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***Mississippi Program***

**South Texas Natives and Texas Native Seeds Projects**

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***Introduction***

*South Texas Natives* (STN) and *Texas Native Seeds* (TNS) are collaborative projects with an overall objective to increase the availability of native seeds for use in restoration and reclamation activities in south, central, and west Texas. STN began in 2001 at the request of private landowners in response to concerns about the use of introduced plants in restoration and reclamation activities in South Texas. TNS began in 2010 at the request of private landowners and the Texas Department of Transportation (TxDOT) to meet native seed supply needs in central and west Texas. Both STN and TNS are headquartered at the Caesar Kleberg Wildlife Research Institute at Texas A&M University-Kingsville. Collaborators include the USDA NRCS Plant Materials Centers in Kingsville and Knox City; Texas AgriLife Research Stations in Beeville, Stephenville, and Uvalde; Tarleton State University; Sul Ross State University; TxDOT; and numerous private landowners. Our primary goal is to collect, evaluate, increase, and commercialize regionally adapted native plant germplasm selections that can be successfully used in restoration and reclamation activities in south, central, and west Texas.

### *Need for STN and TNS*

Land management goals in Texas have changed dramatically in the last 2 decades. These changes are influenced in part by research results indicating lower wildlife habitat value of introduced grass monocultures than native habitats, as well as by changing land use and resulting real estate values for range and pasture land. Throughout much of Texas, primary land management goals are shifting from primarily livestock based toward efforts aimed at benefiting recreational opportunities associated with wildlife and natural ecosystems and enhancing economic value associated with fee and lease hunting of game species. Severe drought conditions of the past few years have accelerated this change in primary land use and management. In many areas of the state over the past 3 years, range and pasture conditions have necessitated a significant reduction in livestock numbers, or in some cases, complete livestock deferral. While drought conditions have clearly altered livestock production across the state, they have had less impact on hunting lease values or rural land prices, clear indications of the present drivers of land value.

As a result in the shift in land management goals, and since native plant dominated landscapes are near-universally accepted as being the superior habitat for native wildlife, the intentional planting of introduced forage grasses is no longer practiced by many private landowners. Unintended negative consequences such as uncontrollable spread and development of persistent botanical monocultures of some introduced forages, particularly Old World bluestem grasses (*Bothriochloa* and *Dichanthium* spp.), have resulted in some landowners developing strong avoidance of the use of introduced plant species. Research indicates that concerns over use of these plants, particularly in terms of potential negative implications to wildlife habitat value in general and biodiversity, are well warranted.

Furthermore, this change amongst private landowners has gradually influenced policy of government agencies away from the use of introduced plants, and toward the use of native plants in their management activities. A clear example is the changes TxDOT has made regarding seeding specifications for reclamation projects along highway right of ways in south Texas. Instead of using seed mixes for erosion control comprised primarily of introduced grasses (as was common and quite effective from an erosion control standpoint throughout the state for most of the last century), today the agency specifies 100% native seed mixes for use in most of the region. Even in regions where native seeds are not readily available, TxDOT completely avoids use of problematic introduced species such as Old World bluestem grasses, and has for over a decade.

Today, in most of Texas, land disturbance activities requiring reseeding, and particularly those associated with energy exploration and transportation infrastructure development, are occurring at an accelerated pace and scope. In regions outside of south Texas, adequate stocks of adapted native seeds are not commercially available, despite the apparent demand. In addition, available seeds are cost-prohibitive for use by many consumers, or on large projects. In other circumstances, available native seeds are of inherently low quality (e.g. sources harvested from untested parentage or wild stands), are of unknown origin, or lack traits necessary for successful use in restoration and reclamation settings. As a result, success of native seeding efforts has historically been poor. Thus, the intent of STN and TNS is to collect, select, and increase

regionally adapted (ecotypic) native seed sources for certified commercial seed production and large scale availability to consumers at reasonable costs.

### ***Methods***

The initial phase of our seed source development program is to obtain a broad collection of populations of each native species of interest in order to ascertain the variability and adaptability of the species, and identify populations with needed traits for commercial production and restoration use. We try to obtain 2 seed collections from wild populations of each plant from each county of our region(s) of interest. In support of this goal, we have obtained almost 3,000 native plant seed collections from across Texas since 2001. Following collection, we establish evaluation plantings at a minimum of 2 locations within the area of intended use of the plant. Each collection is evaluated for 2-5 years for natural adaptations that influence successful use in restoration and reclamation settings, and for natural adaptations that would make successful commercial seed production possible.

After evaluating the germplasm collection, we select populations for release to commercial seed growers and increase the seed of promising collections in isolation to maintain the genetic integrity of each selected native population. Depending on market needs for a species, and evaluated potential of the material, we make multi-origin/population/species blends, or single collection releases of various native plants. Our goal is not to create novel material by breeding or intentional genetic manipulation; instead we seek to identify and increase populations that have the natural adaptations for successful use in restoration and reclamation plantings. The final product delivered to consumers is in most cases not different than the original wild population that the seed was collected from, other than it may have higher seed quality as a result of being produced under intense agronomic conditions, or that it may be a blend of several populations of the plant that possess adaptations that should benefit successful use in restoration and reclamation plantings.

Following increase, we distribute seed to commercial producers and provide technical assistance to insure successful production of the release. Throughout the development process we conduct numerous field trials to evaluate selections in common restoration and reclamation settings. These plantings are also used to develop planting methodology for each seed source and demonstrate successful uses to potential consumers.

### ***Results***

To date, the collaborative STN Project has released or helped commercialize 21 Texas Selected Native Plant Germplasm seed sources. Currently, these seed sources represent the only Texas Department of Agriculture-certified native seeds available to Texas consumers. Eighteen of these selections have been sold commercially by cooperating seed companies. We have negotiated production licenses to stimulate grower investment into production of 7 of these releases. In 2012, the amount of certified commercial seed of releases developed by STN sold to consumers was sufficient for 25,000 acres of restoration and reclamation seedings in the south Texas region. By the end of 2013, commercial production capacity of STN releases should provide seed for over 50,000 acres of native seedings in the region. Retail price for these seeds

is currently the median of the range/reclamation seed market in Texas, with cost typically ranging from \$75-100 per acre. Both STN and TNS are currently evaluating a number of additional native species for future release and commercialization. We have plans to make 9 additional native seed source releases for the south Texas region over the next 5 years, and hope to make as many as 20 native seed germplasm releases for both central and west Texas over the next decade.

