

## Forages and Pastures: General forages and forage systems

### W158 Chemical composition, digestibility and fermentation characteristics of sorghum ensiled with soybean crop residue.

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The fermentation of silage process depends on the initial balance of nutrients in the ensiled forage and must minimize nutritional losses. Agricultural regions have high quantities of crop residues, and sometimes these residues have nutritional value and are used as co-products like soybean hulls but stalks, leaves and broken grains are frequently lost. The objective of this assay was to evaluate the effects of the soybean crop residue inclusion (0, 3 and 6% as fed basis) on sorghum silage quality. Sorghum was harvested at 30% dry matter (DM), mixed with the residues and ensiled targeting density between 600 and 650 kg as fed/m<sup>3</sup> using 6 silos/treatment. The nutritional value was evaluated after 50 d of ensiling. There was a significant effect of the soybean residue inclusion for crude protein (CP) (5.59, 6.50 and 6.74% DM), and neutral detergent insoluble protein (NDIP)/CP (42.46, 35.24 and 32.60%). The soybean residue inclusion reduced the non-fiber carbohydrates (34.51, 31.77 and 29.93% DM) and total carbohydrates (85.84, 84.84 and 83.79% DM) which caused decreases in in vitro DM digestibility (63.49, 63.35 and 59.71%) and in vitro OM digestibility (65.77, 61.64 and 59.05%). Linear increase in gas production (75.50, 101.62 and 129.22 mm<sup>3</sup>/gDM/h) was observed. The pH close to 3.8 at the moment of opening the silo, the constant ammonia-N concentration (72.8 g/kg total N), and the high recovery of DM 86.87% and OM 85.74% indicate heterolactic fermentation favoring acetic acid production which promotes aerobic stability of silage. An inclusion of soybean crop residue up to 6% as fed basis in sorghum silage is possible without effects on the fermentation characteristics of the silage.

**Key Words:** gas production, pH, silage

### W159 Effect of reduced lignin alfalfa on forage quality at three harvest intervals. Zhiqiang Li\*<sup>2</sup>, Zhenzhen Li<sup>2</sup>, David Combs<sup>1</sup>, and Daniel Undersander<sup>1</sup>, <sup>1</sup>University of Wisconsin, Madison, WI, <sup>2</sup>China Agricultural University, Beijing, China.

The present study investigates the effect of reduced lignin on alfalfa quality. Two alfalfa cultivars [Roundup Ready (RR) and double stacked Roundup Ready and Reduced Lignin (RR/RL)] were harvested at intervals of 28, 33, and 35 d. All replicated plots were harvested for 2 regrowth periods in July and August, 2014. CP, aNDF, lignin, NDFD48 value of samples on DM basis were analyzed with NIRS method (FOSS 6500) using NIRSC 2012 Alfalfa Hay Equation. Statistical analysis was done as a 2 way ANOVA using SPSS 22. CP content was not different between RR and RR/RL (27.5 vs 28.0,  $P > 0.05$ ) and declined with advancing maturity ( $P < 0.05$ ). aNDF content was higher in RR than RR/RL (31.6 vs 30.1,  $P < 0.05$ ) though differences among harvest intervals were not significant (30.8 vs 30.5 vs 31.1,  $P > 0.05$ ). Lignin content was not significantly different between RR and RR/RL (5.6 vs 5.5,  $P > 0.05$ ) or among harvest intervals (5.6 vs 5.6 vs 5.5,  $P > 0.05$ ). The NDFD48 of RR/RL was significantly higher than RR (52.2 vs 50.5,  $P < 0.05$ ) and that of 28d harvest interval was significantly higher than 33d and 35d levels (53.1 vs 50.2 vs 50.8,  $P < 0.05$ ). No significant interaction occurred between variety and harvest interval for any of the above 5 indices. The iNDF, kd and total-tract NDF digestibility (TTNDFD) are shown in the table below. The reduced lignin alfalfa tended to be lower

in iNDF and higher in kd though differences were not significant, but was significantly higher in TTNDFD ( $P < 0.012$ ). It appears that RR/RL variety reduces the NDF content and improves NDFD48, and TTNDFD.

**Table 1 (Abstr. W159).**

Item	Interval	RR	RR/RL	Mean	P-value		
					Forage	Forage harvest interval	Forage harvest × interval
iNDF	28d	34.1	29.9	31.7 <sup>b</sup>	0.086	0.001	0.470
	33d	42.1	37.0	39.9 <sup>a</sup>			
	35d	39.3	39.2	39.2 <sup>a</sup>			
	average	38.7 <sup>a</sup>	35.1 <sup>a</sup>	36.8			
Kd	28d	7.8	7.1	7.4 <sup>a</sup>	0.156	0.980	0.153
	33d	7.0	8.2	7.5 <sup>a</sup>			
	35d	6.4	8.9	7.8 <sup>a</sup>			
	average	7.0 <sup>a</sup>	8.0 <sup>a</sup>	7.6			
TTNDFD	28d	53.0	56.3	54.9 <sup>a</sup>	0.012	0.010	0.849
	33d	46.3	51.9	48.7 <sup>b</sup>			
	35d	46.8	51.1	49.2 <sup>b</sup>			
	average	48.6 <sup>b</sup>	53.3 <sup>a</sup>	51.0			

<sup>abc</sup>Means in rows or columns with different superscripts differ ( $P < 0.05$ ).

**Key Words:** alfalfa, lignin, forage

### W160 Characterization of novel polymers for alkaloid

**adsorption.** Manoj B. Kudupojje\*<sup>1,2</sup>, Eric S. Vanzant<sup>1</sup>, Alexandros Yiannikouris<sup>2</sup>, Karl A. Dawson<sup>2</sup>, and Kyle R. McLeod<sup>1</sup>, <sup>1</sup>University of Kentucky, Alltech-University of Kentucky Research Alliance, Lexington, KY, <sup>2</sup>Center for Animal Nutrigenomics & Applied Animal Nutrition, Alltech Inc., Nicholasville, KY.

A methacrylic acid-based molecularly imprinted polymer (MIP) was evaluated for physical and isothermal adsorption properties. Polymers were synthesized by suspension polymerization with (MIP) or without (NIP) ergotamine tartrate (ETA) as template. Polymer morphology was characterized by light scattering diffraction, SEM and BET. Polymer-template interactions were characterized by FT-IR, <sup>1</sup>H NMR and isotherms. For each of 4 alkaloids evaluated, adsorption difference between MIP and NIP interacted ( $P < 0.01$ ) with alkaloid concentration, but product differences were generally consistent across concentrations. With bromocryptine and methylergonovine, average adsorption was greater ( $P < 0.01$ ) for MIP than NIP (62.9 vs 37.1 and 35.8 vs 24.7%, respectively). NIP adsorption was greater ( $P < 0.01$ ) for ETA (93.1 vs 96.7%), and no difference ( $P > 0.05$ ) existed between products for lysergol adsorption (38.1 vs 37.7). The Freundlich model ( $R^2 = 0.99$ ) indicated similar adsorption intensity to ETA for MIP ( $n \sim 1.025$ ) and NIP ( $n \sim 1.011$ ) and the  $Q_{max}$  estimate from the Langmuir model ( $R^2 = 0.99$ ) was 388.7 and 435.4 nM/mg for MIP and NIP, respectively. Both polymers had IR spectra at  $\sim 3500$  (carboxyl stretch),  $\sim 1730$  (carbonyl stretch), and  $\sim 1260$  cm<sup>-1</sup> (C-O stretch) indicating similarities in backbone structure. Spectral shifts observed in polymer-ETA complex samples suggest the interaction with amine groups was via H-bonding, which was confirmed using <sup>1</sup>H NMR. SEM demonstrated compactness of implanted polymer, which, after template removal turned microporous with microvoids. BET analysis showed NIPs to have a smooth surface with few pore structures, whereas MIPs exhibited greater surface area

and porosity; implying that MIPs have a larger surface for adsorption. Light scattering diffraction suggests bimodal particle size distribution for both polymers with larger percentage in 30–80 µm range. These imprinted polymers could be utilized as SPE material, or for extraction of ergot alkaloids from complex materials. Furthermore, the described MIP is a candidate for application as a feed adsorbent to reduce bioavailability of certain alkaloid compounds in the gut.

**Key Words:** molecularly imprinted polymer, ergotamine D-tartrate, isothermal adsorption

**W161 Nutritive value and in vitro degradability of Marandu palisade grass at different locations within the pasture in silvopastoral systems with different babassu palm densities.** Rosane Cláudia Rodrigues, Michelle de Oliveira Maia Parente, Xerxes de Moraes Tosta, Ana Paula Ribeiro de Jesus, Henrique Nunes Parente, Jocélio dos Santos Araújo, Sâmara Stainy Cardoso Sanchês\*, Ivone Rodrigues Araújo, Clésio dos Santos Costa, and Ivo Guilherme Ribeiro Araújo, *Universidade Federal do Maranhão, Chapadinha, Maranhão, Brazil.*

The objective of this study was to evaluate the nutritive value and “in situ” degradability of Marandu grass at different locations within the pasture in silvopastoral systems with different densities of babassu palm (Low density:39, Medium density:72 and High density:92 palm/ha). The silvopastoral system consisted of *Brachiaria brizantha*, the forage specie and Babassu palm *Orbignia phalerata* Martius, tree species. Pre-dried samples of forages were used for determination of dry matter (DM), organic matter (OM), neutral detergent fiber (NDF), acid detergent fiber (ADF), lignin, crude protein (CP), cellulose and hemicellulose. One Santa Inês male sheep, castrated, cannulated in the rumen, with an average body weight of 63 kg was used for ruminal incubation. Samples of forages (5 g) were incubated in the rumen in nylon bags. For each incubation time, 4 bags were used. The experimental design was a completely randomized design with factorial arrangement 3 × 3 (3 incubation times: 6, 24 and 96 h and 3 sampling sites within the pasture: no interference of shadow - NS, an intermediary INT and shadow interference - SI). There was no effect ( $P \geq 0.05$ ) of the density of palm trees or locations within the pasture on the content of NDF, ADF, lignin, cellulose and hemicellulose. The densities in grassland Palm did not influence the chemical composition of grass Marandu only DM content. The sampling sites influenced ( $P \leq 0.05$ ) content of CP and DM. Higher rates of disappearance of DM (RDDM) was observed in 96 h. At all densities, NS and SI had higher RDDM. Pastures with low density of palm (LDP), the location INT showed higher degradation rate and higher digestibility for passages rates 2, 5 and 8%. Locations within the SSPs reviews had a little influence on the nutritive value of grass Marandu, however, the local NS, at higher densities showed the higher protein content. In all pastoral environments, the NS and SI locations had higher DMS and location INT in SSPs with LDP and MDP smaller DMS, but higher degradation rate and effective digestibility, respectively.

**Key Words:** *Attalea speciosa* Mart, *Brachiaria brizantha*, protein

**W162 Effect of the cytokinin BAP on growth, senescence and in vitro degradation of *Lolium perenne* L.** Hilda A. Zavaleta-Mancera\*, Sergio S. González-Muñoz, Ángel H. Soto-Urano, and Omar Hernández-Mendo, *Colegio de Postgraduados, Montecillo, Estado de México, México.*

The cytokinin 6-benzylaminopurine (BAP) is a growth promoter that can delay leaf senescence. Therefore, the objective of this study was to

study the effect of BAP on growth, senescence and in vitro degradation of *Lolium perenne* L. (var. Linn). The experimental design was completely randomized with 4 treatments: 3 concentration of BAP (T:0.1 mM; T2:0.01 mM; T3: 0.001 mM); and a control without BAP (T0). Plants were grown from seed at 25 kg/ha on 68 pots containing a mix of soil:agrolite:peat-moss (1:1:1), in a greenhouse. Plants of 8 mo were cut at 5 cm above substrate. At 21 d of regrowth, plants were sprayed weekly during 65 d (7 times). The variables evaluated were: leaf growth and senescence during 112 d; soluble proteins and photosynthetic pigments during 84 d; chemical and morphological composition and in vitro degradation of the cell wall (6, 12, 24 and 48 h). Means were compared using the Tukey test ( $P < 0.05$ ). All BAP treatments increased net leaf growth (T1: 32%; T2: 18%; T3: 39%) with respect to the control, but leaf senescence and photosynthetic pigments were not significantly different ( $P > 0.05$ ). BAP 0.1 mM promoted accumulation of leaf soluble protein (3.55 mg/gFW) and reduction of acid detergent fiber by 6%, as compared with the control. In vitro degradation was increased only with 0.001 mM BAP at 60 d of regrowth (T0:0.50; T1:0.43; T2: 0.52; T3:0.53). It may be concluded that BAP increased growth and leaf protein of *Lolium perenne* L. and reduced cell wall components.

