall fescue. *In* K. Cassida (ed.) Proc. Amer. Forage and Grass. Council. Roanoke, VA. 12-16 June. pp. 120-124.

Bates, G. 2004. Novel endophytes in tall fescue. *In* Proc. UT Beef and Forage Field Day. Knoxville, TN 10 June. pp. 2-6.

Briggs, L.A., J.C. Waller, H.M. Blalock, and C.J. Richards. 2004. Evaluation of tall fescue, soybean hulls and ionophores in vitro. *J. Anim. Sci.* 82(Suppl. 1):38.

Corrigan, A.M., J.C. Waller, A.M. Saxton, L.C. Miller, and C.J. Richards. 2004. Rumen parameters of cattle grazing tall fescue pastures differing in endophyte status. *J. Anim. Sci.* 82(Suppl. 1):91.

Fisher, A.E., W.W. Gill, C.D. Lane, Jr., D.K. Joines, J.B. Neel and C.J. Richards. 2003. Two-year mineral survey reveals deficiencies and imbalances in Tennessee tall fescue. *Prof. Anim. Sci.* 19:286-289.

Fribourg, Henry A. and John C. Waller. 2004. *Neotyphodium* Research and Application in the USA. *In*: West, C., Spiers, D. and Roberts, C. (Eds). *Neotyphodium in Cool-Season Grasses, Current Research & Applications*. Iowa State Press, Ames, Iowa. (In press).

Oliver, Jack W. 2004. Pathophysiologic response to endophyte toxins. *In*: West, C., Spiers, D. and Roberts, C. (Eds). *Neotyphodium in Cool-Season Grasses, Current Research & Applications*. Iowa State Press, Ames, Iowa. (In press).

Oliver, Jack W. and Lester Fletcher. 2004. Animal disorders and their physiological basis. Tall Fescue Information System. <http://forages.orst.edu/is/tfis/> David Hannaway and Associates, Oregon State University. (In press).

Richards, C.J., J.C. Waller, W.W. Gill, A.E. Fisher, C.D. Lane, and J.B. Neel. 2004. Mineral Imbalances in Tennessee Tall Fescue. *In*: 5th International Symposium on Neotyphodium/Grass Interactions. (R. Kallenbach, C. Rosenkrans, Jr., and T. Ryan Lock Eds.). May 23-26 Fayetteville, AR. pp 148-150.

Schuenemann, Gustavo Martin, 2004 Performance and fertility of yearling bulls grazing endophyte-infected tall fescue pastures. M.S. Thesis. University of Tennessee, Knoxville.

Schuenemann, G. M., J. L. Edwards, M.D. Davis, H.E. Blackmon, F.N. Scenna, N.R. Rohrbach, A.M. Saxton, H.S. Adair, F.M. Hopkins, J.C. Waller, and F.N. Schrick. 2004. Effects of administration of ergotamine tartrate on fertility of yearling beef bulls. *Theriogenology*, (Available online 17 Sep 2004; <http://www.sciencedirect.com/science>).

Schuenemann, G.M., J.L. Edwards, J.L. Lawrence, R.R. Payton, F.N. Scenna, J.C. Waller, J.W. Oliver, and F.N. Schrick. 2004. Developmental competence of oocytes

fertilized *in vitro* with semen from bulls grazing tall fescue pastures. J. Anim. Sci. 82(Suppl. 1):101.

Schuenemann, G.M., J.C. Waller, F.M. Hopkins, H.S. Adair, N.R. Rohrbach, F. N. Scenna, D.I. Bryant, A.M. Saxton, J.W. Oliver, J.C. Riggins, and F.N. Schrick. 2004. Performance and semen quality of yearling bulls grazing tall fescue pastures. J. Anim. Sci. 82(Suppl. 1):299.

Seals, R.C., G.M. Schuenemann, J.W. Lemaster, A.M. Saxton, J.C. Waller and F.N. Schrick. 2005. Follicular dynamics in beef heifers consuming ergotamine tartrate as a model of endophyte-infected tall fescue consumption. J. Anim. Vet. Adv. 4 (1): 97-102.

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