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## **USDA NRCS East Texas Plant Materials Center, Seeking Conservation Solutions Through the use of Native Plants**

Alan Shadow

East Texas Plant Material Center

### **Who We Are and What We Do**

The East Texas Plant Materials Center (ETPMC) is one of 27 centers operated by the Natural Resources Conservation Service (NRCS), United States Department of Agriculture. The ETPMC services 42 million acres and covers portions of Texas, Louisiana, Arkansas, and Oklahoma. The center was established in 1982 and is a joint venture between Soil and Water Conservation Districts in east Texas and northwestern Louisiana, NRCS, Stephen F. Austin State University (SFASU), and US Forest Service. The ETPMC encompasses 75 acres of research and production fields, and is located in the Stephen F. Austin Experimental Forest, south of Nacogdoches, Texas.

The mission of the NRCS Plant Materials Program is to develop and transfer effective plant technology for the conservation of natural resources. In working with a broad range of plant species, including grasses, forbs, trees, and shrubs, the program seeks to address priority needs of NRCS field offices and land managers in both public and private sectors. Emphasis is focused on using native plants to solve conservation problems and to protect and restore ecosystems. Center personnel develop research projects and technical reports for use in developing technical guides for agency personnel and landowners on the use of plant materials in various conservation practices. The ETPMC's area of emphasis includes, but is not limited to:

- Enhancement of water quality through the protection of riparian and wetland areas
- Restoration of degraded pasture, range, and timber lands
- Restoration of surface-mined sites
- Wildlife habitat improvement
- Restoration of saline sites associated with the oil and gas industry
- Improvement of air quality as related to poultry and other livestock industries

### **Current Work**

- Development of rust resistant Indiangrass (*Sorghastrum nutans*) release
- Native Warm Season Grass Release Evaluation
- Adaptation of commercial wildflower mixes for pollinator habitat
- Enhancement of longleaf pine planting
- Evaluation of cover crops and their effects on soil health
- Seed increases of selected material

- *Liatris pycnostachya*, *Tridens strictus*, *Helianthus mollis*, *Schizachyrium scoparium*
- Germination and propagation of endangered species
  - *Hibiscus dasycalyx*, *Leavenworthia texana*, and *Physaria pallida*
- Cooperative studies with ARS and local universities
  - Perennial, warm season grass evaluation for biofuels (ARS)
  - Cold tolerance and adaptation of potential releases from the Kika de la Garza PMC in Kingsville, Texas
  - Simulated silvopasture shading effects on native and introduced forage grasses (SFASU)
  - Identification and quantification of species in seed bank of coastal wetlands (SFASU)
  - Identification of fungal pathogens affecting Indiangrass (*Sorghastum nutans*) (SFASU)
  - Response of native and introduced cool season grasses to endophytes (Rice University)
  - Response of native shrubs and trees used in shelter belts around poultry production facilities (SFASU)

### **New Plant Releases for 2012-2013**

‘**Nacogdoches**’ eastern gamagrass (*Tripsacum dactyloides*) was released as a cultivar in 2012. It will replace ‘Medina’ and ‘Jackson’ eastern gamagrass within the ETPMC service area. ‘Nacogdoches’ showed superior seed production when compared to ‘Jackson’ and ‘Medina’, with no loss in forage production or quality. Studies also showed it to be more disease resistant.

**Cajun Sunrise Germplasm** ashy sunflower (*Helianthus mollis*) was released cooperatively with the Golden Meadow Plant Materials Center and the Louisiana Native Plant Initiative. It has specific use for pollinator and wildlife habitat improvement and increased diversity in conservation plantings.

### **Current Collection Requests**

The ETPMC is currently requesting collections of the following species. Please see the web link for details: [http://www.tx.nrcs.usda.gov/technical/pmc/plant\\_collection\\_11.html](http://www.tx.nrcs.usda.gov/technical/pmc/plant_collection_11.html)

<i>Andropogon gerardii</i>	<i>Desmodium</i> sp.	<i>Ratibida columnifera</i>
<i>Polygonum pennsylvanicum</i>	<i>Helianthus angustifolia</i>	<i>Echinochloa walteri</i>

### **Website and Publications**

The ETPMC produced 17 new technical documents and newsletters during FY 2012. These documents include updated release brochures for all ETPMC plant releases, Technical Notes, Plant Guides, and Plant Fact Sheets. For a complete list of publications past and present, please see:

Proceedings 68<sup>th</sup> Southern Pastures and Forage Crop Improvement Conference

<http://plant-materials.nrcs.usda.gov/etpmc/publications.html>

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*Forage Breeding/Utilization*

**Summer Dormant Tall Fescue Breeding at the Noble Foundation**

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The introduction of improved perennial cool-season grasses, especially tall fescue, to the southern Great Plains has been a major goal of the Noble Foundations grass-breeding program. The harsh dry summers experienced over the last few years have demonstrated the value of summer dormant (Mediterranean) tall fescue in our region. Summer dormant germplasm survived with minimal stand loss, while stands of summer active (Continental) germplasm were severely reduced or completely lost in some areas. As a result, we have increased our breeding program efforts toward developing new summer dormant cultivars targeted for the hot summer dry environments. However, for summer dormant tall fescue to become readily adopted in our region, several limitations within the crop must be improved. Improving germination under warm soil conditions for better establishment and increasing autumn productivity to compete with dual-purpose wheat are the most important factors, but both of these limitations are likely related to the dormancy trait. A critical factor in improvement would be limiting dormancy length within the phenotype allowing plants to regrow when moisture is available. We currently have a number of populations under testing for a near term release that are being evaluated for establishment, persistence under grazing and forage yield. Selected genotypes from these trials will be used to develop new populations that have better germination, persistence and productivity, especially in the autumn. The hybridization of Continental and Mediterranean types, in order to transfer the summer dormancy trait into Continental background, is currently underway with the goal of combining higher biomass production with dormancy. Currently there is no controlled method to assess summer dormancy. Existing field tests, such as recovery after mid-season irrigation or comparisons made to summer active controls can reflect a germplasms ability to go dormant, but the depth and length of the dormancy is not accurately determined and can be very dependent on the yearly environmental conditions. Further research is needed in order to understand the dormancy trait and is important for the success of summer dormant tall fescue in the southern Great Plains.