**Key Words:** *Lolium perenne* L., 6-benzylaminopurine, senescence

**W163 Effect of supplementation strategy and forage quality on in vitro digestibility of Kentucky 31 tall fescue and Tifton 85 bermudagrass.** Jeferson M. Lourenço\*<sup>1</sup>, Matthew W. Studstill<sup>1</sup>, Cathy A. Bandyk<sup>2</sup>, Dennis W. Hancock<sup>1</sup>, and Robert L. Stewart Jr<sup>1</sup>, <sup>1</sup>The University of Georgia, Athens, GA, <sup>2</sup>Westway Feed Products.

A 3 × 3 factorial experiment was conducted to evaluate IVDMD of Kentucky 31 tall fescue (KY-31) and Tifton 85 bermudagrass (T-85) with or without supplementation. The main effects included relative forage quality (RFQ) and type of supplement. Each forage type was harvested at different intervals during the yr of 2013 and 2014 to represent grazing and hay production scenarios in the state of Georgia. After harvested, the nutritive values of forages were assessed via near-infrared spectroscopy, and samples were stratified by RFQ. Forage samples were selected to represent high (HIG), medium (AVG), or poor (LOW) RFQ for KY-31 (171, 111, and 78, respectively) and T-85 (142, 101, and 80, respectively). Supplemental treatments included: 1) commercial molasses-urea based supplement (MUR) or 2) corn gluten feed (CGF) to provide the equivalent of 0.36 kg of supplemental CP; or 3) no supplement (CON). The forage-supplement mixtures were subjected to 48-h in vitro digestion to evaluate the digestibility characteristics. Two in vitro incubations were conducted and bottles (n = 140 in each incubation) were considered the experimental units. Across forage type, IVDMD increased as the incubation time was extended, and it was greatest ( $P < 0.001$ ) when samples were incubated for 48 h. The same response was observed for NDF and ADF digestibilities. No supplement × RFQ interaction was observed for KY-31 ( $P = 0.55$ ). Across RFQ for KY-31, 48-h IVDMD increased ( $P = 0.008$ ) with the addition of LIQ and CGF compared with CON (49.9, 49.6, and 47.7%, respectively). Across supplementation, IVDMD of KY-31 was greatest ( $P < 0.001$ ) for HIG and AVG compared with LOW (62.5, 50.2, and 34.5%, respectively). A supplement × RFQ interaction was observed for T-85 ( $P < 0.003$ ). In vitro dry matter disappearance was lowest for LOW × CON compared with all other supplement × RFQ combinations. These results suggest that forage quality is the main factor affecting IVDMD. However, the addition of LIQ and CGF can increase IVDMD of KY-31 and low RFQ T-85.

**Key Words:** bermudagrass, in vitro, tall fescue

**W164 Herbage accumulation of palisadegrass with variable heights in beginning of deferment period.** Manoel Eduardo Rozalino Santos\*<sup>1</sup>, Laryssa Avelino Luz<sup>1</sup>, Pedro Henrique Marçal Rodrigues<sup>1</sup>, Lucas Coelho Alves<sup>1</sup>, Wirley Duarte de Souza<sup>1</sup>, Simone Pedro da Silva<sup>2</sup>, and Dilermando Miranda da Fonseca<sup>3</sup>, <sup>1</sup>Universidade Federal de Uberlândia, Uberlândia, Minas Gerais, Brazil, <sup>2</sup>Instituto Federal Goiano, Hidrolândia, Goiás, Brazil, <sup>3</sup>Universidade Federal de Viçosa, Viçosa, Minas Gerais, Brazil.

The experiment was conducted to evaluate 2 different strategies for managing *Brachiaria brizantha* (palisadegrass) under deferred grazing. From January to June 2014, the palisadegrass pastures were evaluated at the Federal University of Uberlândia, located in the State of Minas Gerais, Brazil. The experimental site was located at 776 m altitude, 18°30' S and 47°50' W. Annual precipitation was around 1.584 mm. Medium temperature was 22.3°C. The experimental area was made up of 6 paddocks (experimental units) of 800 m<sup>2</sup>. Two pasture heights in the beginning of deferment period were evaluated: 15 cm and 45 cm. Before the deferment period, the pastures were managed in continuous stocking with sheep. The deferment period was 90 d. The experiment was carried out using a randomized completely design with 3 repetitions and subdivided plots. On 1, 45 and 90 d of deferment period, the tillers number m<sup>-2</sup> was quantified. In each experimental unit, 15 tillers were marked. The lengths of live portions of leaf blades and stems of tillers were measured weekly. The collected data were used to calculate the growth, senescence and herbage accumulation rates. The conversion factors were generated to transform the measures in cm tiller<sup>-1</sup> day<sup>-1</sup> to kg ha<sup>-1</sup> day<sup>-1</sup> of dry matter. The growth rate (GR) was higher at the beginning (87.1 kg ha<sup>-1</sup> day<sup>-1</sup>) than at the end (11.4 kg ha<sup>-1</sup> day<sup>-1</sup>) of deferment period. Deferred pasture with 45 cm (73.5 kg ha<sup>-1</sup> day<sup>-1</sup>) also showed higher GR, compared with deferred with 15 cm (34.9 kg ha<sup>-1</sup> day<sup>-1</sup>). Leaf senescence rate (LSR) was higher at end (78.0 kg ha<sup>-1</sup> day<sup>-1</sup>) than at the beginning (24.7 kg ha<sup>-1</sup> day<sup>-1</sup>) of deferment period in the pasture with 45 cm. The herbage accumulation rate (HAR) was higher at the beginning (37.6 kg ha<sup>-1</sup> day<sup>-1</sup>) than at end (-13.5 kg ha<sup>-1</sup> day<sup>-1</sup>) of deferment period. Deferred pasture with 45 cm showed greater HAR (22.1 kg ha<sup>-1</sup> day<sup>-1</sup>) of that with 15 cm (2.0 kg ha<sup>-1</sup> day<sup>-1</sup>). We conclude that the reduction in palisadegrass height at the beginning of deferment period results in pasture with lower growth, senescence and herbage accumulation.

**Key Words:** growth, senescence, tiller

**W165 Balance between the emergence and mortality of tiller in *Brachiaria brizantha* under variable heights in winter.** Manoel Eduardo Rozalino Santos\*<sup>1</sup>, Ludiêmilem Keith Parreira da Costa<sup>1</sup>, Bruno Humberto Rezende Carvalho<sup>1</sup>, Denis Douglas Pessoa<sup>1</sup>, Heron Alves de Oliveira<sup>1</sup>, Roger Carvalho Cardoso<sup>1</sup>, Miriã Gonçalves Simplicio<sup>1</sup>, Simone Pedro da Silva<sup>2</sup>, and Dilermando Miranda Fonseca<sup>3</sup>, <sup>1</sup>Universidade Federal de Uberlândia, Uberlândia, Minas Gerais, Brazil, <sup>2</sup>Instituto Federal Goiano, Hidrolândia, Goiás, Brazil, <sup>3</sup>Universidade Federal de Viçosa, Viçosa, Minas Gerais, Brazil.

The experiment was conducted to evaluate 3 different defoliation strategies of *Brachiaria brizantha* (palisadegrass) in winter. From April 2013 to March 2014, the palisadegrass were evaluated at the Federal University of Uberlândia, located in the State of Minas Gerais, Brazil. The experimental site was located at 776 m altitude, 18°30' S and 47°50' W. Annual precipitation was around 1.584 mm. Medium temperature was 22.3°C. The experimental area was made up of 12 plots (experimental units) of 9 m<sup>2</sup>. In one management strategy, palisadegrass was maintained at 30 cm high during all the trial. In the other, the palisadegrass was kept at an average of 15 cm during the winter (July to September

2013), and at 30 cm from the early spring until the summer (October 2013 to March 2014). At last, the palisadegrass was kept at an average of 45 cm during the winter and at 30 cm from the early spring until the summer. The experiment was carried out using a randomized completely design with 4 repetitions and subdivided plots. The defoliation strategies correspond to plots. The year seasons were the subplots. In each experimental unit, all tillers inside the 2 frames with 0.0625 m<sup>2</sup> were counted and marked with colored plastic. Every 30 d, all tillers were recounted and new tillers were marked with a different wire color. The collected data were used to calculate the balance between the emergence and mortality of tiller (BAL). The tillers number was quantified in each season year. The BAL was ( $P < 0.05$ ) lower in winter (-7.2%) and later spring (-5.0%), intermediate in summer (11.6%) and higher in early spring (26.2%). This response pattern was due to unfavorable weather conditions in winter. On the other hand, the high development of shoots in tillers in early spring may have generated higher shading at plant base in late spring, causing negative BAL. The defoliation strategies did not affect the BAL. We conclude that palisadegrass keep with 15 cm in winter showed higher tiller number during all experimental period, when compared with grass with 30 and 45 cm in winter.

**Key Words:** defoliation, tiller density population, seasons of the year

**W166 Effects of exogenous fibrolytic enzymes on in vitro digestibility and gas and methane production of corn silage.** Vania R. Vasconcelos\*<sup>1,2</sup>, Kathy G. Arriola<sup>2</sup>, Andressa Campos<sup>2</sup>, Felix X. Amaro<sup>2</sup>, Rafael M. Martins<sup>2</sup>, Musibau A. Bamikole<sup>2,3</sup>, and Adegbola T. Adesogan<sup>2</sup>, <sup>1</sup>Universidade Federal do Piauí, Campus Agrícola da Socopo, Teresina, Piauí, Brazil, <sup>2</sup>Department of Animal Sciences, University of Florida, Gainesville, FL, <sup>3</sup>Department of Animal Science, University of Benin, Benin City, Nigeria.

This study examined effects of enzyme type and duration of the enzyme-substrate interaction (preincubation) period before in vitro fermentation on the in vitro digestibility and gas and methane production of corn silage (CS). Exactly 1 mL of 0.1 M citrate phosphate buffer (pH 6.0; Control) or the buffer and either xylanase (XYL; 1 mg/g) or xylanase-cellulase (MIX 3.4 mg/g) fibrolytic enzyme preparations were incubated with 0.5 g of dried, ground CS at room temperature for 0, 12, 24 and 48 h in a 120-mL culture bottle. Subsequently, 40 mL of buffered-rumen fluid was added to each bottle and the contents were incubated for 24 h at 39°C. At least 3 replicates of each treatment combination were examined in each of 5 runs. Total gas and methane production, volatile fatty acids (VFA), pH and in vitro digestibility of dry matter (DMD) and neutral detergent fiber (NDFD) were measured. The data were analyzed as a completely randomized design with a 3 × 4 factorial treatment arrangement using the GLIMMIX procedure of SAS (SAS Inst. Cary, NC). There were no ( $P > 0.10$ ) enzyme by time interactions for any measure except DMD ( $P = 0.09$ ). Preincubating MIX for 12 or 24 h with CS resulted in less ( $P < 0.05$ ) DMD than that at 0 h but similar DMD to that at 48 h. Preincubating XYL with CS for 12 h resulted in greater ( $P < 0.05$ ) DMD than that at 0, 24 or 48 h. Both MIX and XYL increased NDFD but MIX had the greatest value ( $P < 0.05$ ; 58.6 and 53.6 vs 51.0%, respectively). Compared with CON, MIX increased gas production (40.1 vs. 42.9 mL) and decreased methane production ( $P < 0.05$ ; 0.023 vs. 0.019 mg/mL) but XYL had similar values to the other treatments (41.4 mL and 0.021 mg/mL, respectively). Across enzyme treatments, pH was greater after 12 h of preincubation (6.34 vs. 6.28) and gas production was greater after 48 h (45.5 vs. 40.17 mL) compared with other incubation times. The MIX enzyme was more effective than the XYL enzyme at increasing the fermentation and digestion of CS. Enzyme-substrate preincubation



period had enzyme-specific effects on DMD and no effects on NDFD or other fermentation measures.

