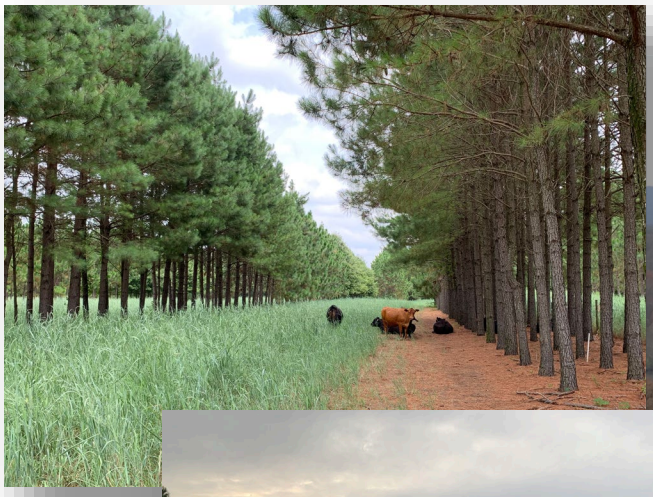
2022

Proceedings of the 75th Southern Pasture and Forage Crop Improvement Conference



Asheville, NC
July 26 – July 28, 2022

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Breeding for Resistance to Blast (Pyricularia oryzae) on Early Planted Annual Ryegrass

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Annual ryegrass (*Lolium perenne* L. spp. *multiflorum* (Lam.) Husnot) is a high-quality forage utilized heavily in the Southeast for grazing, specifically during the winter months. Blast (*Pyricularia oryzae*) is a fungal pathogen that infects gramineous species and is a common problem in perennial and annual ryegrass stands. This study was conducted to use restricted, recurrent phenotypic selection methods within four annual ryegrass cultivars (Vertyl, OR34, Marshall, and Jumbo) for resistance to *P. oryzae* with the intent to assess heritability of resistance genes. Five, three-month-old plants of each cultivar were inoculated with a spore solution of 1 x 10^5 conidia per fl. oz. and maintained for 72 hours at 80-90°F, 85% RH. Control plants were sprayed with 1% potato dextrose broth. Marshall acted as a susceptible reference cultivar to confirm pathogen virulence while Vertyl acted as the resistant reference cultivar. Disease severity ratings were calculated using Assess 2.0® software from 25 random leaf samples taken from each plant. Percentage disease severity rating for inoculated Vertyl, OR34, Jumbo, and Marshall was 7.80, 17.69, 26.37, and 35.26, respectively. Disease severity was significantly different ($P<0.0001$) among all four cultivars. Due to contamination among the controls, disease severity was recorded for Vertyl, OR34, Jumbo, and Marshall at 7.36, 6.49, 15.87, and 16.72, respectively. Vertyl and OR34 showed significantly greater resistance to blast than Jumbo and Marshall. The top performers of Vertyl and OR34 were planted into two crossing blocks at separate locations along with a heat-tolerant annual ryegrass germplasm with the objective to test the progeny for resistance to blast.

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Comparison of Desktop and Handheld Near Infrared Spectroscopy Devices to Determine Forage Nutritive Value

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The quality of predictions for plant-, soil-, and animal-responses from near infrared spectroscopy (NIRS) data depends on accurate and precise chemometric modeling. There are several devices available in the market to collect spectra with a wide range of specifications (e.g., spectral range and resolution, desktop vs. portable). Limited work, however, has been reported that compares predictions of basic estimates of forage nutritive value when using different NIRS devices on the sample. Samples from two warm-season perennial grasses [switchgrass (*Panicum virgatum* L.) and bermudagrass (*Cynodon dactylon* L.)] were used to: 1) develop NIRS models using three NIRS devices of contrasting specifications to predict crude protein (CP), acid detergent (ADF) and neutral detergent (NDF) fibers, and in vitro true dry matter digestibility (IVTD); and 2) compare predictions among the three NIRS devices. The three NIRS devices used were desktop FOSS 6500, handheld microPhazir, and the NIRscan Nano EVM. Different mathematical transformations for the same analyte were needed to optimize the NIRS model for each device. Among devices, the standard errors of calibration (SEC) and cross-validation (SECV), and standard error of prediction (SEP) were comparable, in some instances better, to estimates of the NIRS Consortium level 2 equation release statistics for grass hay ('13GH50-2.eqa') and mixed hay ('16mh50-2.eqa'). Consistently, the FOSS models had the highest r^2-values; remarkably, the predictive power of the best models fitted for the other two handheld devices is very similar. Our results warrant utilization and further application of handheld devices.