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*Extension*

**The Bermudagrass Stem Maggot: A Review**

D.W. Hancock<sup>1</sup>

Since first being reported in southern Georgia in July 2010, the bermudagrass stem maggot (BSM; *Atherigona reversura* Villeneuve) has infested and damaged forage bermudagrass (*Cynodon dactylon*) throughout the southeastern United States. Our objectives for this presentation were to summarize the available literature on this new, invasive species and provide additional insight from what is currently known about other *Atherigona* spp. The BSM, along with other *Atherigona* spp., are small, muscid flies native to Central and Southeast Asia. The adult fly of the BSM lays its eggs on bermudagrass leaves. Upon hatching, the BSM larva slips into the sheath, down the tiller, and penetrates the pseudostem at the first node. The BSM larva then feeds on the vascular tissue, sap, and (potentially) the subsequent decaying plant material before exiting the tiller, pupating in the soil, and emerging as a fly. As a result of the larval feeding, bermudagrass exhibits senescence and necrosis of the terminal leaves on the affected shoots. The affected leaves are easily pulled out of the sheath and show obvious damage near the affected node. In severe infestations, over 80% of the tillers in a given area may be affected. There is a paucity of information about the lifecycle of *A. reversura* and how it can be managed or controlled, but some information is available on basic larva behavior, fly physiology, and the potential differences in resistance among some bermudagrass varieties. Stargrass (*C. nlemfuensis* Vanderyst) and hybrids of *C. dactylon* with *C. nlemfuensis*, including ‘Coastcross-II’ and ‘Tifton 85’ have been shown to be less susceptible to damage by the BSM and should be employed in IPM strategies wherever these cultivars are adapted. Additional research is underway to better understand the lifecycle of this species, confirm and quantify the efficacy of chemical control measures, and quantify the severity of damage in yield, quality, and aesthetics.

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## **Bermudagrass Decline/Stem Maggot: The Florida Case**

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The weather conditions of the last several years have been marked by extreme patterns throughout most pastures and forage crops producing areas in the eastern southern United States. Debilitated bermudagrass stands by extremes in weather conditions become easy targets to opportunistic soil-borne pathogens such as ‘take-all root rot’ (*Gaeumannomyces graminis* var *graminis*) fungus acting alone or in combination with other insect pests. This presentation aims to report findings from different field visits by interdisciplinary team of extension specialists from the University of Florida (forage agronomy, plant pathology, and entomology), to bermudagrass hay fields/pastures in North Central Florida where bermudagrass decline had been reported. In affected fields, the history of the field was gathered, and 10-inch diameter core samples containing above and belowground tissue were used for laboratory analysis and pest id. Diagnostics of field samples have consistently confirmed the presence of fungal disease ‘take all’ and bipolaris, however, the bermuda stem maggot (*Atherigona reversura*), in several severely affected fields were not recovered. These findings indicate that more information is needed to understand the association between weather patterns, management, fungal diseases and the presence of stem maggot.

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## **Native Grass Perceptions: Producer and Professionals Surveys in Tennessee**

P. Keyser\*, S. Schexnayder, A. Willcox, G. Bates, and J. Waller

Native warm-season grasses (NWSG) offer a potentially important forage option to the cattle industry, but in order to help focus research and extension efforts, knowledge and attitudes of producers and professional educators (Extension, NRCS) regarding these grasses need to be understood. During summer 2011, we conducted a mail survey of 1,620 beef cattle producers and in Feb 2014 we surveyed 312 professionals in Tennessee. Few producers intentionally grew NWSG (5%) and familiarity was low, 66.7% “not at all familiar”; for professionals this figure was 5%. In response to specific questions about key attributes of NWSG important for forage production, producers did not know/no opinion 67.3% - 79.1% of the time; those with an opinion tended to underestimate quality, yield, ability to produce gain, drought tolerance, stand persistence, and likelihood of spreading and overestimate fertilizer requirements. Professionals’ knowledge regarding these same attributes was accurate but they tended to overestimate producer knowledge and underestimate producer perceptions regarding NWSG. Producers indicated that they were somewhat interested (30.4%), interested (30.7%), or very interested (22.2%) in improving summer forage quality; professionals tended to overestimate this interest. Willingness to spend (out-of-pocket costs) to establish “quality, perennial, summer forage that would persist over a ten-year period” met or exceeded actual costs for 37.4% of producers; professionals tended to overestimate this willingness to spend. Using willingness to “move cattle among your pastures 2 – 3 times per month” as a surrogate for willingness to incur greater management intensity to achieve specific outcomes, producers indicated (on a 5-point scale) that a three-fold increase in summer gains (3.90), a two-fold increase in summer gains (3.81), qualifying for a 50% cost-share (3.78), improved drought tolerance (3.44), and eliminating summer hay feeding (3.43) would motivate their adoption of NWSG. Professionals considered issues related to establishment to be the most important barrier to adoption of NWSG and that reduced fertilizer costs and improved gain and production were most likely to motivate adoption by producers. These results suggest that few producers currently use NWSG forages, most are not familiar with them, and their potential is somewhat underestimated among those who report being familiar with NWSG. They also suggest that based on interest in improving summer forage, willingness to spend to establish summer forages, and willingness to increase management intensity, there is a prospective role for NWSG on many Tennessee beef farms. Professionals have a sound foundation for improving producer knowledge regarding native forages.

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## **Economics of Native Grass Forage Production: How We Got Lucky and Where to from Here?**

C. Boyer\*, J. Lowe, J. Waller, P. Keyser, and G. Bates

Understanding the economic implications of forage production is critical to evaluating forage options and formulating management recommendations for producers. During 2009 – 2013, a team of researchers at the University of Tennessee (UT) conducted several studies evaluating native grass forages by themselves and as a component of integrated forage-biomass systems. Using standard UT production budgets and the results of these studies, we conducted economic evaluations of the various forages tested. The first of these studies, an evaluation of two native forages with and without legumes and grazed by bred dairy heifers, demonstrated that i) legumes were not economically justified, ii) switchgrass (SG) was cheaper (\$0.38/AUD) than a big bluestem/indiangrass blend (BBIG; \$0.65/AUD), and that forages were much cheaper than commodity rations (\$1.89 - \$3.06/AUD) providing comparable performance. A second trial examining performance of beef steers on the same two grasses plus eastern gamagrass all grazed for 90 days during the summer indicated that in terms of lb beef produced/ac (503 lb/ac) and net return (\$431/ac), SG outperformed the other forages. A second component of that same study evaluated 30-day early season grazing followed by biomass production for the balance of the growing season. A break-even price of biomass was calculated that would justify cessation of grazing. Depending on location (i.e., management), biomass prices of \$37 and \$105/ton (SG), would justify biomass production over grazing. The third study examined the same integrated forage-biomass approach but in the context of hay production. This study demonstrated that i) earlier hay harvests (boot vs. seedhead) were more profitable (\$62 vs. \$76/ton, respectively, for SG breakeven price), ii) SG alone was preferable to BBIG and SG+BBIG, and iii) a single dormant-season harvest was preferable to either two-cut system in terms of producing cheaper biomass. These kinds of data can be valuable in developing practical models that can evaluate production options and production systems. However, empirically based data are needed from other forage trials to ensure that the models are well-grounded and can address different forage systems (Bermuda-tall fescue, NWSG-tall fescue, etc.) and different production models (stocker vs. cow-calf, spring vs. fall herds). A regional cooperative approach for developing these management models and tools should be explored.