**Key Words:** fibrolytic enzyme, gas production, digestibility

**W167 Use of two natural antimicrobial additives in solid-state fermentation of apple bagasse.** J. L. Guevara-Valdez\*, C. Rodriguez-Muela, L. A. Duran-Melendez, D. Diaz-Plascencia, E. Santellano-Estrada, and R. Marquez-Melendez, *Universidad Autonoma de Chihuahua, Chihuahua, Chihuahua, Mexico.*

The objective of this study was to evaluate the antimicrobial effect of oregano essential oil and zeolite in solid state fermentation (SSF) of apple bagasse using 5% clinoptilolite zeolite (ZEO), oregano essential oil (0.1% OEO) and both additives (ZXA), compared against the traditional method including apple bagasse, urea, ammonium sulfate and mineral mix as control (CTL). The experiment included 3 replicates per treatment in laboratory plastic containers of 1 L, with sampling at 0, 6, 12, 24, 48, 72 and 96 h. Data were analyzed by repeated measures over time and multiple means comparison. Variables analyzed were aerobic mesophilic bacteria by plate count, pH with a potentiometer, and yeast count by improved Neubauer chamber. Results showed that maximum growth of yeast were obtained at 48 h in ZXA ( $462 \times 10^6$  cells/g), while CTL achieved it at 96 h ( $470.5 \times 10^6$  cells/g), thereby reducing the fermentation time and optimizing the process by the oregano extract antimicrobial activity and the capacity of the zeolite to regulate the concentration of nitrogen compounds. The count of aerobic mesophilic bacteria was decreased significantly ( $P < 0.01$ ) at 48 h, from  $0.70 \times 10^6$  cfu/g in CTL to  $0.25 \times 10^6$  cfu/g in ZXA, being OEO the lower bacterial count treatment ( $0.11 \times 10^6$  cfu/g). There was a higher pH ( $P < 0.01$ ) in ZEO (4.80) and ZXA (4.62) versus CTL (4.06) and OEO (4.03), indicating that the adsorptive capacity of the zeolite allowed a slow and adequate release of the ammonia in the zeolite to the fermentation medium, resulting in a most efficient use of ammonia by yeasts, also regulating the pH and preventing volatile loss. We conclude that the use of both additives provides microbiological advantages over traditional SSF, reducing the fermentation time since yeasts have more available nitrogen compounds, and less foreign bacterial contamination, which could compete for substrates, production of secondary metabolites or modify pH. This guarantees a clean and free microbiological contaminants process.

**Key Words:** yeast, mesophilic bacteria, apple bagasse

**W168 In vitro fermentation and digestion characteristics of shrubs *Croton cortesianus* and *Leucophyllum frutescens* browsed by white-tailed deer (*Odocoileus virginianus*).** M. S. Alvarado<sup>1</sup>, M. A. Cerrillo-Soto<sup>1</sup>, M. Guerrero-Cervantes\*<sup>1</sup>, A. S. Juárez-Reyes<sup>1</sup>, R. G. Ramírez<sup>2</sup>, H. Rodríguez<sup>2</sup>, and T. G. Domínguez<sup>1</sup>, <sup>1</sup>Universidad Juárez del Estado de Durango, Durango, Mexico, <sup>2</sup>Universidad Autónoma de Nuevo León, San Nicolás de los Garza, Nuevo León, México, <sup>3</sup>Universidad Autónoma de Nuevo León, Linares, Nuevo León, México.

Native vegetation in northeastern Mexico is mainly composed of shrubs and small trees, which are commonly selected by white-tailed deer. The aim of the study was to determine, seasonally, the in vitro fermentation profiles of *Croton cortesianus* and *Leucophyllum frutescens*. Foliage was sampled from summer 2004 to spring 2005 for a total of 4 consecutive seasons in Los Ramones in the state of Nuevo Leon, Mexico. In vitro gas production was recorded at 3, 6, 9, 12, 24, 48, 72 and 96 h. As inoculum, rumen fluid from fistulated sheep was utilized. Kinetic parameters

such as the asymptotic gas production (B), rate of gas production ( $k$ ) and lag phase (L) were estimated by the exponential model  $G = b \times (1 - e^{-k(t-L)})$ . Microbial protein synthesis, ME content and in vitro organic matter digestibility (IVOMD) were also evaluated. Data were analyzed using ANOVA for a completely randomized design. The asymptotic gas production (B) ranged from 151 mL/g DM in *L. frutescens* in spring to 220 mL/g DM in *C. cortesianus* in winter. The rate of gas production ( $c$ ) was the lowest in *C. cortesianus* in summer (0.050%/h) while the highest (0.082%/h) in *L. frutescens* collected in winter. Values regarding lag phase (L) ranged from 0.43 to 22.06 h; in general, this variable was superior in *C. cortesianus* during summer, autumn and winter (2.06, 1.60 and 1.23 respectively). Microbial protein synthesis measured as purines was similar among shrubs and seasons. Mean values ranged from 4.04 in to 7.80  $\mu\text{mol}$  in *C. cortesianus* in spring and winter. Estimates of ME were highest in *C. cortesianus* among seasons (summer 1.73; autumn, spring 1.70 and winter 1.66 Mcal/kg DM). The same scenario was registered with the IVOMD content where values varied from 55 to 84%. Highest digestibility values were registered in *C. cortesianus*. Data suggest that *C. cortesianus* represents a better feed reserve for white-tailed deer in the semiarid regions of northeastern Mexico.

**Key Words:** gas production, white-tailed deer, native shrubs

**W169 Effect of lactic acid bacteria with bacteriocinogenic activity on the microbial populations and fermentation of alfalfa silage in tropical conditions.** V. P. Silva, O. G. Pereira\*, K. G. Ribeiro, T. C. Da Silva, M. C. N. Agarussi, L. D. A. Rufino, R. M. Martins, F. X. Amaro, and A. M. Corrêa, *Universidade Federal de Vicosa, Vicosa, Minas Gerais, Brazil.*

Lactic acid bacteria (LAB) are used as silage additives to ensure the conservation of the nutritive value of forage by reducing the pH through acid production and inhibition of undesirable microorganisms in the epiphytic flora. The objective of this work was to evaluate the effect of a commercial inoculant and 2 strains of LAB with potential bacteriocinogenic activity on the microbial populations and the fermentation of alfalfa silage. The alfalfa was harvested 82 d after sowing and was wilted for 6 h. After, it was chopped into a 1.5 cm particle size and packed in bags, with 3 replications. A  $4 \times 6$  factorial arrangement (4 inoculants and 6 fermentation periods) was used in a completely randomized design. The inoculants (I) were: 1) Control; 2) Sil All (CI; Alltech, Brazil); 3) Strain 10.4 (S-10.4; *Pediococcus acidilactici*); and 4) Strain 6.16 (S-6.16; *P. pentosaceus*). These strains have potential bacteriocinogenic activity and were isolated from *Stylosanthes* silage. The fermentation periods (P) were: 1, 3, 7, 14, 28 and 56 d after ensiling. The concentration of lactic acid and propionic acid were not affected by the interaction  $I \times P$  ( $P > 0.05$ ). There was effect of I on the DM, pH, ammonia, lactic acid and acetic acid. Silages treated with S-10.4 and S-6.16 resulted in the lowest pH. After 56 d, all silages treated with inoculants had lower ( $P < 0.05$ ) pH compared with the control. The silage treated with S-6.16 showed the highest ( $P < 0.05$ ) concentration of lactic acid (3.07% of DM) at 56 d. There was no effect ( $P > 0.05$ ) of I on the concentrations of CP, NDF, ADIN, and lignin at 56 d. Only the population of enterobacteria was affected ( $P < 0.05$ ) by P, showing a decrease overtime and the lowest number on d 14 (1.05 cfu/g). The strains evaluated improved the fermentation of alfalfa silage in tropical conditions by reducing the concentration of ammonia nitrogen, and increasing the concentration of lactic acid, leading to a faster pH drop and control of undesirable microorganisms.

**Key Words:** inoculant, lactic acid bacteria, strain

**W170 Effect of wilting and inoculant on microbial populations and fermentation profile of alfalfa silage in tropical conditions.**

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The objective of this study was to evaluate the effects of wilting (W) and microbial inoculant (I) on the fermentation characteristics and microbial populations of alfalfa silage. Data were analyzed as a  $2 \times 2 \times 6$  factorial arrangement with the effects of wilting (absence or presence), microbial inoculant (with and without) and period of fermentation (P) (1, 3, 7, 14, 28 and 56 d), and their interaction in a completely randomized design with 3 replications. Alfalfa was harvested at 56 d of regrowth and chopped into particles of 1.5 cm. Alfalfa was wilted for 6 h in the field before ensiling, in the material submitted to this treatment. The inoculant used was Sil-All 4x4 W.S. (Alltech, Brazil), applied at the rate of  $10^5$  cfu/g of fresh forage. After applying treatments the forage was packed in plastic bags of  $25 \times 35$  cm and sealed by using vacuum sealer. Wilting increased the DM content of the fresh alfalfa from 133.9 g/kg to 233.4 g/kg DM and the population of lactic acid bacteria (LAB) from  $5.28 \log$  cfu/g to  $6.88 \log$  cfu/g before ensiling. The number of enterobacteria and yeasts were affected ( $P < 0.05$ ) by P, registering a higher number of these microorganisms on the first day of ensiling. The pH and ammonia nitrogen concentration were affected by the interaction  $W \times P$  ( $P < 0.05$ ), recording the lowest values on wilted-alfalfa silages from the 7th day of ensiling. There was effect of the interaction  $W \times P$  ( $P < 0.05$ ) on the concentrations of lactic, acetic and propionic acids. Except for the first day of fermentation, we observed higher concentrations of lactic acid in the wilted silages, however in both wilted and non-wilted silages the values decreased from the 7th day of ensiling. The concentration of acetic acid in the wilted alfalfa was lower than non-wilted alfalfa in all period of fermentation. The wilting of alfalfa was not enough to promote adequate silage fermentation in presence or absence of microbial inoculant.

**Key Words:** pH, organic acid, microbial inoculant

**W171 Seeding rate affects performance of ball clover mixed with annual ryegrass in North Florida.**

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Legumes have the capacity to associate with rhizobia strains and fix atmospheric  $N_2$ . Ball clover (*Trifolium nigrescens* Viv.) has reseeding ability and when planted in mixtures with annual ryegrass (*Lolium multiflorum* Lam.) contributes to add N to the systems and to expand the grazing season. This experiment tested 3 seeding rates of ball clover (0.9, 1.8 and  $2.7 \text{ kg ha}^{-1}$ ) in a mixture with annual ryegrass compared with annual ryegrass in monoculture, fertilized ( $50 \text{ kg N ha}^{-1}$ ) or not with N. Response variables included percentage of ball clover, dry matter yield (DMY) annual ryegrass, DMY ball clover, total DMY, percentage of plant N derived from atmosphere (%Ndfa) and N fixed contained in the shoot ( $N_{\text{fix}}$ ). The study was performed in a complete randomized block design with 4 replicates. Ball clover proportion in the mixture increased ( $P = 0.02$ ) from 32% (at  $0.9 \text{ kg ha}^{-1}$  seeding rate) to 47% (at  $1.8 \text{ kg ha}^{-1}$  seeding rate), with no significant differences ( $P > 0.05$ ) observed between the 2 higher seeding rates ( $1.8$  and  $2.7 \text{ kg ha}^{-1}$ ). Ball clover DMY increased linearly ( $P = 0.02$ ) with increasing seeding rates, with DMY of 711, 1,117, and  $1,165 \text{ kg ha}^{-1}$  for 0.9, 1.8, and  $2.7 \text{ kg ha}^{-1}$  seeding rates, respectively. Annual ryegrass DMY ( $P < 0.0001$ ) and total DMY ( $P = 0.0007$ ) were greater in the N fertilized treatment

( $3,810 \text{ kg DM ha}^{-1}$ ). Average %Ndfa was 95% for ball clover and there was no difference among treatments ( $P > 0.05$ ). The  $N_{\text{fix}}$  showed linear increase with seeding rate ( $P = 0.02$ ) with values ranging from 18 to  $28 \text{ kg N ha}^{-1}$ . Treatments including seed rates of 1.8 and  $2.7 \text{ kg ha}^{-1}$  were similar in botanical composition, DMY ball clover, DMY ryegrass, total DMY, and  $N_{\text{fix}}$ . From the producer perspective, it is more economical to use  $1.8 \text{ kg seeds of ball clover ha}^{-1}$ . Increasing seed rates of ball clover in annual ryegrass mixtures allowed greater legume contribution in the pasture, improving forage N without decreasing yield.