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Tree-Species Effect on Forage Productivity and Heat-Stress Mitigation in a Silvopasture of North Carolina

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Ecosystem services provided by silvopastoral systems are mediated by specific management, environmental conditions, and overall design of the system. Using an original alley-cropping design that transitioned to silvopasture, we hypothesized that selection of trees affects understory forage nutritive value and productivity, light/shade environment, and heat-stress mitigation. The silvopastoral system was located at the Center for Environmental Farming Systems in Goldsboro, North Carolina, USA. Three overstory tree-species were *Pinus palustris* (PP; longleaf pine), *Pinus taeda* (PT; loblollly pine), and *Quercus pagoda* (QP; cherrybark oak). The understory forage component consisted of a four-way mixture of native warm-season grasses [big bluestem (*Andropogon gerardii*, 'Eastern', KY origin), gamagrass (*Tripsacum dactyloides*, MO origin), indiangrass (*Sorghastrum nutants*, 'NC ecotype'), and switchgrass (*Panicum virgatum*, 'Alamo')]. Understory dry matter yield, crude protein and total digestible nutrient concentrations of the harvested forage were not affected by tree species. Overstory effects on microclimate variables were not different among tree-species, were more noticeable during the daytime of the summer months and were at the most 1-degree point for temperature and temperature-humidity index and 3 points for relative humidity. The main feature of the silvopasture system design in our study was the provision of year-round shade by the tree-component, with varying levels of shade (ranging from 90 to 6% of incident photosynthetic active radiation) due to tree species and season. Our results describe and highlight the potential of silvopasture design with forage alleys to mitigate heat stress and allow high forage productivity as a function of tree species in the southeastern USA.

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Utilizing Cover Crops as Winter Forage in an Integrated Crop-Livestock System

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Integrated crop-livestock systems (ICLS) are designed to combine crop production with cover crops and grazing while simultaneously improving soil health, reducing winter forage needs, and increasing net revenue. The objective of this experiment was to determine animal and cover crop performance in a soybean production system. This study consisted of a randomized complete block with three replications and was conducted at the Coastal Plain Branch Experiment Station (CPBES) in Newton, MS and the Prairie Research Unit (PRU) in Prairie, MS. Treatments included: conventional soybean production respective for each location (CS); cereal rye established as a cover crop for a no-till soybean system (CC); and cereal rye established as a cover crop for a no-till soybean system and grazed (GC). All paddocks were stocked at approximately 2000 lb ac^{-1} using replacement beef heifers. Forage samples were collected throughout grazing periods and were analyzed for forage mass (FM) and nutritive value (crude protein – CP, total digestible nutrients - TDN) using near-infrared spectroscopy (NIRS). Animal performance data included average daily gain (ADG), gain per acre (GAIN), and animal days (AD) from CG paddocks only. Mean FM from CG paddocks was 999 lb DM ac^{-1} at CPBES compared to 705 lb DM ac^{-1} at PRU. CP concentration was 25.6% from CPBES and 15.8% from PRU. Mean TDN was 56.3% at CPBES compared to 57.5% at PRU. Mean ADG, GAIN, and AD at CPBES were 2.83 lb hd^{-1} d^{-1}, 356.7 lb ac^{-1}, and 126 d yr^{-1}, respectively. At PRU, mean ADG, GAIN, and AD were 2.78 lb hd^{-1} d^{-1}, of 103.7 lb ac^{-1}, and 50.4 d yr^{-1}, respectively. Differences in GAIN between locations can be attributed to higher initial body weight (BW) at CPBES 671 lb hd^{-1} compared to PRU 506 lb hd^{-1}, resulting in greater forage consumed. Also, differences in AD can be contributed to increased FM at CPBES due to earlier establishment and more favorable growing conditions throughout winter and early spring. A second year of data collection, combined with soybean and soil analysis will help determine the effects of grazing a cereal rye cove crop on two distinct soils in eastern Mississippi.