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*Poster Session*

**Chemical composition of high sugar and conventional ryegrass varieties grown in greenhouse conditions**

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Plant breeders have recently focused on increasing the sugar content of grasses as a means to improve their nutritional value. The objective of this study was to compare the chemical composition of four ryegrass varieties: two intermediate tetraploids [Bandito2, (conventional) and Abereve, (high sugar)] and two annual diploids [Lonestar, (conventional) and Enhancer, (high sugar)]. Seeds were planted at an approximate rate of 40 lbs/acre into sixteen pots per variety. Pots (1 gallon capacity) were hand watered daily and fertilized weekly with water soluble 20-10-20 (N-P-K). A total of three harvests (5 cm cutting height) were clipped at six-week intervals. All harvests were taken at approximately 3 PM on days with full sunlight. Material was immediately weighed, placed in cloth bags, and flash frozen in liquid nitrogen. Plant material was stored at -20C until lyophilized and ground through a Wiley mill to pass a 1 mm screen. Plant tissue analyses included NDF and ADF content (ANKOM fiber bag technique), water-soluble carbohydrate content (WSC; colorimetric phenol-sulfuric acid assay) and crude protein concentration (combustion method). Forage DM increased ( $p < 0.05$ ) from Harvest 1 to 3, and was higher ( $p < 0.05$ ) for annuals than intermediate varieties. Across samplings, WSC was higher for Abereve (15.64 g/100 g) and Lonestar (15.30 g/100 g) than for Bandito2 (13.00 g/100 g) and Enhancer (13.97 g/100 g). However, there was a sampling x variety interaction ( $p < 0.05$ ). There were no differences among varieties in Harvest 1 (mean = 11.90 g/100g); however, in Harvest 2, WSC was higher for Abereve (18.35 g/100 g) and Lonestar (18.53 g/100g) than for Bandito2 (13.78g/100 g) and Enhancer (15.29 g/100 g). In Harvest 3 Abereve and Lonestar were also higher (15.94 and 15.80 g/100 g, respectively) than Bandito2 (14.03 g/100 g), whereas Enhancer had an intermediate value (14.44 g/100 g). NDF content was higher ( $p < 0.05$ ) for Lonestar and Enhancer than for Abereve, whereas Bandito2 had intermediate values. NDF content increased from Harvest 1 to Harvest 3. Although statistically significant, chemical differences among varieties were likely not biologically significant. The lack of low night temperatures in the greenhouse environment may have decreased the potential of high sugar varieties to accumulate water-soluble carbohydrates.

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## **Berseem Clover Pastures as a Problem-Based Extension Demonstration Tool**

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Florida small ruminant farms are increasing, and so is the need for research-based information about pasture management and utilization. Many small ruminant farms are located in Marion County, Florida, and operated by first generation farmers with little farming experience. To effectively educate this audience, a partnership was created between the Florida Meat Sheep Alliance, the Marion County Small Farms Extension Program, the University of Florida Forage Extension Program, and a progressive sheep farmer. The method used for extension education was applied research/demonstration. The planning included the identification and selection of winter options as the producers' knowledge needs, the selection of Berseem Clover (*Trifolium alexandrinum*) theme as part of the pasture management skills to be taught, the establishment of the applied research, and implementation of Small Ruminant Forage Field Day. A 2-acre Berseem area was established, and 135 pregnant sheep were used in rotational strip stocking to approximately 3-inch stubble height during limited periods throughout the day. The berseem pastures were used to demonstrate different practices associated with pasture management and utilization. Key aspects demonstrated included (i) general forage management (soil sampling, soil pH and contrasting forage establishment practices, fencing and grazing techniques, winter legumes), and (ii) specific Berseem management and utilization, included the key point of field day demonstration: how an adequately managed winter pasture can be a source for high quality feed for small ruminants in Central Florida, as well as a cover crop that can enhance soil health. Field day evaluations feedback showed that the use of Berseem Clover pastures were an effective tool to increase the awareness of sheep and goat farmers of the available forage resources developed by the University of Florida.

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## **Interpretation of *in vitro* rumen fermentation gas curves from biomass, using a single pool exponential model**

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Estimation of feed values of forage, based on fiber analysis and CP (crude protein), has provided a useful tool for the forage industry in beef and dairy operations, hay trade, etc. Although convenient, these analyses do not describe actual digestion aspects of forage in the rumen because of the non-uniform nature of plant cell wall compounds. Although it is an indirect method, incubation tests in the laboratory, with rumen fluid and artificial saliva, in test tube conditions (*in vitro* rumen fermentation technique) simulating rumen digestion may be closer to actual fiber degradation profiles of various feedstuffs. Several published articles have demonstrated possible applications of the *in vitro* rumen fermentation techniques for estimation of lignocellulosic feedstuff fermentability. This study compares fiber digestion potential of feedstuffs using fiber analysis, *in vitro* digestibility, and *in vitro* rumen fermentation gas modeling techniques. Switchgrass and energycane samples collected from different sources had wide variation in ADF (acid detergent fiber), NDF (neutral detergent fiber), ADL (acid detergent lignin), and IVTD (*in vitro* true degradability). Regression analysis of IVTD with ADF, NDF, ADL, and NDFD (neutral detergent fiber digestibility) indicated wide ranges for regression coefficients ( $R^2$ ) from the samples. *In vitro* rumen fermentation gas analysis was conducted on biomass samples at two different lignin concentrations (100 vs. 120 g ADL kg<sup>-1</sup> DM). Quantification of fermentation pool size, fermentation rate constant, and fermentation lag time were made using a single pool exponential model. The biomass samples were also tested for potential fuel conversion under *in vitro* conditions, by replacing the rumen fluid fermentation procedure with cellulosic hydrolysis-yeast fermentation. Fermentation pool size and lag time with energycane were greater than for switchgrass, but the fermentation rate was lower than for switchgrass. An impact of the lignin concentration on the fermentation gas kinetics of the biomass was detected with rumen fluid based fermentations, while the lignin impact was not seen with a yeast-based fermentation.