**Key Words:** botanical composition, legume, N-fixation

**W172 Effects of hybrid and inoculant application on chemical composition and fermentation indices of barley silage.**

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This study examined the effect of hybrid and inoculant application on the chemical composition, fermentation indices and fatty acid profile of barley silage. Two Korean barley hybrids (Yuyeon, YU and Youngyang, YO) were harvested at dough stage, which were 24.9% and 27.1% of dry matter, respectively. The forages were chopped to 4–6cm lengths and treated with or without inoculant at the ratio of  $1.2 \times 10^4$  cfu/g of *L. plantarum* on fresh weight basis. Treatments had a  $2 \times 2$  factorial arrangement with 4 replicates. Each replicate was ensiled in a 10-L mini silo for 100 d and analyzed for chemical composition and in vitro DM digestibility. Data were analyzed with a model including hybrid, inoculant and the interaction using the GLM procedure of SAS. The YU silage had greater ( $P < 0.01$ ) ash, acid detergent fiber and in vitro dry matter digestibility and mold counts than YO silage, but lower ( $P < 0.01$ ) lactate and acetate concentrations. For YU but not YO, inoculation decreased the NDF concentration ( $P = 0.002$ ), lactic to acetic acid ratio ( $P = 0.004$ ), lactic acid bacteria ( $P = 0.007$ ) and yeast counts ( $P < 0.001$ ) and increased the pH ( $P = 0.032$ ) and ammonia-N concentration ( $P = 0.026$ ) (hybrid  $\times$  inoculant interaction). The YU silage had greater ( $P < 0.005$ ) C14:0, C16:0, C18:3n-3 and saturated fatty acid concentrations than YO silage, but lower ( $P = 0.001$ ) C18:2n-6 concentration. Inoculation decreased ( $P < 0.05$ ) C18:3n-3 concentrations, but increased ( $P < 0.05$ ) C18:2n-6 and saturated fatty acid concentrations. For YU but not YO, inoculation decreased total fatty acid ( $P = 0.034$ ) and polyunsaturated fatty acid ( $P = 0.003$ ) concentrations but increased C18:0 ( $P = 0.011$ ), C18:1n-9 ( $P = 0.044$ ), monounsaturated fatty acid ( $P = 0.033$ ) concentrations (hybrid  $\times$  inoculant interaction). The PCR analysis followed by gel electrophoresis showed higher concentration of *L. plantarum* DNA in the inoculated silage. In conclusion, YU silage was more digestible but it had greater mold counts than YO silage. Inoculation did not improve the fermentation but it reduced the acetate and 18:3n-3 fatty acid concentrations and increased the C18:2n-6 and saturated fatty acid concentration.

**Key Words:** barley silage, fatty acid profile, inoculant

**W173 Comparison of in situ digestion of corn stover treated by two alkali methods to untreated corn stover and soyhulls.**

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The objective of this study was to evaluate the in situ NDF digestibility of corn stover treated at ambient temperature with a solution of sodium hydroxide and ethanol co-solvent. The treatment process is patented by Cellulose Sciences International (CSI) of Madison, WI. Digestion kinetics were evaluated in situ for untreated corn stover, corn stover treated with CaOH at 70 g kg<sup>-1</sup>, corn stover treated by the CSI process and untreated soyhulls. All materials were ground through a 2 mm screen in a Wiley mill and 0.5 g was sealed into Ankom F57 bags. Bags were placed in the rumens of 2 fistulated cows for 0h, 12h, 24h, 30h, 36h, 42h, 48h, 96h, 120h, and 240 h in reverse order. Bags were then washed, dried and contents analyzed for residual NDF. The 240h time point was used as the estimate of indigestible NDF (iNDF). The rate of digestion of potentially digestible NDF (pdNDF) was determined from the slope of the natural log of the pdNDF residue verses time. The fraction of iNDF and the rate of pdNDF degradation between forages were compared by ANOVA (PROC Mixed, SAS, v 9.3) as a randomized design with cows as replicates. Least square treatment means were compared by PDIF. The digestion rate of pdNDF (kd,) of CSI-treated corn stover (5.36%/h) was higher than CaOH-treated stover (2.27%/h,  $P < 0.01$ ), and untreated corn stover (1.76%/h,  $P < 0.001$ ). The kd of soyhulls (4.93%/h) was similar CSI-treated stover ( $P = 0.56$ ). The iNDF proportions in CSI-treated stover and soyhulls, were similar (2.8 and 3.6% of NDF, respectively,  $P = 0.26$ ). The CSI-treated stover had lower iNDF than CaOH-treated stover or untreated stover (2.8, 27.3 and 35.1% of NDF, respectively,  $P < 0.0001$ ). Results indicate that the CSI-treatment process improved rate and extent of digestion of corn stover to a greater degree than the CaOH treatment process. The CSI treatment process appears to convert corn stover into a source of highly digestible fiber with digestion characteristics similar to soyhulls.

**Key Words:** in situ, NDF, NaOH

**W174 Effects of different source additive and wilt condition on the pH value, aerobic stability, and carbohydrate and protein fractions of alfalfa silage.** Lian Tao<sup>1</sup>, He Zhou<sup>2</sup>, Nai-feng Zhang<sup>1</sup>, Bing-wen Si<sup>1</sup>, Yan Tu<sup>1</sup>, Tao Ma<sup>1</sup>, and Qi-yu Diao\*<sup>1</sup>, <sup>1</sup>Feed Research Institute, Chinese Academy of Agricultural Sciences, Key Laboratory of Feed Biotechnology of the Ministry of Agriculture, Beijing, China, <sup>2</sup>Institute of Grassland Science, College of Animal Science and Technology, China Agricultural University, Beijing, China.

To improve alfalfa silage quality and reduce additive cost, the potential of applying the fermented juice of epiphytic lactobacillus (FJEL) as an additive was evaluated. The experiment was designed as a 5 × 3 2-factor (wilt condition and additive) test. The second cut alfalfa at the budding stage was harvested, exposed to sunlight for 0 (20.04% DM; type 1), 5.2 (34.15% DM; type 2) or 8.5 h (54.58% DM; type 3). Alfalfa stuff were harvested in the next morning, exposed to sunlight and then natural rainfall for 1 h (33.20%DM; type 4) or 3 h (24.58% DM; type 5) before cutting. Alfalfa forage of each type was cut to 1–2 cm, then treated with distilled water (control), FJEL, or commercial lactobacillus product (CLP) at 10 ml/kg fresh weight (FW). The FJEL was made from alfalfa juice that was anaerobically stored for 2 d. The treated forages (approximately 500 g) were ensiled in vacuum-sealed polyethylene bags for 45 d, with 3 replicates for each treatment. The statistical significance of the effects of additive, wilt condition, and additive × wilt condition on silage quality were analyzed using a repeated measures one-way ANOVA. The application of FJEL decreased ( $P < 0.01$ ) the pH value (4.44 vs. 4.93 or 4.66) and volatile fatty acid (VFA; 38.32 vs.49.55 or 44.82) content and increased ( $P < 0.01$ ) the concentrations of lactic acid (LA; 68.99 vs.51.84 or 63.29) compared with those of the control and CLP treatment. However, the FJEL treatment had the lower ( $P <$

0.01) aerobic stability (254 vs. 274 h), soluble fiber (148.89 vs. 154.85 g/kg DM), available NDF (145.39 vs. 154.25 g/kg DM), rapidly rumen degradable CP (59.91 vs. 62.33 g/kg DM) than CLP treatment. A higher pH and lower LA, sugar, starch and soluble fiber contents were found in the rain treatments compared with those of the no-rain treatments ( $P < 0.01$ ). In conclusion, the application of FJEL could improve silage quality compared with the control; in addition, its effect as a fermentation stimulant may be comparable to or even better than CLP.

**Key Words:** alfalfa silage, wilt condition, epiphytic lactic acid bacteria

**W175 Yield and nutritive value for ruminants of organic winter cereals–bard vetch intercrops.** Alexey Diaz<sup>1,4</sup>, María Dolores Carro<sup>2</sup>, Carlos Palacios<sup>3</sup>, Cristina Saro<sup>1</sup>, Iván Mateos<sup>1</sup>, María Luisa Tejido<sup>4</sup>, and María José Ranilla\*<sup>1,4</sup>, <sup>1</sup>Animal Production Department, University of León, León Spain, <sup>2</sup>Agriculture Production Department, Technical University of Madrid, Madrid, Spain, <sup>3</sup>Construction and Agronomy Department, University of Salamanca, Salamanca, Spain, <sup>4</sup>IGM (CSIC-ULE), Finca Marzanas s/n, Grulleros, León, Spain.

Organic livestock in the European Union must be fed with organic feed, and forage should be at least 60% of the diet of herbivorous animals. However, the productivity of crops in organic farming is frequently lower than that in conventional farming, and organic cultivation of winter cereals often reduces forage CP content. Intercropping of winter cereals with legumes can provide both higher forage yield and quality compared with winter cereal monocultures, but the results may differ with cultivation conditions. The objective of this study was to investigate the potential of winter oats and barley intercropping with bard vetch (*Vicia articulata*) to enhance forage yield and quality as compared with cereals as a monoculture. The experiment was carried out in the province of Zamora (Spain) in 2014, as a randomized complete block design with 4 replications. Whole-plant DM yield was determined in June and chemical composition and in vitro DM digestibility (IVDMD) of harvested forages were analyzed. In addition, samples (500 mg) of each forage were incubated with 50 mL of buffered sheep rumen fluid at 39°C for 24 h and VFA production was measured. Intercropping with bard vetch increased ( $P < 0.05$ ) forage yield by 25 and 18% for oats and barley, respectively, compared with monoculture. Intercropping also increased CP contents ( $P < 0.05$ ; mean values 629 vs. 949 g/kg DM), and decreased ( $P < 0.05$ ) NDF and ADF contents. The IVDMD was also higher ( $P < 0.01$ ) for intercrops than for cereal monocultures. The presence of bard vetch in the cultures increased total VFA production ( $P < 0.001$ ) by 27 and 15% for oats and barley, respectively. This was due to an increase in the production of acetate, propionate and butyrate ( $P < 0.05$ ), but no effects ( $P > 0.05$ ) of intercropping were detected for the acetate:propionate ratio or the molar proportions of individual VFA. The results indicate that forage yield and quality of oats and barley can be enhanced by intercropping with bard vetch under the cultivation conditions of this study. These results should be confirmed in multi-year studies before drawing up guidelines for organic farmers.

**Key Words:** organic cultivation, cereal, legume intercropping

**W176 Comparison of total tract neutral detergent fiber digestibility of different varieties of barley silage selected on the basis of in vitro NDF degradability.** Natalie G. Preston\*<sup>1,2</sup>, Jayakrishnan Nair<sup>1</sup>, Peiqiang Yu<sup>1</sup>, David A. Christensen<sup>1</sup>, John J. McKinnon<sup>1</sup>, and Timothy A. McAllister<sup>2</sup>, <sup>1</sup>University of Saskatchewan, Saskatoon,



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Selecting forages with increased neutral detergent fiber (NDF) digestibility has been hypothesized to increase dry matter intake (DMI) in ruminants, but this hypothesis has not been tested using barley (*Hordeum vulgare*) silage. The objective of this study was to compare the total-tract NDF digestibility of different barley silage varieties selected for increased in vitro NDF degradability at 30 h using rumen cannulated sheep. Nine cannulated wethers in a triplicated 3 × 3 Latin square design were fed a 50:50 barley silage: concentrate pellet ration on a dry matter (DM) basis. Varieties of barley silage ensiled and fed included; CDC Cowboy, CDC Copeland, and Xena, based on selection for high, intermediate, and low NDF degradability, respectively. Of the 7 ensiled barley varieties tested, NDF degradability after 30 h incubation in an ANKOM fiber analyzer, CDC Cowboy had the highest NDF degradability at 34.2% of DM, CDC Copeland and Xena were selected based on their intermediate and lower degradability of 28.3% and 26.2%, respectively ( $P < 0.05$ ). Lambs were fed ad libitum during a 12 d adaptation period. On d 12–14, lambs were restricted to 95% intake during which ruminal pH was recorded over 48 h using rumen pH loggers set to record pH every minute. On d 18, lambs were restricted to 90% intake, and housed in metabolic crates for total fecal collection over 4 d. Data were analyzed using the Proc Mixed procedure of SAS as a triplicate Latin square with day as a repeated measure within period. Lambs fed Xena had higher ( $P < 0.01$ ) DMI (773 g/d) as compared with those fed Cowboy (667 g/d), both of which did not differ from Copeland (714 g/d). Digestibility of DM was greater ( $P < 0.05$ ) for Copeland (69.3%) than Cowboy (65.6%) both of which did not differ from Xena (67.5%). Ruminal pH was reported as mean, max, min, and time < 5.8. Treatment did not affect mean, max, or min pH ( $P > 0.05$ ), but time pH < 5.8 was longer ( $P < 0.05$ ) for Xena, 301 min/d, than Cowboy, 123 min/d. Based on DM digestion and intake it can be inferred that selecting varieties based on improved in vitro NDF degradability does not improve DMI or total-tract digestibility of barley silage in sheep.