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Physiological and Behavioral Responses of Heifers that Grazed Either Wild-Type or Novel Endophyte-Infected Tall Fescue

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Fescue toxicosis presents serious challenges and huge economic losses to the beef industry in the U.S. Replacing wild-type endophyte-infected (WE) tall fescue (TF) with novel endophyte-infected (NE) TF can eliminate this problem but adoption of this technology has been limited. We aimed at demonstrating the physiological and behavioral responses of heifers that grazed either WE or NE TF using relatively non-invasive techniques. Angus or Angus cross heifers (n = 24) were assigned to either WE or NE pastures for a 56-d grazing period during the summers of 2020 and 2021. Heifer ADG and hair retention scores were recorded once every 4 wk and intravaginal temperatures were recorded for two consecutive days at this interval. Extremity temperatures were determined using thermographic imaging and hair was collected from the left rump for cortisol analysis. Animal behavior was detected using time-lapse trail cameras. The overall ADG of heifers that grazed NE was greater ($P = 0.0160$) compared to heifers that grazed WE in 2020, but not in 2021 ($P = 0.9623$). Hair retention was greater for heifers that grazed WE compared to heifers that grazed NE ($P = 0.0029$). Heifers that grazed WE TF had lower ($P \leq 0.0075$) temperatures at ears, tails and hooves and 0.3-0.9 °C greater intravaginal temperatures than heifers that grazed NE, especially during daytime. Hair cortisol levels of heifers that grazed WE were greater ($P < 0.0001$) compared to heifers that grazed NE. From 1200h-1700h each day, heifers on WE pasture spent 1.5 more ($P = 0.0003$) hours loafing and 0.9 fewer ($P = 0.0402$) hours lying down than heifers on NE pastures. These results suggest that heat stress and other physiological changes in heifers grazing WE could be mitigated by renovating pastures with NE TF.

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Preliminary Observations of Perennial Peanut Survival in Northwest Georgia

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Summer forage production in the southeastern US is generally abundant, but often of marginal nutritional value. Development and expansion of production from perennial peanut have provided germplasm that is adapted to high summer temperatures and offers high forage quality, particularly since the release of the cultivar 'Florigraze' in 1981. Warming temperatures associated with changing climate warrant evaluation of perennial peanut at more northern latitudes. Our objectives were to initially examine the survival and potential performance of released perennial peanut cultivars in northwest Georgia at 34°N at the UGA Northwest Research and Education Center. Three forage types ('UF-Tito,' 'UF-Peace,' and 'Apalachee) and three ground covers ('Ecoturf,' 'Cowboy,' and 'Waxy Leaf') entries were established in 5'x 5' plots in randomized complete block arrangement. Nine transplants were equally spaced within each of four plots per entry on 27 July 2021. Overhead sprinkler irrigation was provided during the first week due to dry conditions. Between 10 November 2021 and 15 March, 2022 minimum air temperatures of freezing or below were recorded on 63 days. Temperatures were below 25° on 18 days and reached an extreme low of 17.5°. Except for 'UF-Tito' and 'UF-Peace,' initial survival of these perennial peanut entries is encouraging. Spring growth of 'Waxy Leaf' and vegetative expansion of 'Cowboy' suggest acceptable adaptation to the climate and soils of the area (Table 1). Future persistence and production remain to be evaluated.