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## **Alfalfa Establishment into Existing Bermudagrass Pasture**

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Alfalfa (*Medicago sativa* L.) planted into existing warm-season perennial grass pastures such as bermudagrass [*Cynodon dactylon* (L.) Pers.] may provide N through N fixation, improve forage nutritive value and intake, and extend the grazing season. However, legumes generally have poor seedling vigor and can be difficult to establish. The objectives of this study were aimed at improving alfalfa seedling vigor (establishment) and were to determine the effects of planting date (15 Sept 2012, 25 Oct 2012, and 15 Feb 2013), seedbed preparation (clean tilled, hayed, and hayed + glyphosate), and fungicide and insecticide seed treatments (UTC, insecticide [Cruiser], fungicides [Apron and Maxim], and fungicide + insecticide mixtures [Cruiser Maxx, Cruiser + Apron, and Cruiser + Apron + Maxim at the maximum labeled rate] on alfalfa seedling density (30 days after establishment), forage production, and botanical composition of 600 RR alfalfa planted into existing 'Midland 99' bermudagrass sod at Burneyville, OK. Seedbed preparation did not affect alfalfa seedling density when planted in September or February, but hayed and hayed + glyphosate resulted in more seedlings when planted in October. Inclusion of insecticide resulted in more alfalfa seedlings than UTC or fungicide when planted in October and February. When planted in September, greatest total forage yield (7144 lbs dry matter [DM]/acre) was obtained in the hayed seedbed (99% bermudagrass), while hayed + glyphosate resulted in the least yield (3393 lbs DM/acre) but greatest alfalfa contribution (82%). When planted in October, alfalfa was the greatest contributor (75%) in the clean tilled seedbed, while bermudagrass was the greatest contributor in hayed (86%) and hayed + glyphosate (80%) seedbeds. Planting in February limited alfalfa establishment in all seedbeds (average 7% alfalfa). Seed treatment was only effective when planted in October, when there was some yield advantage with insecticide addition. Overall, seedbed preparation and planting date had greater impact on alfalfa establishment and yield than fungicide and insecticide treatments. This research is currently being repeated for a second season to determine if alfalfa is a viable replacement for N fertilizer in bermudagrass pastures. Future research will evaluate the potential of alfalfa interseeded in bermudagrass under grazing.

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## **Evaluating Gibberellic Acid as a Growth Promotant for Winter Annual Forages in Georgia**

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Promoting additional yield from winter annual forage systems in the Southeastern USA could substantially reduced the need for conserved forage at this time of year, improve overall productivity, and increase profitability. A small plot experiment (randomized complete block with four replications) was conducted at the UGA Plant Sciences Farm near Watkinsville, GA in the winter and spring of 2011-2012 and 2012-2013 to compare the effects of GA<sub>3</sub> (RyZup SmartGrass<sup>®</sup>, Valent USA, Libertyville, IL) on forage production of cereal rye (CR), annual ryegrass (AR), or cereal rye + annual ryegrass (RRG) when the GA<sub>3</sub> was applied early (Nov/Dec), in mid-season (Feb/Mar), or both. Additionally, an on-farm experiment conducted in 2012-2013 was conducted in Macon County, GA with two treatments, GA<sub>3</sub> versus an untreated control, to compare the effects of GA<sub>3</sub> on AR forage yield. In the on-farm trial, the application was made on 4 January 2013. In all cases, the GA<sub>3</sub> was applied at 0.5 oz. of ai/A with 1% v/v nonionic surfactant. In the small plot experiment, forage growth was measured using a rising plate meter (RPM; NZ Agriworks, LTD.; Feilding, NZ) and harvested with a plot harvester. The on-farm trial was replicated three times and yield was assessed with hand-clipped samples from three 0.1-m<sup>2</sup> quadrats per experimental unit taken at four harvest dates. In the small plot experiment, each application resulted in a significant ( $P < 0.001$ ) yield increase (11.8 - 21.9% increase) across all three forage treatments in 2011-12. In 2012-13, yield response (17.3% increase) to GA<sub>3</sub> application was only significant ( $P < 0.05$ ) on the RRG forage treatment when it received both the early and mid-season applications. However, weather in the 21 d following both applications in the 2012-13 growing season were not such that would support a significant response to the application. In the on-farm treatment of that same year, the GA<sub>3</sub>-treated ryegrass averaged 18.6% more forage than the untreated control ( $P < 0.01$ ). The application of GA<sub>3</sub> can be expected to increase yield from rye and/or annual ryegrass forage systems by 10-20% provided that weather conditions are not extremely cold or warm the days following the application.

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## **Organic Forage and Animal Production in South Korea**

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Forages are one of the most important aspects of organic livestock production. Both forages and livestock combine together to form the basis of the organic agriculture system. Summer and winter forage crops in double cropping systems are growing in popularity in South Korea because of their high forage yield and utilization. This paper summarizes the results of a survey and analysis of organic forage production systems in South Korea. A comparison between conventional and organic forage production systems showed that the organic system produced lower yields and had higher production costs than the conventional system, but this was offset by the higher value of the livestock products produced. Forage sorghum and sudangrass were the most popular summer annual forage crops because of higher production and lower cost, but the most efficient organic cropping systems included legume and grass combinations. The forage production of summer crops (corn, sorghum and sudangrass) was higher than the winter crops (rye, oats, Italian ryegrass and clovers) in an organic system and the resulting production costs were lower. The production of organic sorghum and rye, and sudangrass and rye were higher than other double crop options, followed by sorghum and hairy vetch, and sorghum and crimson clover. The area needed for organic forage production for 20 growing beef cattle was 4.6 to 5.6 acres under dryland production, and 9.0 to 10.6 acres for rice paddy production. For finishing 20 beef cattle, the area needed was 4.7 to 6.3 acres under dryland production and 6.2 to 7.3 for rice paddy production. And the area needed for 70 head of dairy cattle was 54.6 to 73.0 acres under dryland production and 72.2 to 84.7 acres for rice paddy production. These experimental results indicated that the optimum organic forage production system is double cropping using a dryland system. This survey showed that organic forage and livestock production systems are viable and sustainable in South Korea and certain double cropping combinations are most efficient.

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## **Southern Forages: An Information Transfer “Success Story”**

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Knowledge of forage-livestock production concepts and a way to locate practical forage information are needed by producers of grazing animals. Discussions that began in 1985 concerning the need for a comprehensive, practically oriented forage reference book led the authors to write the book *Southern Forage*, which was eventually published in 1991 by the Potash and Phosphate Institute (now the International Plant Nutrition Institute). The book provides information about establishment, management, and utilization of forage species commonly grown in the Southeast as well as animal related aspects of forage-livestock production. A comprehensive appendix and a thorough index were added to facilitate location of information on specific topics. The response to the book was gratifying, leading to the publication of second, third, and fourth editions of the book in 1996, 2002, and 2007, respectively. Subsequently developed items based on the book have included a publication titled Forage Crop Pocket Guide (of which over 95,000 copies have been printed), posters on Forage Grasses and Forage Legumes that describe and contain color pictures of various species discussed in the *Southern Forages* book, and a summary of concepts from the book (Keys to Forage Profitability) published in a document form and also used in a DVD. Seminars based on principles in the book have been presented in numerous states within the USA and in several other countries. The popularity and wide use of this book and related materials suggest that the forage-livestock principles covered in *Southern Forages* have no geographic boundaries. It also provides evidence that meeting a major educational need may have more dramatic results than initially expected.