**Key Words:** barley silage, neutral detergent fiber, digestibility

**W177 Effect of reduced lignin alfalfa on forage quality at 3 harvest intervals.** Zhiqiang Li<sup>1,2</sup>, Dan J. Undersander<sup>1</sup>, David K. Combs<sup>1</sup>, and Zhenzhen Li<sup>1,2</sup>, <sup>1</sup>University of Wisconsin, Madison, WI, <sup>2</sup>Department of Grassland Science, China Agricultural University, Beijing, China.

The present study investigated the effect of reduced lignin alfalfa on forage quality. A 2 × 3 factorial design was used. Two alfalfa cultivars (Roundup Ready (RR) and double stacked RR and Reduced Lignin (RR/RL)) were harvested at intervals of 28d, 33d, and 35d. All replicated plots were established in June and harvested for 2 regrowth periods in July and August in 2014. Four replicates were used. Statistical analysis was a 2-way ANOVA using SPSS 22. Crude Protein (CP), Neutral Detergent Fiber (aNDF), Lignin, NDF Digestibility in 48 h (NDFD48) were analyzed by NIRS (FOSS 6500 using NIRSC 2012 Alfalfa Hay Equation). CP content was not significantly different between RR and RR/RL (27.5 vs 28.0,  $P > 0.05$ ) and declined with advancing maturity ( $P < 0.05$ ). aNDF content of RR was significantly higher than RR/RL (31.6 vs 30.1), though differences among harvest intervals were not significant (30.8 vs 30.5 vs 31.1). Lignin content was not significantly different between RR and RR/RL (5.6 vs 5.5) or among harvest intervals (5.6 vs 5.6 vs 5.5). The NDFD48 of RR/RL was significantly higher than RR (52.2 vs 50.5). Indigestible NDF (iNDF), Rate of fiber digestion ( $K_d$ ), and Total-tract NDF Digestibility (TTNDFD) had not been reported for the RL germplasm and were shown in the table below.

The reduced lignin alfalfa tended to be lower in iNDF and higher in  $K_d$  though differences were not significant, but was significantly higher in TTNDFD. It appears that RR/RL reduced the aNDF content and improved NDFD48 and TTNDFD.

**Table 1 (Abstr. W177).** Comparison between RR and RR/RL in iNDF,  $K_d$  and TTNDFD

Item		RR	RR/RL	Average	P-value		
					Forage	Harvest interval	Forage × harvest interval
iNDF (%NDF)	28 d	34.1	29.9	31.7 <sup>b</sup>	0.086	0.001	0.470
	33 d	42.1	37.0	39.9 <sup>a</sup>			
	35 d	39.3	39.2	39.2 <sup>a</sup>			
	average	38.7 <sup>a</sup>	35.1 <sup>a</sup>	36.8			
$K_d$ (%)	28 d	7.8	7.1	7.4 <sup>a</sup>	0.156	0.980	0.153
	33 d	7.0	8.2	7.5 <sup>a</sup>			
	35 d	6.4	8.9	7.8 <sup>a</sup>			
	average	7.0 <sup>a</sup>	8.0 <sup>a</sup>	7.6			
TTNDFD (%NDF)	28 d	53.0	56.3	54.9 <sup>a</sup>	0.012	0.010	0.849
	33 d	46.3	51.9	48.7 <sup>b</sup>			
	35 d	46.8	51.1	49.2 <sup>b</sup>			
	average	48.6 <sup>b</sup>	53.3 <sup>a</sup>	51.0			

**Key Words:** variety, harvest interval, hay quality

**W178 Microbial counts, fermentation, and aerobic stability of oats with and without combo inoculant ensiled in vacuum bags and plastic bucket silos.** Juan J. Romero<sup>\*1</sup>, Jinwoo Park<sup>2</sup>, Youngho Joo<sup>2</sup>, Yuchen Zhao<sup>3</sup>, Axel Gonzalez<sup>1</sup>, Marco A. Balseca-Paredes<sup>1</sup>, and Miguel S. Castillo<sup>1</sup>, <sup>1</sup>Department of Crop Science, North Carolina State University, Raleigh, NC, <sup>2</sup>Department of Animal Science, Gyeongsang National University, Jinju, Korea, <sup>3</sup>Department of Animal Nutrition and Feed Science, China Agricultural University, Beijing, China.

The objective was to evaluate the use of 2 types of experimental silos to characterize microbial counts, fermentation, and aerobic stability of oats ensiled with and without addition of a homolactic and heterolactic inoculant. From each of 6 sections in a field, whole-plant oats at heading stage were harvested, wilted, chopped, treated (INO) or not (CON) with inoculant, packed into 20L plastic bucket silos (BKT) or 15.2 × 30.5cm nylon-polyethylene embossed vacuum bags (BAG), and ensiled for 217d. The inoculant added contained *Lactobacillus buchneri* and *Pediococcus pentosaceus* ( $4 \times 10^5$  and  $1 \times 10^5$  cfu/g of fresh oats, respectively). Experimental design was a complete randomized design replicated 6 times. Treatment design was the factorial combination of 2 silo types × 2 inoculation treatments. At d 0 there were no differences between BAG and BKT, and between INO and CON on DM ( $44.0 \pm 1.0$ , %), pH ( $6.11 \pm 0.07$ ), and counts of lactic acid bacteria ( $9.28 \pm 0.13$ ), yeasts ( $4.88 \pm 0.09$ ), and molds ( $3.97 \pm 0.08$ ). At opening (d 217) there was no difference in DM ( $42.9 \pm 0.9$ , %) among treatment combinations. There was a lower pH ( $4.25$  vs.  $4.41 \pm 0.02$ ), yeasts ( $1.10$  vs.  $4.13 \pm 0.34$ ), and NDF ( $65.0$  vs.  $67.0 \pm 0.40$ ) for INO compared with CON, respectively ( $P \leq 0.05$ ). Lactic acid bacteria count ( $6.39$  vs.  $5.65 \pm 0.17$ ), DM recovery ( $96.1$  vs.  $92.9 \pm 0.43$ , %), and aerobic stability ( $565$  vs.  $133 \pm 29$ , h) were greater in INO compared with CON, respectively ( $P \leq 0.05$ ). Molds were similar when INO was applied to BKT (1.68) and BAG (1.42) but higher in BKT (2.82) compared with BAG ( $0.80 \pm 0.41$ ) for CON (silo type × inoculation,  $P \leq 0.05$ ). In summary, differences due to silo type were only significant for mold count at opening. The

combo inoculant used increased lactic acid bacteria, decreased pH and NDF, and improved aerobic stability by decreasing yeast count of oats silage. Silo bags are an alternative technique to buckets to adequately characterize lactic acid bacteria, yeasts, and fermentation of ensiled oats.

**Key Words:** silo, microbe, inoculant

**W179 Change in chemical and microbial composition during aerobic challenge of maize silage with and without *L. buchneri* inoculation.** Ida K. Hindrichsen\*, Nina Milora, Marianne Richelieu, and Asger Geppel, *Chr. Hansen A/S, Hørsholm, Denmark.*

Inoculation of *L. buchneri* (LB) is well recognized for extending aerobic stability of silage during feed out. The effect is mainly documented by measuring temperature change during small scale aerobic challenge. The objective of the current study was to investigate the microbial and chemical changes occurring during re-exposure of air to mini-silos inoculated with or without *L. buchneri* (LB). Newly harvested maize was collected from a farm in Denmark in September 2013. The maize was inoculated with tap water or LB and vacuum packed in 1-kg bags and stored at 25°C for 2, 7 or 15 weeks (n = 5 per treatment). For the aerobic challenge, the silage was divided into 2 containers (1.2 L; 274 kg/m<sup>3</sup>) with a 1 cm hole in the top and bottom, and kept at room temperature for 156 h. After aerobic challenge for 0, 3 and 7 d chemical and microbial analysis were performed on all samples. Data were statistically analyzed as a randomized complete block by using GLM procedure by SAS. The none-fermented maize was highly contaminated with yeast and mold of log 6 and log 5, respectively. Aerobic stability and number of yeast was not significantly ( $P > 0.05$ ) improved by inoculating with LB after 2 weeks, but LB inoculation improved the aerobic stability and reduced number of yeast significantly ( $P < 0.05$ ) compared with control, when the silage was kept anaerobic for 7 or 15 weeks. During the aerobic challenge both the microbial and chemical composition changed. Yeast enumeration significantly ( $P < 0.05$ ) increased during the aerobic challenge, except for the LB inoculated silage after 15 weeks of anaerobic fermentation, where yeast count was lower than detection level (log 2). Acetate, ethyl acetate, lactate, and ethanol levels decreased significantly ( $P < 0.05$ ) during aerobic challenge for both treatments and anaerobic fermentation time points. Considerable chemical changes occur during aerobic challenge and with increased anaerobe fermentation the effect on aerobic stability by inoculation with LB improves.

**Key Words:** volatile organic compound, maize silage, aerobic stability

**W180 Biological N<sub>2</sub> fixation and performance of cool-season legumes mixed with annual ryegrass.** Jose C. B. Dubeux Jr.\*<sup>1</sup>, Lynn E. Sollenberger<sup>2</sup>, Ann R. S. Blount<sup>1</sup>, Cheryl Mackowiak<sup>1</sup>, Erick R. S. Santos<sup>1</sup>, Hiran M. S. Silva<sup>1</sup>, and Martin Ruiz-Moreno<sup>1</sup>, <sup>1</sup>*North Florida Research and Education Center, University of Florida, Marianna, FL*, <sup>2</sup>*Agronomy Department, University of Florida, Gainesville, FL.*

Symbiotic association between forage legumes and N<sub>2</sub>-fixing microorganisms reduces the need for pasture N fertilization and increases forage N concentration. Pastures of cool-season legumes mixed with annual ryegrass (*Lolium multiflorum* Lam.) are an option to extend the grazing season in subtropical regions. We investigated the association of 4 cool-season legumes with annual ryegrass and contrasted with annual ryegrass in monoculture. Clovers tested included balansa (*Trifolium michelianum* Savi), ball (*Trifolium nigrescens* Viv.), berseem (*Trifolium alexandrinum* L.), and crimson (*Trifolium incarnatum* L.). Treatments were replicated

4 times in a randomized complete block design. Response variables analyzed included total dry matter yield (DMY), clover DMY, annual ryegrass DMY, <sup>15</sup>N grass, <sup>15</sup>N legume, botanical composition, N concentration of grass and legume components, shoot N yield for grass and legume, percentage of N derived from atmosphere (%Ndfa), and N<sub>2</sub>-fixation by the legume. Legume/annual ryegrass mixtures yielded more biomass (average of 2,590 kg DM ha<sup>-1</sup>) compared with unfertilized annual ryegrass (980 kg DM ha<sup>-1</sup>). Among mixtures, crimson clover/annual ryegrass was the most ( $P < 0.01$ ) productive one (4,580 kg DM ha<sup>-1</sup>). Crimson (2,230 kg DM ha<sup>-1</sup>) and berseem (1,720 kg DM ha<sup>-1</sup>) clovers were the 2 most productive legumes. Annual ryegrass yielded more biomass ( $P < 0.001$ ) when mixed with crimson clover compared with other clover mixtures. Clover percentage in the mixtures ranged from 26 to 74%, with berseem showing the highest proportion. Total shoot N yields were 29, 41, 49, 88, and 11 kg N ha<sup>-1</sup> for balansa, ball, berseem, crimson, and unfertilized ryegrass, respectively. The %Ndfa for all clovers were high, varying from 67 to 98%. N<sub>2</sub>-fixation ranged from 11 to 52 kg N ha<sup>-1</sup>, with crimson fixing the greatest amount. Crimson clover presented the best overall performance when mixed with annual ryegrass in North Florida.