Table 1. Spring survival ratting of perennial peanut made on 11 May and 3 June 2022:

ENTRY	***11-May***	***3-June***
APALACHEE	7.0	8.3
WAXY LEAF	6.8	6.8
COWBOY	6.5	6.5
ECOTURF	3.3	6.0
UF-PEACE	2.3	2.8
UF-TITO	1.8	3.3

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Isolation and culture of Epichloë sp. for re-infection of endophyte-free southeastern wildrye (Elymus glabriflorus)

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The mutualistic relationship between endophytic fungi and grasses has shown to improve the hardiness and robustness of the host plant. This symbiotic relationship is common in most grasses, including native cool-season grasses that are important in both forage and grassland ecosystems. Members of the *Elymus* genus, including Canada wildrye (*E. canadensis* L.) (CAWR) and Virginia wildrye (*E. virginicus* L.), commonly host the endophytic fungi, *Epichloë*, while southeastern wildrye [*E. glabriflorus* (Vasey ex L.H. Dewey) Scribn. & C.R. Ball] (SEWR) may not. It is currently unknown if SEWR has a similar mutualistic relationship with *Epichloë*. In this study, seed of nine *Elymus* accessions (GRIN-Global) as well as seed and vegetative material from locally adapted SEWR populations were assessed for endophyte infection status. Infection status was confirmed (endophyte-infected (E+) or endophyte-free (E-)) using both seed squashing and leaf peel techniques and assessed using light microscopy at 100x magnification. Seed of one SEWR and eight CAWR accessions were assessed for endophyte infection by soaking seeds in 5% NaOH to soften the seed coat. Softened seeds were stained with aniline blue and gently squashed between a microscope slide and coverslip. Infection status was determined by presence or absence of mycelia within the aleurone layer of each seed. Epidermal leaf peels were excised from mature SEWR leaves, stained and observed. Infection status was determined by presence or absence of mycelia in the apoplast of epidermal cells. Following assessment, all SEWR germplasm was E-, while six *E. canadensis* accessions were E+. Endophyte-infected seeds were germinated and pseudostems from mature plants were used to isolate the endophyte within the plant. This was done by surface sterilizing the pseudostem sections with 10% bleach solution then placing them on potato dextrose agar plates and set in a dark 73°F germination chamber for 6 weeks, or until endophyte growth was identified. The isolated endophyte will be used to infected E- SEWR plants. Infection status of SEWR will be determined using leaf peels and polymerase chain reaction procedures. This research will help determine if artificial endophyte infection can be performed successfully in SEWR.

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Evaluation of Tetraploid Bahiagrass Lines for Beef Cattle Systems in the SE

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Cattle ranchers in the Southeastern United States have relied on bahiagrass (*Paspalum notatum* Flügge), a hardy, warm-season perennial forage, since the early 1900s. Most breeding and selection have focused on diploid 'Pensacola types', but many producers favor tetraploid "Argentine types" for their wider leaf blades and fewer seedheads. Due to the inherent challenges of breeding apomicts, there is a gap in the availability of tetraploid cultivars for commercial use. The main objective of this study was to evaluate nine new tetraploid breeders' lines from multiple UF breeding programs under different grazing methods for their agronomic performance and persistence under grazing compared to Argentine. The study was conducted at the UF Beef Research Unit in Gainesville, FL during two consecutive growing seasons (2020 - 2021). Two grazing treatments were imposed through mob stocking: 'intensive' grazing was characterized by a two-week grazing interval to a 5 cm stubble height, and 'moderate' grazing was a four-week interval to a 10 cm stubble height. Treatments were meant to impose different levels of stress on the plants to evaluate persistence and productivity traits. Lines possessing more upright growth habits, Hybrids 3 and 93, outperformed Argentine in forage accumulation (9000 vs. 5100 kg/ha, in year 2). Most top performing entries had comparable nutritive value to Argentine, ranging from 51 to 53% in vitro organic matter digestibility, and 12 to 13.5% crude protein. The season had a major impact in nutritive value, with all entries declining in digestibility and protein during the summer (summer slump). Tillering responses were variable depending on entry and treatment, but most entries presented a similar number of tillers (ranging from 700 to 980 tillers/m^2) for both grazing pressures. Intensive grazing produced greater forage accumulation and nutritive value for most entries, while moderate grazing resulted in less weed encroachment and greater ground cover over time. Percentage cover was much lower for intensive grazing (67%) after two seasons than for moderate (87%). Four entries are now being considered for further evaluation before cultivar release, projected in 2026.