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## **Productivity of wheat and annual ryegrass following no-till establishment of glyphosate tolerant soybeans.**

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Soybeans (*Glycine max*) cv ‘Asgrow 4933 RR’ were no-till planted into killed and unkilld strips of summer grasses (*Cynodon*, *Paspalum* and *Digitaria species*) in the Spring of 2012 and 2013 that previously had tall fescue (*Schedonorus arundinaceus*). Wheat (*Triticum aestivum*) cv ‘LA841’ and annual ryegrass (*Lolium multiflorum*) cv ‘Marshall’ were no-tilled planted into the harvested soybean stubble in the October of 2012 and November of 2013. Soybean hay yield was estimated by clipping with a Carter flail machine. Lime and potash were applied according to soil test recommendations, but the initial pH of the Marietta soil was 5.3 and potash (K) levels were Low (< 100 lbs of extractable K per acre). Wheat and ryegrass were fertilized with N at 0, 30 and 60 lbs per acre as either 33-0-0 or 34-0-0 at establishment in 2012 and following each harvest. In 2013 the entire area received 300 lbs of 15-5-10 per acre and the N source and N rates were applied initially in March of 2014. Soybean hay in October of 2012 was 1005 lbs/acre and 2270 lbs/acre in October 2013. Soybean grain yield was very low. It was not measured in 2012 and only 3 to 5 bu/acre in 2013. Soybean hay was harvested at full maturity in October and protein levels were low (11.3% versus 8.2% for summer grasses), indicating that low soil pH inhibited proper nodulation. Ryegrass and wheat responded to N rates but their yield was also low (3200 lbs/acre for ryegrass and 1500 lbs/acre for wheat). Wheat was absent in the May harvest and may be a better forage to grow before soybeans. Ryegrass continued to grow into May and would compete with soybean planting. Delaying soybean harvest in 2013 until November resulted in a late planting of ryegrass and wheat. Protein levels in ryegrass and wheat (13 to 14%) were similar in the control plots (0 N) indicating that soybeans provided similar N to 30 or 60 lbs N even with poor nodulation. Correction of pH and potash levels following pasture utilization is critical for proper no-till soybean productivity. Glyphosate tolerant soybeans or corn provide unique tools for pasture renovation to destroy old tall fescue infected with a toxic endophyte (*Neotyphodium coenophialum*).

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**Laboratory seed processing to increase purity and improve planting ease in southeastern wildrye [*Elymus glabriflorus* (Vasey ex L.H. Dewey) Scribn & C.R. Ball]**

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Southeastern wildrye is a robust, native, cool-season perennial grass that is suitable for revegetation, soil stabilization and possibly forage use in the southeast United States. Southeastern wildrye seed form in a terminal spike (ear) that can reach a diameter of two or more inches, due largely to the long, thin awns that extend from the base of each seed unit. These appendages decrease Pure Live Seed (PLS) percentage in bulk seedlots and make seed handling in conventional planting equipment difficult, which leads to poor establishment. The objective of this study was to decrease bulk seedlot weight through laboratory processing without negatively impacting overall seedlot germination, thus increasing PLS percentage of seedlot. Seed cleaning processes using basic laboratory equipment were used separately and in combination to increase purity of seedlots and ease seed flow through conventional equipment. A batch debearder (Mater Seed Company, OEM Inc.; Corvallis, OR) and an impeller-type fractionating aspirator (Carter Day International; Minneapolis, MN) were used to remove awns and other inert material from southeastern wildrye seedlots with a 4x3 factorial arrangements of treatments in a completely random design with subsampling. Seedlots of 0.25lb were tested using debearding levels of 0, 2, 4, and 8 minutes. After debearding treatment, seedlots were divided into four subsamples of 0.0625lb. Subsamples were aspirated at levels of no aspiration, moderate (11.0 mph) and high (15 mph), and seed fractions were collected as heavy, medium, medium/light and light material. Data were analyzed ( $\alpha = 0.05$ ) using a General Linear Model (GLM) in SAS Statistical Analysis Software. There was a significant ( $P < 0.0001$ ) effect on seedlot weight due to debearding treatment, with mass of heavy fraction being significantly decreased and mass of medium, medium/light and light fractions being significantly increased as level of debearding increased from 0 to 8 minutes, compared to control seedlots. Treatment combinations also significantly affected overall seedlot germination percentage as well as germination per unit weight of seedlot fractions.

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## **Grazing Evaluation of New Auburn University Experimental Annual Ryegrass Cultivar in Alabama**

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Forage availability in the Southeastern USA is limited during winter and supplemental feeding increases management cost. Therefore, a breeding program was initiated in 2005 to improve the winter productivity of annual ryegrass. A random-mating base population was subjected to two cycles of phenotypic recurrent selection for increased biomass accumulation during winter. Cycle 2 produced higher DM yield in winter than cycle 0 and cycle 1 populations in a 2-year study conducted at five locations in Alabama. The actual worth of newly developed forage cultivar can really only be determined by observing animal performance. Thus, we conducted a grazing trial for two years (2011 and 2012) in Central Alabama at the Beef Cattle Unit of the E.V. Smith Research Center in Milstead, AL. Trials were seeded into a prepared seedbed in mid October to early November. Beginning in mid January of each year, stocker weight was measured for four consecutive 28-day grazing periods. The trial was conducted with leased steers and the mean initial body mass were substantially different between two years. We therefore expressed the stocking rate for each paddock in terms of a 225 Kg animal unit Polynomial regression within a mixed models environment, combined across year was used to predict animal responses for three cultivars - Cycle 2, Gulf and Marshall at calculated stocking rates ranging from 2.47 to 7.43 steer ha<sup>-1</sup>. Gain ha<sup>-1</sup> and average daily gain showed a quadratic response to increasing stocking rate for all treatments. Even though the predicted gains ha<sup>-1</sup> were not different among treatments at lower stocking rates, Cycle 2 had higher gain than Gulf and Marshall and the difference increased with increasing stocking rate from 4.95 to 7.43 steers ha<sup>-1</sup>. Similarly, the predicted average daily gain on Cycle 2 was higher than other cultivars as stocking rates increased from 4.95 steer ha<sup>-1</sup> and above. These results showed better performance of experimental cultivar Cycle 2 than Gulf and Marshall at higher stocking rates.