**Key Words:** balansa, ball, berseem

**W181 Rumen papillae size and blood serum enzymatic cofactors concentration of bulls fattened under two feeding systems at the Mexican dry tropic.** Carlos Rodríguez-Muela\*, Nilda E. Ruiz-Holguin, Gabriela Corral-Flores, José A. Ramírez-Godínez, Alberto Flores-Mariñelarena, Pablo F. Mancillas-Flores, and Claudio Arzola-Alvarez, *Universidad Autónoma de Chihuahua, Chihuahua, México.*

The objective was to evaluate the effect of the feeding system on rumen papillae (RP) development and the animal welfare. The feeding systems used were: Intensive Silvopastoral (SPI) with grazing leucaena and Tanzania and African star grasses; Feedlot system (FLT) with a diet based on 70% of concentrate and 30% of corn stover. Eighty bulls of 2 breeding groups Brahman×Charolais (Bh×Ch) and Brahman×Brown Swiss (Bh×Ps) randomly distributed at both systems were used. The study lasted 195 d. Blood samples were taken at 0, 71, 132, and 195 d. Initial animal's body weight was 195 kg. Animals were killed at 450 kg body weight. Tissue samples of rumen were taken during slaughter of animals. Evaluated variables were length and width of RP using a Vernier caliper. The concentration of Cu, Zn and Mn in blood serum was measured by atomic absorption spectrophotometry. Data were analyzed with a completely randomized design with factorial arrangement 2 × 2. Measures repeated in time and 0d as a co-variable for the blood serum enzymatic cofactors concentration (SEC) were used. SPI favored ( $P < 0.01$ ) RP development, with values of 1.16 ± 0.05 and 1.11 ± 0.05; 0.38 ± 0.03 and 0.36 ± 0.03 cm in length and width of RP of Bh×Ch and Bh×Ps respectively (Table 1). There were a decrease ( $P < 0.01$ ) in Cu, Mn and Zn concentration for sampling day, with lowest values at 132d, due to a possible caloric stress for environmental high temperature and relative humidity. There was effect of system for SEC ( $P < 0.05$ ), with increase for Cu and Mn but decrease of Zn in SPI. We concluded that SPI allowed to a better RP development by the quality of the fiber consumed in the diet, no matter the breed group, and a larger serum concentration of Cu and Mn, although with a significant reduction of Zn concentration.

*Contd.*



**Table 1 (Abstr. 181).** Length and width of RP<sup>1</sup> and SEC of bulls fattened under two feeding systems

Variable	FLT	SPI
RP length (Bh×Ch)	0.63 ± 0.09 <sup>b</sup>	1.16 ± 0.05 <sup>a</sup>
RP length (Bh×Ps)	0.76 ± 0.07 <sup>b</sup>	1.11 ± 0.05 <sup>a</sup>
RP width (Bh×Ch)	0.20 ± 0.05 <sup>b</sup>	0.38 ± 0.03 <sup>a</sup>
RP width (Bh×Ps)	0.22 ± 0.04 <sup>b</sup>	0.36 ± 0.03 <sup>a</sup>
Cu (mg/L)	0.108 ± 0.004 <sup>b</sup>	0.124 ± 0.004 <sup>a</sup>
Mn (mg/L)	0.379 ± 0.010 <sup>b</sup>	0.424 ± 0.011 <sup>a</sup>
Zn (mg/L)	0.533 ± 0.030 <sup>a</sup>	0.406 ± 0.032 <sup>b</sup>

<sup>1</sup>Length and width of RP are expressed in cm.

**Key Words:** papillae, enzymatic cofactors, feeding system

**W182 Effect of kernel processor and theoretical length of cut on physical characteristics of forage corn harvested with one row harvester.** Gilson S. Dias Júnior<sup>\*1</sup>, Nilson N. Morais Júnior<sup>1</sup>, Ronaldo F. Lima<sup>1</sup>, Fabiana F. Cardoso<sup>1</sup>, Ozana F. Zacaroni<sup>1</sup>, Renata A. N. Pereira<sup>3,2</sup>, and Marcos N. Pereira<sup>1,2</sup>, <sup>1</sup>Universidade Federal de Lavras, Lavras, MG, Brazil, <sup>2</sup>Better Nature Research Center, Ijaci, MG, Brazil, <sup>3</sup>Empresa de Pesquisa Agropecuária de Minas Gerais, Lavras, MG, Brazil.

Adequate kernel breakage and sufficient particle size are desirable in corn silage (CS). Most Brazilian dairy farms use one-row forage harvesters. For such machines, a kernel processor (KP) was developed (MU9000462–0 U2 INPI patent). We evaluated the effect of theoretical length of cut (TLOC) and KP on CS particle size and kernel damage. Corn (Dow 2B587 Hx) was harvested at half milk line maturity (36.4% DM, 52.1% NDF, 30.0% starch). Treatments were a factorial combination of TLOC (3, 4.5, 6, 8.5 mm) and KP (with or without), and 50 m rows were harvested in triplicate. Statistical model had effects of TLOC, KP, and their interaction. Particle size distribution was measured with the Penn State Particle Separator. Visible kernels were quantified and classified in extreme (E), poor (P) or intact (I) breakage. Kernel in situ degradation in 12 h was 24.4% for E, 12.6% for P, and 11.5% for I, in 24 h 39.5%, 26.2%, and 23.6% ( $P < 0.05$  E vs. P and E vs. I), and the residue of 72 h 25.2%, 39.4%, and 48.3% (all differ at  $P < 0.05$ ), respectively. The KP reduced visible kernels in forage (44.2 vs. 70.5 g/500 g forage,  $P < 0.01$ ) and the proportion of P+I (23.2 vs. 41.0 g/500 g forage,  $P < 0.01$ ). The TLOC 3 mm without KP (traditional in practice) had more visible kernels (56 g/500 g forage) than 8.5 mm with KP (44 g/500 g forage). The reduction in visible kernels with smaller TLOC was larger when KP was not used ( $P < 0.01$  for interaction). The proportion of particles below the 8 mm screen was 22 and 28% of fresh forage for TLOC 6 and 8.5 mm with KP, respectively, and 35% for 3 mm without KP. The TLOC 3 mm without KP had smaller proportion of starch below the 8 mm screen (21% of starch) than all TLOC with KP (29 to 35% of starch). The TLOC 3 mm without KP had 72% of NDF greater than 8 mm and 6 and 8.5 mm with KP had 79% and 82%, respectively. Although KP reduced NDF particle size, the reduction was not as large as the reduction induced by small TLOC. Reducing TLOC was more effective in reducing NDF particle size when KP was not used ( $P < 0.01$  for interaction). Large TLOC with KP resulted in forage with longer NDF and increased kernel damage than small TLOC without KP, which is nutritionally desirable.

**Key Words:** forage harvester, particle size, corn silage

**W183 The relative effects of external factors on variability of in situ fiber digestion.** Abebe T. Hassen, Fredric Owens<sup>\*</sup>, Lesa Nuzback, Chris Iiams, and Mark Hinds, *DuPont Pioneer, Johnston, IA.*

Differences in fiber digestibility among high-yielding corn silage hybrids usually are small. Therefore, screening tools should be precise. This study was designed to evaluate the relative influence of several external factors on variability among in situ NDF digestibility values, and estimate the potential precision improvements from increasing the number of steers and of replicate samples per steer. Samples from 3 corn hybrids were used as check hybrids during 85 routine in situ trials conducted over several years. Dry ground whole plant from the check hybrids were weighed into sealed Dacron in situ bags; duplicate bags containing each check hybrid were placed into each of 4 larger mesh bags with other samples being assayed. Within each 48 h run, 4 steers were used. Initially data were averaged by hybrid, run, steer, and mesh bag. These then were analyzed by hybrid using a model that included random effects of run, steer, run × steer interaction, and an error term. Data pooled across hybrids were analyzed using models that included the above effects as well as hybrid. In separate models, the hybrid effect was considered fixed and random. Mean in situ fiber digestibility for check hybrids ranged from 56% to 69%; ranking of these hybrids was consistent across runs. Results from the pooled analysis showed that of the total variability, 56% could be attributed to the error term. Contributions of run, steer, and their interaction were 15%, 20%, and 9%, respectively with contributions being similar when analyzed by hybrid. Repeatability SD of hybrid measurements based on 4 data points per steer was 2.2%. Reproducibility SD of measurements based on different steers and runs was 4.4%. Intra-class correlation of measurements from a hybrid evaluated within the same run using different steers was 0.64. Current results showed that SEM would be reduced by 30 to 40% by increasing the number of steers per run from 1 to 4. Based on 4 steers per run, SEM could be reduced an additional 16% by increasing the number of mesh bag per steer from 1 to 4. Additional improvements in precision from resource re-allocation were minimal.

**Key Words:** digestibility, fiber, in situ

**W184 Characterizing corn silage in Brazil.** M. Pinho<sup>1</sup>, M. Martins<sup>1</sup>, D. Combs<sup>2</sup>, J. Goeser<sup>3</sup>, D. Meyer<sup>3</sup>, L. Meyer<sup>3</sup>, Z. Meyer<sup>3</sup>, F. Lopes<sup>4</sup>, and M. H. Ramos<sup>\*1</sup>, <sup>1</sup>3rlab, Belo Horizonte, Minas Gerais, Brazil, <sup>2</sup>University of Wisconsin, Madison, WI, <sup>3</sup>Rock River Laboratory, Watertown, WI, <sup>4</sup>Kemin Industries, Indaiatuba, São Paulo, Brazil.

A data set of 1796 commercial samples of corn silage assessed for nutritive value by NIR was utilized to generate population descriptive information for the dairy industry in Brazil. Representing silage samples were harvested in the year of 2014 and came from 13 states. Corn silage data were queried from a commercial database and population descriptive statistics were generated with MS excel. Average NDF and starch content were 50% and 24% of DM with a SD of 6.67 and 8.05, respectively, suggesting Brazil corn silage is of lesser energetic value. Typical US corn silages average 44 and 29% NDF and starch for comparison. Rumen in vitro NDF digestibility and predicted in vivo TTNDFD (total-tract neutral detergent fiber digestibility) values exhibited substantial variation, with CV ranging from 15.8 to 38.1, suggesting that opportunity exists to improve forage quality. The database presented here showed a great variation in carbohydrate content (NDF and starch) and NDF availability (TTNDFD). To our knowledge, this is one of the first studies documenting corn silage produced in Brazil variability. With the variation in important nutrients and measurements presented here, there may be potential for genetic selection and improvement for

Brazilian growing conditions. Selecting for lower NDF, greater starch and greater fiber digestibility, including greater TTNDFD, will result in hybrids that allow for greater milk production.

**Table 1 (Abstr. W184).**

Item	CP	NDF	Starch	Sugar	Fat	Ash	NDFD			TTNDFD
							at 24 h	at 30 h	at 48 h	
Median	6.9	50.5	25.1	0.9	3.4	3.3	16.4	24.8	40.2	36.9
Average	6.9	50.8	24.5	1.1	3.3	3.3	16.0	24.5	39.9	36.8
SD	1.0	6.6	8.0	1.0	0.7	0.9	6.1	5.7	7.0	5.8
CV	14.5	12.9	32.6	90.1	21.2	27.3	38.1	23.3	17.5	15.8

<sup>1</sup>All units are % of DM; NDFD = NDF digestibility.

**Key Words:** corn silage, total-tract neutral detergent fiber digestibility, milk2006

**W185 Effect of light intensity and wavelength on concentration of antiherbivory compounds in *Flourensia cernua* leaves.**

Rick E. Estell<sup>\*1</sup>, Ed L. Fredrickson<sup>2</sup>, and Darren K. James<sup>1</sup>, <sup>1</sup>USDA-ARS Jornada Experimental Range, Las Cruces, NM, <sup>2</sup>Eastern Kentucky University, Richmond, KY.

Shrub encroachment negatively affects forage production and range-land health in many semi-arid regions. *Flourensia cernua* (tarbush) has increased in the northern Chihuahuan Desert at the expense of grasslands. Our previous studies have shown a negative relationship between tarbush terpene concentrations and livestock herbivory. Concentrations of secondary compounds are affected by many biotic and abiotic factors, including amount and wavelength of solar radiation. A 3-year study was conducted to examine the impact of shade and UV light restriction on phenolic and terpene concentrations in tarbush. Our hypothesis was that UV restriction and partial shade would reduce carbon based secondary compounds. Sixty plants were randomly selected and assigned to 3 treatments (control, UV light restriction, or 50% incident light restriction) in a randomized complete block. Frames covered with clear plastic film (UV blocking treatment), black shade cloth (50% shade treatment) or frame only were placed over 20 plants each. Leaves were collected from each plant in late September each year and freeze-dried for total phenolic analysis (Folin-Denis method) or frozen for leaf surface terpene analysis (extracted with ethanol and identified and quantified with GCMS). Data were analyzed using repeated measures linear mixed effects models with treatment as the fixed effect and year as a repeated effect. Means were separated by LSD. Mean concentrations of total phenolics and total volatiles in tarbush were 82.4 and 12.5 mg/g DM, respectively. Tarbush leaves contained 102 individual terpenes (including 19 unknowns). No year x treatment interactions were detected for any variable ( $P > 0.05$ ). Total phenolics did not differ between controls and UV restricted plants, but were lower for shaded plants than the other 2 treatments ( $P < 0.05$ ). Total volatiles were higher for the UV restriction treatment than controls ( $P < 0.05$ ), with shaded plants not differing from either treatment. Treatment effects were detected for 18 compounds ( $P < 0.05$ ). Shade reduced total phenolics as predicted, but did not affect total volatiles. In contrast to our expectations, UV restriction had no effect on total phenolics, and increased total volatile concentrations.