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Nitrogen Use Efficiency of Cool-season Annual Grasses in Mississippi

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There are an estimated 700,000 acres of cool-season grasses being grown in Mississippi for grazing and baleage production. One of the current limitations in forage production is the cost of nitrogen (N) fertilizer. The objective of the study was to determine optimal fertilization rates that could maintain forage production and nutritive value and improve nitrogen use efficiency (NUE). The study was conducted at the Henry H. Leveck Animal Research Farm at Mississippi State University. The experimental design was a randomized complete block in a split-plot arrangement. The main plots were five N rates (0, 60, 90, 120, and 150 lb N ac^{-1}). Urea (46-0-0) was applied in 50/50 application when the grass reached three inches after establishment and after the first harvest. The subplots were five cool-season grass species ('Marshall' annual ryegrass, 'Wrens Abruzzi' cereal rye, 'Canmore' oat, 'Surge' triticale and 'Pembroke' wheat). Annual ryegrass and the small grains were planted at 25 and 100 lb PLS ac^{-1}, respectively. Treatments were harvested using a push mower equipped with a bagging system when plants reached 12 to 15 in height. Biomass subsamples were analyzed for nutritive value using a Foss DS2500 NIR instrument (Foss North America, Eden Prairie, MN) and the 2022 mixed grass hay equation from the NIRS Forage and Feed Testing Consortium (Berea, KY). Data were analyzed in the PROC GLIMMIX of SAS at $\alpha = 0.05$. Seasonal biomass production was impacted by N rate ($P = 0.003$) and grass species ($P < 0.0001$). Differences in dry matter yield were observed between the 120 and 150 lb N ac^{-1} application rate. However, N treatments had a 22 (60 N), 19 (90 N), 13 (120 N), and 27% (150N) increase in biomass production compared to the control. Mean NUE was about 21 lb of biomass per unit of N and there were no differences among fertility rates or forage species. Greater N rates exhibited greater levels of CP and there was a decline in nutritive value with seasonality. Preliminary data indicate that the N rate of 60 lb N ac^{-1} in split applications might be sufficient to achieve optimum biomass production of cool-season annual grasses.

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Crabgrass for Repairing Hay Feeding Areas