Keywords: ADG, gain ha<sup>-1</sup>, standard stocking rate, nutritive quality, forage availability

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## **Evaluation of southeastern wildrye, tall fescue, and orchardgrass to N fertilization and cutting frequency in north central Mississippi**

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With over 2,000,000 acres of pasture and hay production in Mississippi, responsible and profitable agronomic management decisions are vital to ecological health as well as local and state economies. Current research strives to determine sustainable, cost-effective production practices to maximize efficient nutrient management and profits. In grass production systems nitrogen fertilizer is the greatest carbon input and cost. Application of fertilizer and harvest timing drive hay yield and quality. To determine the best relationship between these two factors, a study consisting of four nitrogen rates (0, 120, 180, and 240 lb/A) delivered in split applications, and four harvest intervals (one harvest at 112 days, two harvests in 56 day increments, three harvests in 37 day increments, and four harvests in 28 day increments, over the course of the growing season) were superimposed in strips in a split plot design of three cool-season grass species in a randomized block. The grasses were: southeastern wildrye [*Elymus glabriflorus*], tall fescue [*Schedonorus arundinaceus*], and orchardgrass [*Dactylis glomerata*]. The main effect was species, which were replicated four times at three locations x environment: Starkville, MS (Fall 2013 and Spring 2014) and Brooksville, MS (Spring 2014). Treatments of nitrogen rate and harvest regime are designated by “strips”. Nitrogen applications are imminent. Data to be taken include: above ground biomass yield and ground cover over the course of the study as affected by harvest frequency, nutritive value measurements of acid detergent fiber and neutral detergent fiber, crude protein, and *in vitro* dry matter digestibility. The results of this research will help determine appropriate cultural practices to optimize quality and yield of these three cool-season forages in Mississippi and provide important basic information on the agronomic management of southeastern wildrye.

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## **Establishing native warm-season grasses: How much does it cost?**

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### **Rationale**

Native warm-season grasses (NWSG) are perennial, bunch-type species that can be an excellent source of forage production for livestock in the southern region of the United States. Native warm-season grasses also provide vital cover for wildlife if established and maintained correctly. However, relatively few landowners in the region have considered NWSG due to the lack of information available pertaining to total cost of establishment. The purpose of this poster is to outline the costs associated with establishing NWSG in comparison to traditional forage grasses so that landowners will have more complete information when considering which forage system to establish.

### **Objectives**

Bahiagrass (*Paspalum notatum* Flugge) and bermudagrass [*Cynodon dactylon* (L.) Pers.] are the two most common warm-season perennial grasses planted in Mississippi for forage production. The cost of establishing these two species is compared to the most common mixture of NWSG: big bluestem (*Andropogon gerardii* Vitman), little bluestem [*Schizachyrium scoparium* (Michx.) Nash], and indiagrass [*Sorghastrum nutans* (L.) Nash]. The objective of this poster is to thoroughly define the costs associated with the establishment of these three perennial grass systems on a per acre basis.

### **Materials and Methods**

It is assumed that the establishment site is a mixed grass pasture in need of renovation. Cost of establishment for bermudagrass was assessed for two methods; sprigging (Sumrall 007) and by seed (common). Sprigging is most often conducted with hay production in mind, whereas direct seeding is a more common method for grazing purposes. Operating costs for establishment include labor, seed, soil preparation, planting, fertilization, and weed control. Fertilizers applied were based on costs obtained from USDA-AL Department of Ag Market News on Monday, March 3, 2014. For the NWSG, no nitrogen or phosphorous (diammonium phosphate contains 18% nitrogen) was added due to the effect nitrogen has on encouraging weed competition. Also, no lime is recommended as long as pH is > 5.0. Ownership costs for establishment includes only tractor and machinery depreciation Land costs and general farm overhead are equal for each establishment practice and are therefore not included in this analysis.

## **Results**

Our results show that it is more expensive to establish NWSG as compared to bahiagrass and bermudagrass (seeded and sprigged). The largest portion of the added costs pertains to seed cost.

## **Implications**

This poster provides valuable information to landowners considering which type of forage system to establish on their property. This poster should also lead to more questions about the use of NWSG. While we show that the establishment costs are higher as compared to the more commonly used warm-season perennials, it would be just as valuable to show the maintenance costs and both the monetary and environmental benefits of all the species, which we analyzed. Such work would provide a full valuation over the lifetime of the stands for landowners to consider.

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## **Tolerance of Four Clover Species to Varying Rates of Pre and Post-Emergent Broadleaf Pasture Herbicides**

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Broadleaf weed control in mixed grass/clover stands has long been an issue for beef and forage producers in Mississippi. There are few herbicides on the market that successfully control broadleaf weeds without causing serious damage to existing clover. Our goal was to incorporate into field experiments, broadleaf herbicides which exhibited greatest safety on clover. Our objectives were to evaluate the tolerance of four clover species to broadleaf herbicides applied pre and post-emergent in greenhouse studies. Varying rates of Pursuit (imazethapyr), Spartan (sulfentrazone), Raptor (imazamox), and Image (imazaquin) were applied to containerized, native soil seven days prior to planting arrowleaf, berseem, crimson, and white clover. Pursuit, Raptor, Image, and Aim (carfentrazone) were also applied post emergent when the same clover species reached the third trifoliolate growth stage. Pre-emergent data indicated that Raptor at 2.5 fl. oz. was least injurious to clover 28 days after planting, but was not more significant than Pursuit at 3 and 6 fl. oz. per acre. Post-emergent data indicated that Raptor at 12 fl. oz. per acre may be used in addition without causing significant damage to clover. In both studies, Image applied at 6 and 12 oz. caused the greatest clover injury at 21 days after treatment. Species interaction indicated that crimson clover was least affected by pre-emergent applications through 28 days after planting, but exhibited greatest injury from post-emergent treatments. Ongoing trials are currently evaluating rates of Sharpen (saflufenacil) alone and tank mixed with Pursuit applied to the same clover species. Field trials are also underway on mixed grass/clover pasture to evaluate early applications of 2,4-D and Pursuit mixtures, prior to a summer application of GrazonNext HL (2, 4-D + aminopyralid), Grazon P+D (picloram + 2, 4-D), and Rejuvra (aminocyclopyrachlor + triclopyr). We expect that by spraying broadleaf weeds at the juvenile state and after clover bloom, to obtain weed control with minimal clover stand loss.