**Key Words:** light, phenolic, terpene

**W186 In situ ruminal degradability of diets based on passion fruit (*Passiflora edulis*) flour substituting maize.** Adolfo Sánchez<sup>\*1</sup>, Emma Torres<sup>1</sup>, Leon Montenegro<sup>1</sup>, Italo Espinoza<sup>1</sup>, and Daniela

Sanchez<sup>2</sup>, <sup>1</sup>Universidad Técnica Estatal de Quevedo, Quevedo Los Rios, Ecuador, <sup>2</sup>Universidad Estatal Amazonica, Puyo Pastaza, Ecuador.

This investigation was carried out in the Nutritional Metabolism and Ruminant Laboratory, located at the Experimental Campus “La Maria,” of Quevedo State Technical University (UTEQ – Ecuador) with the objectives of determining in situ ruminal degradability of dry matter (DM), organic matter (OM), neutral detergent fiber (NDF), and acid detergent fiber (ADF), as well as of identifying ruminal pH variation in cattle fed with diets based on passion fruit flour. A complete randomized block design (CRBD) was applied with 4 treatments (T1: 0%; T2: 10%; T3: 20% and T4: 30% inclusion of passion fruit flour substituting maize in diet), (diet components: corn, rice powder, bagasse soy, CaCO<sub>3</sub>, Ca (H<sub>2</sub>PO<sub>4</sub>)<sub>2</sub> x H<sub>2</sub>O and NaCl) and 3 blocks (cattle rumen fistulated) and 7 incubation times (0; 3; 6; 12; 24; 48 and 72 h). To establish the differences between treatment averages, Tukey ( $P \leq 0.05$ ) test was applied. The highest ( $P < 0.05$ ) degradability within 48 and 72 DM - OM and NDF - ADF incubation hours was registered by treatments T1 and T2 (67.68; 69.10% MS - 65.40; 66.71% DM); (71.79; 74.14% OM - 69.28; 70.07% OM); T4 and T3 (86.46; 88.33% NDF - 80.44; 81.02% NDF); (53.94; 56.21% ADF - 47.86; 49.36% ADF respectively). The levels of passion fruit flour inclusion made it possible to keep a (6.3 – 6.8) pH after 12 h of incubation, what is considered adequate for aminolytics and fibrolytics microorganism growing.

**Key Words:** digestibility, degradability, feeding

**W187 Dry matter production of four *Brachiaria* grasses.** Virginia L. N. Brandão, Gabriel C. B. Oliveira, Bruno P. Ignacchiti, Kaik Faria, Marcos Rosa, Guilherme D. Castro, Marcos I. Marcondes<sup>\*</sup>, and Fernanda H. M. Chizzotti, Universidade Federal de Viçosa, Viçosa, Minas Gerais, Brazil.

Studies to determine and compare the productive potential of forages from genus *Brachiaria* under same management conditions are scarce. Therefore, we believe that cultivars with similar morphological characteristics have similar nutritional value, and that management can affect this response. Thus, we aimed to determine and compare the productivity of forage produced during dry and rainy season of *Brachiaria* pastures when managed with 28 d or 95% light interception as criteria for interrupting regrowth. The treatments consisted of 4 cultivars of *Brachiaria*: *B. decumbens* ‘Basilisk’, *B. brizantha* ‘Marandu’, *B. brizantha* ‘Piatã’ and *B. brizantha* ‘Xaraés’, managed under 2 pasture strategies: every 28 d (28D), or when the canopy reaches 95% of light interception (IL95). The experiment was designed in completely randomized blocks, in a factorial arrangement of 4 x 2, with 3 replications (blocks). The evaluated variable was dry matter production (DM) in the pre- and post-grazing. The management did not affect DM production per year ( $P = 0.696$ ), but during the rainy season the IL95 had higher DM than 28D. During dry season the 28D management provided higher DM than IL95, because the dry season had 6 grazing cycles, while IL95 had only one cycle. Xaraés was the most productive forage, with 14,961 kg DM/ha/yr; Marandu and Piatã were not different (12,766 and 13,076 kg DM/ha/yr respectively), and *B. decumbens* had the lowest productivity (10,986 kg DM/ha/yr). We conclude that management of IL95 provided higher DM during rainy season; however, they had the same productivity per year. Xaraés had the greatest total dry matter production, and *B. decumbens* had the lowest productivity.

**Key Words:** season, light interception, fixed-days management

**W188 Forage yield of four maize cultivars sown in single and double rows.** Marco A. Ramírez<sup>\*1</sup>, Pedro A. Martínez<sup>2</sup>, Jesús Jarillo<sup>3</sup>, Francisco A. Castrejón<sup>1</sup>, and Luis Corona<sup>1</sup>, <sup>1</sup>*Departamento de Nutrición Animal, Universidad Nacional Autónoma de México, FMVZ, México City, México*, <sup>2</sup>*Departamento de Zootecnia, Universidad Autónoma Chapingo, Texcoco, México*, <sup>3</sup>*CEIEGT, Universidad Nacional Autónoma de México, Veracruz, México*.

In Mexico corn silage is widely fed to dairy and beef cattle, and in the market, farmers have many maize hybrids and native cultivars with some sowing strategies to choose from. The objective of the study was to determine total forage yield and by component (leaf, stem, ear and husk, kg DM ha<sup>-1</sup>) in 4 maize cultivars under 2 sowing strategies. Maize cultivars were 2 hybrids: Gladiator and Fog, and 2 native: Red and White; sowing strategies were single and double row, the former was seeding in rows every 80 cm, the latter in pairs of rows separated 40 cm with 80 cm between consecutive pairs of rows. Seeding rate was 80 000 plants ha<sup>-1</sup>. Experimental design was a completely randomized design in a factorial arrangement 4 (maize cultivars) × 2 (sowing strategies) with 4 replicates and the experimental unit was a 4.8 × 3 m plot. Harvest was 135 d after sowing. The cultivar × sowing strategy interaction did not influence ( $P > 0.05$ ) any of the variables measured. There was a trend ( $P = 0.10$ ) for native cultivars to show higher total forage yield than the hybrids (25408 vs. 21481.5 respectively); while double-row sowing tended ( $P = 0.19$ ) to promote on the average 12% higher total forage yield than single-row (24,763 vs 22,203). Native cultivars gave 63% higher ( $P < 0.05$ ) stem yield (14635.5) than the average of the 2 hybrids (8958) which showed similar ( $P > 0.05$ ) stem yield. Gladiator showed the lowest ( $P < 0.05$ ) leaf yield (2,677), 34% lower than the average yield observed in the other 3 cultivars (3589.7) which showed no difference ( $P > 0.05$ ) among them. Both hybrids gave 48% higher ( $P < 0.05$ ) ear yield than the average of the 2 native cultivars (6939.5 vs. 4672) which gave similar ( $P > 0.05$ ) ear yield. Only in leaf yield did sowing strategy show an influence, double-row gave 18% more ( $P < 0.05$ ) leaf than single-row (3646 vs. 3078 respectively). Native cultivars might show higher total forage yield than hybrids but of lower quality as the formers have higher amount of stems and lower of ears. It was concluded that total forage yield and by component are influenced by maize cultivar and sowing strategy and that total forage yield should not be the only one attribute to decide on which maize cultivar and sowing strategy to use on the farm.

**Key Words:** maize, cultivar, sown

**W190 Effects of maturity at harvest on the nutritional value, yield and milk production potential of corn hybrids planted under tropical/subtropical conditions.** Kathy G. Arriola<sup>\*1</sup>, Rafael M. Martins<sup>1</sup>, Thiago F. Bernardes<sup>1</sup>, Fabiola M. da Silva<sup>1</sup>, Felipe X. Amaro<sup>1</sup>, Bibiana Coy<sup>1</sup>, Enrique Alias<sup>2</sup>, Ernesto Marin<sup>2</sup>, Ludwig Leyton<sup>2</sup>, Zhengxin X. Ma<sup>1</sup>, Ibukun M. Ogunade<sup>1</sup>, Yun Jiang<sup>1</sup>, Musibau A. Bamikole<sup>1</sup>, and Adegbola T. Adesogan<sup>1</sup>, <sup>1</sup>*University of Florida, Gainesville, FL*, <sup>2</sup>*University of El Salvador, San Salvador, El Salvador*.

This study examined the effect of maturity at harvest on key agronomic and nutritional traits of corn hybrids planted in the Florida Summer. Eighteen corn hybrids from 5 seed companies (Agra Tech, Croplan Genetics, Mycogen, Pioneer, and Syngenta) were grown on 4 replicate plots (1.8 × 6.1 m) in each of 4 blocks in August 2013. Hybrids were harvested at target maturity stages of 30, 35, 40, and 45% DM by removing 1.8-m sections from 2 rows in each plot. Temperatures ranged from 14.1 to 29.3°C and rainfall was 432 mm during the growing season. Disease ranking (1, low to 5, high scale), DM yield, kernel milk line

position, and chemical composition at harvest were measured. Milk-per-ton (MPT) and milk-per-hectare (MPH) values were calculated with the Milk 2006 model. Data were analyzed with a model including hybrid, maturity and the interaction using the Glimmix procedure of SAS. Mean DM concentrations at harvest were 32.3, 34.6, 40.7, and 42.5% at the respective target maturity stages above. Milk-per-hectare was unaffected by maturity (1,529–1,679 kg/t) but MPT was greater when hybrids were harvested at 30 or 35% DM than at 40 or 45% DM (1668 vs. 1531 kg/t). The NDF digestibility decreased at each maturity stage ( $P < 0.05$ ; 59.2, 58.0 and 57.2 and 55.7%, respectively), whereas DM yield did not change (22.2 t/ha) until the 45% DM stage when it increased (25.5 t/ha). For most hybrids, disease ranking and NDF concentration decreased to a nadir and starch concentration peaked when they were harvested at 40% DM (hybrid × maturity,  $P < 0.05$ ). Kernel milk line position increased quadratically with maturity for most hybrids (hybrid × maturity,  $P < 0.05$ ). Six hybrids had among the highest MPT (>1641 kg/t) and MPH (>39164 kg/ha) values and their NDF digestibility (57.3 to 60.3%) and starch concentration (27.7 to 32.0%) ranges were moderately high. Differences in MPT and MPH among hybrids of 150 kg/t and 14,132 kg/ha, respectively were evident. Yield and quality measures were simultaneously optimized when hybrids were harvested at 35 to 40% DM.

**Key Words:** corn hybrid, maturity, dry matter yield

**W191 Application of *Pediococcus pentosaceus*, *Pichia anomala*, and chitinase to high moisture alfalfa hay at baling: effects on ruminal digestibility.** Long Jin<sup>1</sup>, Lysiane Dunière<sup>1</sup>, Joseph.P. Lynch<sup>1</sup>, Eric Chevaux<sup>2</sup>, Tim.A. McAllister<sup>1</sup>, John Baah<sup>3</sup>, and Yuxi Wang<sup>\*1</sup>, <sup>1</sup>*Agriculture and Agri-Food Canada, Lethbridge, AB, Canada*, <sup>2</sup>*Lallemand animal nutrition, Blagnac, France*, <sup>3</sup>*Best Environmental Technologies Inc., Edmonton, AB, Canada*.