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Hay feeding areas are often left neglected with compacted soils and high weed pressures after hay feeding are over. These areas have the potential to be productive because of soil fertility buildup from hay feeding. A three-year Extension demonstration was set up at the Middle Tennessee AgResearch and Education Center in Lewisburg to investigate different forages and weed control options for improving these hay feeding areas. This demonstration showed that soil fertility can increase dramatically from hay feeding and with minimal ground preparation and some broadleaf weed control, forages could be established with good quality and yield. Crabgrass was a forage that worked extremely well in this scenario. To promote the practice of repairing hay feeding areas, this demonstration was shared at Master Beef Producer Meetings and Field Days. In addition, funding from the Master Beef Producer Program was used to purchase crabgrass seeds to give to producers. After filling out a short survey, producers were given a small bag of crabgrass seed and a factsheet with instructions on establishing and managing crabgrass in repaired hay feeding areas. The pre-survey results showed that sixty producers had never planted crabgrass. Producers' opinions of using crabgrass showed that 53% liked crabgrass, 41% were indifferent and 6% did not like crabgrass. Producers shared that 51% use the same hay feeding areas every year and 45% switch areas. In a post-survey, using a ranked system (1=very low; 10=very high), producers liked crabgrass with an average of 8.1. Producers' ranked crabgrass establishments with an average of 7.3. All producers established crabgrass by broadcasting seed and some used disking. Crabgrass was used only for grazing by 92% of producers and for both grazing and hay production by 8%. Observed pest issues included pigweed, ironweed, and mint, as well as armyworms. When asked if they would consider using crabgrass in the future, 67% of producers said yes, 25% said maybe and 8% responded no. This is an example where Extension demonstrations and fee-based programming provide support to promote practices that can benefit the productivity and efficiency of producer operations.

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Alabama Bermudagrass Hay Growers Summit Targets Advanced Producers

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The Bermudagrass Hay Growers Summit is an in-state Extension workshop that began in 2017 and is based on grassroots need to educate advanced hay producers seeking more than basic hay production instruction. The original objective was to provide current information and timely updates for bermudagrass hay producers in northern Alabama. Typically held in February, the timing allows for immediate implementation of certain practices before spring green up. It has evolved into a statewide event after proven success as a regional offering. The workshop utilizes a traditional lecture format with varying educational components, based primarily on past participant evaluations. Educational topics have covered insect pests, weed control, fertilizer requirements, and application timing, nutrient management, industry perspectives, nutrient availability, cash flow budgeting, and hay storage techniques. The average attendance for the target audience is 18 people, with a total of 11,266 acres under their management each year. Due to university restrictions for in-person programming, the 2021 meeting was conducted virtually and open to anyone (95 in-state; 33 out-of-state attendees). Extension news articles, email blasts, social media posts, word of mouth, and local advertising are utilized each year to promote the workshop. A mix of PowerPoint presentations, speaker panels, and round table discussions throughout the day encouraged group interaction. Evaluation results over six years (2017-2022) indicate that 98.2% of participants found the information useful to their operation and 98.8% reported the program met their expectations. The average rating (1-5 scale) of all topics delivered was 4.63 across all years, indicating satisfaction with selected topics. Evaluation results show a 29.4% average increase in knowledge and the average, annual economic impact from implementing the information presented of $17,704.60 per person. While it is important to reach new and beginning farmers and ranchers, progressive producers need continued education designed to meet their production needs in an ever-changing enterprise.

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UF Silage Hybrid Decision Tool – A New Approach to Variety Trials Data Mining

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Variety testing is an important service Extension provides. Information on crop productivity, disease resistance and other relevant characteristics are essential for decision making during planting season. The UF/IFAS Silage Hybrid Trial tested has been testing commercial corn and sorghum hybrids since 2008. However, lack of easy access to data and cumbersome spreadsheets and reports limit utilization of such resources by our producers. The objective of this project was to create a simple, easy-to-use query tool for decision making support on forage variety choices in Florida, which can improve them utilization of data and impact of the variety testing program. For the design of the system, we mapped with users and specialists about important data to be shown, and which filtering should be included regarding productivity and nutritive value of tested materials. The library contains 1491 entries of corn and sorghum, with up to 23 characteristics. Typescript language and React framework have been used to develop the platform. The development of the query tool follows a simple "website" approach that allows for quick searches and highlights important information. It does not require downloading of data or software. User can select species, company, and season, and sort thought ten different parameters. A graphic display combining quantity and quality parameters assists on visual interpretation of the data. This tool will be launched during the 2022 Corn Silage Field Day, where a needs assessment will be performed to evaluate current use of data. Further investigation will be needed to assess the success of the tool. Our goal is to improve access and utilization of valuable data generated by the UF Forage Team. This tool can help producers in decision making for over 50,000 acres of silage corn planted in Florida. Furthermore, it can be expanded to other forage and agronomic crops.