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## **Stocking rate and supplementation affect performance of beef heifers grazing ‘Nelson’ ryegrass**

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Little information is available concerning the evaluation of tetraploid ryegrasses under different stocking rates. The objective of the present experiment was to evaluate the performance of beef replacement heifers grazing ‘Nelson’ ryegrass at different stocking rates and when supplemented with corn or soybean hulls at “high” stocking rates. At the LSU AgCenter Iberia Research Station, three stocking rates (3 replicates) were evaluated using 90 crossbred heifers (550±14 lb on d 0) continuously stocked on ‘Nelson’ annual ryegrass: 1 (low), 2 (medium), and 3 (high) heifers/acre. Also, groups grazing at the high stocking rate were supplemented with ground corn (C) or soybean hulls pellets (SBH) at a daily rate of 1% of the heifers’ body weight. Unsupplemented heifers at 3/acre were taken out of the pasture for 28 days due to lack of forage, and then returned to their respective pastures until the end of the trial. Heifers at the low and medium-stocking rate gained more ( $P < 0.05$ ) than those at 3 heifers/acre (2.5, 1.8 and 0.8 lb/day, respectively). Those heifers that grazed at the high stocking rate but were supplemented were intermediate, and gained 0.5 lb/day more (1.35 lb/day) than those unsupplemented at equal stocking rate. Beef produced per acre was similar ( $P = 0.39$ ) for 2 heifers/acre (458 lb/acre) and for supplemented groups (484 and 457 lb/acre, for C and SBH, respectively). Only those heifers stocked at 1 and 2 heifers per acre reached the appropriate BW at breeding (826 and 777 lb, respectively), while supplemented heifers were intermediate (724 and 706 lb, for C and SBH, respectively) and those unsupplemented at the high stocking rate weighed on average 647 lb. Assuming that C and SBH cost \$250/ton and the average daily supplement consumed was 6 lb/head, it represents \$0.75/head/day. This is the cost of 0.5 lb more of gain of supplemented heifers compared with those unsupplemented at 3 heifers/acre. Preliminary data suggest that ‘Nelson’ ryegrass is a viable alternative for replacement heifers. Supplementation with a high-energy supplement is recommended when grazing at more than 2 heifers/acre although the cost/benefit must be evaluated *a priori*.

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## **Forage *Brassica* species variety trial**

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Utilization of *Brassica* species as livestock fodder has enjoyed renewed interest among cattle producers. Three turnips (Apin, Barkant, and Seven-Top), 3 rapeseeds (Barsica, Bonar, Winfred), 2 turnip × rapeseed crosses (Pasja, T-Raptor), and 1 turnip × mustard cross (Vivant) were tested in two studies regarding dry matter (DM) production, canopy heights, and seedling density after either 2 and 4 months (regrowth study = RG), or only 4 months (stockpile study = SP) of growth. All varieties were established at a rate of 5 lbs/acre into a conventionally tilled seedbed. A randomized complete block design was used for both studies. Prior to planting on August 26, 2013, biomass growth in a selected 5-acre field was suppressed with glyphosate, disked twice, and culti-packed. The plot size was 4.5 × 25 feet in accordance with the planned harvesting procedure for which a Wintersteiger Cibus S plot harvester was used. Immediately after planting, premixed NPK fertilizer was applied to each plot according to soil test recommendations. Number of plants per square foot measured 3 weeks after establishment ranged between 4 and 6 across all varieties. For RG, DM yields ranged from 1,034 to 2,112 lbs/acre at the Oct 22 harvest date, with Winfred yielding highest and Appin lowest. At the second harvest for RG on Dec 3, Appin showed the lowest amount of regrowth along with Seven-Top of less than 250 lbs DM/acre. Dry matter production of Pasja with 699 lbs/acre was the highest observed for that date. Yields for SP (harvested only on Dec 3) ranged from approximately 3,300 to over 5,500 lbs DM/acre. Winfred (5,536 lbs DM/acre) was similar to Bonar and Barsica, but out-yielded all other varieties. Canopy heights were similar across varieties in both studies; for RG, heights ranged from 20 to 23 inches on Oct 22. For SP, canopy heights ranged between 19 and 25 inches.

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## **In vitro phenotyping assays to discriminate Mediterranean and Continental tall fescue morphotypes**

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Summer dormancy is a phenomenon exhibited by the Mediterranean tall fescue to tolerate extreme summer conditions. Exploitation of the summer dormancy related trait and genetic improvement can be a key strategy to improve persistence of tall fescue in the south-central USA. Identifying traits associated with summer dormancy along with phenotyping method is very critical and yet to be developed. An In vitro experiment was conducted in growth chambers using four Mediterranean (summer dormant) and four Continental (summer active) tall fescue genotypes following completely randomized design with five replications. One growth chamber was maintained at 24/16°C day and night temperature and 10 h photoperiod as optimum growing condition, while another chamber was maintained at 34/24°C day and night temperature and 16 h photoperiod as summer environmental condition. Among the measured traits, electrolytic conductivity was significantly higher (20-60%) in Mediterranean genotypes than the Continentals at both optimum and summer dormant conditions. Overall, all the summer dormant genotypes showed higher electrolytic conductivity and leaf porosity than any Continental genotypes. However, significant variations between the two morphotypes for leaf porosity and growth rate were only visible at summer dormant condition. Leaf porosity was 150% higher, but the leaf growth rate was 150% lower in Mediterranean than the Continental genotypes. Concomitantly, all the continental genotypes showed higher leaf growth rate than any summer dormant genotypes. The two morphotypes did not show any significant differences for osmotic potential, leaf chlorophyll content, pH of the conductivity solution, number of stomata, length of stomata, width of stomata, length of stoma and width of stoma in the two conditions. This study with some additional verification will lead to identify traits and phenotyping procedure for summer dormancy under green house and growth chamber conditions, which will help the breeders for selecting summer dormant genotypes under controlled environmental condition.

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## **Increasing Legume Grazing For Higher Beef Gain On Pastures: An Improved High-Tannin Birdsfoot Trefoil Cultivar With Trans-Regional Potential**

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This is a first report on a NIFA grant (Award No. 2013-67013-21408) that was funded during the 2013 funding cycle. This collaborative effort involves eight scientists from seven academic institutions. Birdsfoot trefoil (BFT), a non-bloating forage legume, has potential to improve sustainability of pasture systems in the Eastern Transition Zone (ETZ) of the USA. Tannins in BFT can improve protein utilization efficiency and reduce methane emissions and nitrogen excretion by grazing animals. This proposal combines the expertise of a plant breeder with that of forage management researchers and extension specialists. Our ultimate goal is to develop a trans-regional BFT cultivar with high condensed-tannin concentration and wide geographic adaptation with longer stand life than existing cultivars. APPROACH 1 begins with a collection of old cultivars that have not been marketed for a number of years and ends with the creation of five synthetic populations ready to undergo seed yield testing prior to release. Selection environments will include three in the ETZ, and one each in the Upper Midwest (UMW) and Intermountain West (IW). At each location, BFT will be evaluated for up to four (or 4) years in mixed stands with tall fescue. Selection criteria will be survival, plant size, and tannin content. One synthetic population will be developed at each location. APPROACH 2 will utilize approximately 25% of the USDA-NPGS germplasm accessions. Accessions will undergo two cycles of recurrent selection for survival, tannin content, growth habit, and seed mass and yield at a site in each of the regions of intended production, viz. ETZ, UMW and IW. End products will be three pre-breeding populations that may then be incorporated into future cultivar development programs.

**Keywords:** forage breeding, forage legume, forage management, grazing, germplasm

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