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Management of Dual-Purpose Wheat Varieties in the Southeastern U.S.

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Dual-purpose wheat is commonly used in the Great Plains but differences in wheat varieties, beef cattle herd composition, and growing season make it underutilized in the Southeast. This study evaluated the biomass, nutritive value, and grain yield of four wheat varieties, including: 'AGS 2024' (AGS), 'Pioneer 26R41' (Pioneer), generic feed wheat (Feed), and 'GA Gore' (Seed) managed under three grazing frequencies: no-grazing (NG), low frequency (LF) and high frequency (HF). The experiment was a randomized complete block (n = 4) with three, mob-grazing intervals. Replications were fertilized with 120 lb N/A in split applications across the growing season. Samples were clipped before and after grazing (PreG and PostG, respectively). Forage biomass and nutritive were determined at PreG and grain yield was determined at the end of the season. Data were analyzed using PROC GLIMMIX (SAS Inst., Cary, NC). Year 1 forage biomass was greater in PreG AGS than all other varieties (1,351 lb/A; $P < 0.01$) and Feed PreG had the greatest CP ($P < 0.01$; 31.6%). Year 2 forage biomass was greater for PreG AGS (3,362 lb/A; $P < 0.01$). Year 2 forage biomass was lowest for Seed (2,298 lb/A) but was not different from PostG Feed forage biomass (2,298 and 1,950 lb/A, respectively; $P = 0.25$). The NDF concentration in Year 1 was not different between LF and HF (35.2%; $P = 0.92$). Seed and Feed had the lowest ADF concentration in Year 1 and were different from all other varieties (17.91% and 20.1%, respectively; $P < 0.01$). In Year 1, the grain yield of Pioneer and AGS did not differ but were greater (55.9 Bu/A) than Feed and Seed (43.2 Bu/A and 22.8 Bu/A, respectively; $P < 0.01$). In Year 2, the grain yield was greatest for Pioneer and was different from all other varieties (54.64 Bu/A; $P < 0.01$). Year 1 and Year 2 data do suggest dual-purpose wheat is a possible management strategy in the Southeast.

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Cover Crop Biomass and N yields in Mississippi Corn Production Systems

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Dramatic increases in nitrogen (N) fertilizer prices have caused many corn producers in the state of Mississippi to consider fall-planted cover crops as an option to increase soil organic matter as well as supplement N to the corn crop. Many species of forages can be utilized as cover crops, but they need to be evaluated in the parameters of a corn system to assess their viability as an N-providing cover crop. The objective of this project was to evaluate the biomass and N yield of several forage species over three years and at two locations. Data from the Mississippi State Cover Crop Variety Trials from 2018-2020 at Newton and Starkville locations were summarized by crop species and analyzed for biomass and nitrogen yield. At two termination dates (March 15 and April 1), above-ground biomass was determined via plot harvest and subsamples removed for nitrogen analysis. Delaying termination until April 1st increased biomass and nitrogen yield by 50 and 35 % respectively. Clovers averaged from 53 to 86 lbs of N ac^{-1} in Starkville and 54 to 118 lbs of N ac^{-1} in Newton. The greatest producers of N among the clovers were variable between locations. The coastal plains soils in Newton the most southern location benefited the greatest in terms of N from berseem, vetch, crimson, and winter pea yielding over 100 lbs of N ac^{-1}. Heavy loam soils in Starkville benefited balansa, berseem, red clover, and vetch yielding over 74 lbs of N ac^{-1}. In recent years, corn in the state has been planted by April 1st, leading to recommendations that cover crops should be terminated by March 15th. However, this decreases possible nitrogen production by legumes due to minimal biomass production. Grass cover crops like ryegrass and cereal rye may be productive by mid-March but N addition to the system was limited.

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