Baling of alfalfa hay at higher than optimum moisture level can lead to spoilage and a reduction in the nutritive quality of the forage. Organic acids such as propionic acid (PA) have been added to high moisture hay (HMH) to prevent the growth of spoilage microorganisms, but the high rates of application, costs and environmental concerns associated with these preservatives has discouraged hay producers from using them. The objective of this study was to assess the effects of applying *Pediococcus pentosaceus* (PED) and *Pichia anomala* (PIC) alone or in combinations with chitinase (CH) at baling on the nutritional quality of high-moisture alfalfa hay using in vitro and in situ procedures. Alfalfa hay was harvested at the mid-bloom stage, wilted to 73–77% DM and baled without (HMH) or with PED, PIC, PED+PIC, PED+CH, PIC+CH, and PA. The control (HMH), PED+CH, PIC+CH and PA and alfalfa hay baled at >85% DM (NMH) were repeated in 3 consecutive yrs. Other treatments were assessed only in single yr. Samples collected 90 d after baling over the 3 yr were assessed in vitro and only 1 yr samples were assessed for rumen degradability. For all 3 yr, in vitro DM disappearance (IVDMD), asymptotic gas production and rate of gas production of HMH, irrespective of treatment, was lower ( $P < 0.05$ ) than NMH. Among treatments, PED+CH and PIC+CH had higher ( $P = 0.01$ ) IVDMD than HMH and PA, but only PED+CH had higher ( $P < 0.01$ ) asymptotic and rate of gas production as compared with HMH and PA in yr 1. The potential degradable fraction of DM did not differ among treatments. However, PED+CH and PIC+CH had a higher ( $P < 0.01$ ) rapidly degradable fraction than PA. The 24-h in situ NDF digestibility of PED+CH and PIC+CH was higher ( $P < 0.001$ ) than that of all other treatments including NHM. These results suggest that application of *P. pentosaceus* or *P. anomala* combined with chitinase at baling of



high moisture alfalfa hay has potential to reduce nutrient losses and to increase fiber digestibility.

**Key Words:** high moisture alfalfa hay, additives, in situ digestibility.

**W192** *Malva sylvestris* extract affected kinetics of fermentation, methane production, and protozoa population of barley grain incubated with rumen fluid. Saba Khamooshi<sup>1</sup>, Farokh Kafilzadeh<sup>1</sup>, Hossein Jahani Aziz Abadi<sup>2</sup>, and Golnaz Taasoli\*<sup>1</sup>, <sup>1</sup>Razi University, Kermanshah, Iran, <sup>2</sup>Kurdistan University, Kurdistan, Iran.

This study was conducted to evaluate the effect of *Malva sylvestris* leaf or stem extracts on in vitro fermentation kinetic, methane production and protozoa population of barley grain. Juice from leaves and stems were prepared by extraction from crushed materials. The extracts were then centrifuged at  $454 \times g$  for 15 min before use. The extracts were added at levels of 0, 25, 50 and 100  $\mu\text{L}/250$  mg barley incubated in 30 mL mixture of buffer and rumen fluid. Addition of both extracts increased the potential gas production (mL/200 mg DM), and constant rate (mL/h) but decreased the lag time (h) of barley grain ( $P < 0.01$ ). Methane production from fermentation of barley grain decreased due to the addition of the extracts ( $P < 0.01$ ). Methane reduction potential from fermentation of barley grain were 13.15, 7.30 and 13.28% when leaf extract was added at 25, 50 and 100  $\mu\text{L}/250$  mg barley, respectively. Corresponding values for similar levels of the stem extract were -1.94, 1.80 and 9.12%, respectively. Protozoa population in incubated barley grain medium with no extract was  $9.94 \times 10^4/\text{mL}$ . The extracts particularly the extract from leaf resulted in much more protozoa reduction from barley grain fermentation (average values of protozoa population when leaf and stem extracts were added to barley grain incubation medium were  $7.67 \times 10^4$  vs.  $7.85 \times 10^4/\text{mL}$ ). The result of this study show *M. sylvestris* extract has some potential in improving the fermentation of barley grain

**Key Words:** *Malva sylvestris*, methane production, protozoa population.

**W193** Effect of a protease enzyme (papain) on in vitro NDF digestibility of alfalfa hay stem. Shahab Payandeh, Farokh Kafilzadeh, and Golnaz Taasoli\*, Razi University, Kermanshah, Iran.

An in vitro experiment was conducted to examine the effect of a protease (papain, EC 3.4.22.2) on ruminal fiber digestibility of alfalfa hay stem. Exactly 100 mg of enzyme powder was solubilized using 5 ml of water. Serum bottles containing 500 mg of alfalfa hay stem, modified McDougall's buffer and rumen fluid with addition of 0, 50, 100 or 200  $\mu\text{L}$  of the papain solution/g alfalfa hay stem DM were incubated under anaerobic conditions at 39°C for 24 and 48 h. Total gas production and NDF disappearance were determined. Partitioning factor (PF) was calculated as the ratio of NDF degraded (mg) to the volume of gas (mL) produced. Data were analyzed as a completely randomized design by ANOVA using SAS 9.2. The enzyme with a level of 200  $\mu\text{L}/\text{g}$  alfalfa hay stem DM significantly ( $P < 0.05$ ) increased in vitro NDF degradability after 24h incubation (40.2, 41.6, 40.6 and 45.9% in alfalfa hay stem, alfalfa hay stem+50, alfalfa hay stem+100 and alfalfa hay stem+200  $\mu\text{L}$  of enzyme/g alfalfa hay stem DM, respectively). No significant difference was observed after 48h incubation. The PF was also increased significantly ( $P < 0.01$ ) with addition of all levels of papain (1.57, 1.76, 1.70 and 1.77 in alfalfa hay stem, alfalfa hay stem+50 alfalfa hay stem+100 and alfalfa hay stem+200  $\mu\text{L}$  of enzyme/g alfalfa hay stem DM, respectively). From the result of this experiment, it appears that addition of papain at the highest level has a pronounced effect on the

digestion of NDF after 24h incubation. It is concluded that this enzyme has some potential on removing structural proteins in the cell wall, allowing ruminal microbes to gain faster access to digestible substrates.

**Key Words:** papain, NDF digestibility, partitioning factor

**W194** Effect of bacterial additives on fermentation quality and aerobic stability of rye silage harvested at dough stage. Young Ho Joo\*<sup>1</sup>, Seong Shin Lee<sup>1</sup>, Dong Hyeon Kim<sup>1</sup>, Hyuk Jun Lee<sup>1</sup>, Sardar M. Amanullah<sup>1,3</sup>, Ouk Kyu Han<sup>2</sup>, and Sam Churl Kim<sup>1</sup>, <sup>1</sup>Division of Applied Life Science (BK21Plus, Inst. Agric. & Life Sci.), Gyeongsang National University, Jinju, Gyeongsangnam-do, South Korea, <sup>2</sup>National Institute of Crop Science, RDA, Suwon, South Korea, <sup>3</sup>Bangladesh Livestock Research Institute, Dhaka, Bangladesh.

This study was carried out to determine the effect of different additives on chemical composition, fermentation characteristics and aerobic stability of rye silage harvested at dough stage. Rye forage was grown at National Institute of Crop Science, Suwon, South Korea, and harvested at 37% of dry matter. The harvested forages were divided into the following 4 treatments: CON (distilled water at 2 mL/kg of fresh forage); LP (*L. plantarum* t  $1.5 \times 10^4$  cfu/g of fresh forage); LB (*L. buchneri* at  $1.2 \times 10^4$  cfu/g of fresh forage) and MIX (mixture of LP and LB at 1:1 ratio). The forage was chopped to 3–6 cm length and ensiled into 10 L bucket silo with 4 replications for 0, 1, 4, 7, 48 and 100 d. On 100 d of ensiling, crude protein concentration (7.61 vs. 6.63%) in LP was higher ( $P < 0.05$ ) than that in CON. The concentrations of neutral detergent fiber and hemicellulose were higher ( $P < 0.05$ ) in LB (73.7 and 24.6%) and MIX (72.9 and 24.0%) than those in CON (70.4 and 21.7%) and LP (69.5 and 22.6%), while acid detergent fiber concentration was lowest ( $P < 0.05$ ) in LP (46.9 vs. 48.7, 49.1 and 48.9%). The CON had higher ( $P < 0.05$ ) pH (4.56 vs. 4.15, 4.11 and 4.12) than all treatments applied bacterial additives. The pH in LB and MIX silage decreased more drastically than those in CON and LP on early ensiling periods (d 0–7). The concentrations of lactate and propionate were highest ( $P < 0.05$ ) in LP (13.4 and 5.72%), but acetate concentration was highest ( $P < 0.05$ ) in LB (27.5%) and MIX (22.1%). Lactate to acetate ratio (1.23 and 1.43 vs. 0.29 and 0.35) was higher ( $P < 0.05$ ) in CON and LP than that in LB and MIX. Lactic acid bacteria (6.71, 6.59 and 6.48 vs. 5.25 log<sub>10</sub> cfu/g) in CON, LP and LB were higher ( $P < 0.05$ ) than that in MIX, whereas aerobic stability (760.5 vs. 616.3, 606.5 and 634.3 h) was higher ( $P < 0.05$ ) in MIX than all other treatments. Yeast was highest ( $P < 0.05$ ) in LB (7.64 log<sub>10</sub> cfu/g), while mold was not detected in all treatments. In conclusion, LP or MIX supplementation can improve the aerobic stability by increase of acetate concentration which has strong anti-fungal effect.

**Key Words:** aerobic stability, barley silage, inoculant

**W195** Fermentation quality and chemical composition of mixed silage with shrub and corn. Bing-wen Si\*<sup>1</sup>, Zong-li Wang<sup>2</sup>, Qi-zhong Sun<sup>2</sup>, Hong-mei Wang<sup>1</sup>, and Qi-yu Diao<sup>1</sup>, <sup>1</sup>Feed Research Institute, Chinese Academy of Agricultural Sciences, Key Laboratory of Feed Biotechnology of the Ministry of Agriculture, Beijing, China, <sup>2</sup>Grassland Research Institute, Chinese Academy of Agricultural Sciences, Hohhot, Inner Mongolia, China.

With development of Chinese animal husbandry, shortage of feedstuffs is a main limit factor for livestock development. Rush bushclover (RB) and shrubby sweetvetch (SS) have the characteristics of high biomass, drought resistance, leanness tolerance. Moreover, they are of high nutritive value, rich in crude protein (CP), and potential new

resources for livestock feed. Shrub is seldom used as material to make silage as legumes are often considered hard to ensile well due to low fermentable carbohydrate content in combination with a high buffering capacity (BC). Whole-crop corn is ascribed to easy ensiling procedure and has high fermentative quality and palatability for cows, because of the chemical composition of corn, mainly in high fermentable carbohydrates. Silage produced from a mixture of whole-crop corn and 2 kinds of shrub is likely to have a better fermentation quality and nutritive value compared with silage consisting solely of herbage from RB and SS. RB and SS (315 and 274 g dry matter per kg) were cut into 2 to 5 cm by a rubbing filament machine and ensiled in 1.5 L laboratory silos with whole-crop corn as mixtures of 1, 0.7, 0.5, and 0.3 of fresh weight (FW). After 60 d, the nutrition and fermentation quality of all treatments were analyzed. Results showed that the pH of silage consisting solely of herbage from RB and SS were significantly ( $P < 0.05$ ) higher and the lactic acid content were significantly ( $P < 0.05$ ) lower than silages mixed with whole-crop corn. With the increase of the proportion of corn, lactic acid and acetic acid content also increased ( $P < 0.05$ ). Dry matter and WSC content decreased with the increase of the proportion of corn ( $P < 0.05$ ). In conclusion, RB and SS with a high BC and a low WSC concentration is best ensiled using whole-crop corn. Inclusion of 0.5 to 0.7 of whole-crop corn is recommended to ensure a good fermentation.

**Key Words:** mixed silage, fermentation quality, shrub

**W196 Late season forage yield, quality, and digestibility from mixed cropping of organic certified corn and soybean hybrids at different seeding rates.** Ishwary Acharya\* and David Casper, *Dairy Science Department, South Dakota State University, Brookings, SD.*

The production of forage resulting from the mixed cropping of corn and soybeans at planting has the potential to yield greater quantities of digestible nutrients to meet the nutrient requirements of lactating dairy cows. A field plot study was laid out using a completely randomized design to evaluate 2 organic corn hybrids [Normal (N) and MasterGrazed (MG)] with 2 soybean hybrids [Regular (R) and Vining (V)] at 4 seeding rates (R1 = 65:35; R2 = 55:45; R3 = 45:55, and R4 = 35:65 of corn and soybean) having a 2 × 2 × 4 factorial treatment design replicated 3 times. Forage was hand harvested 93 d after planting during the 2014 growing season, inoculated, packed into buckets, weighed, and ensiled for 60 or 90 d. Buckets were then re-weighed, opened, and forage samples collected and submitted for nutrient analysis (Analab, Inc., Fulton, IL). Yield of DM (6.74 and 7.65 T/ha for N and MG, respectively) for main effect of corn was similar ( $P > 0.05$ ), while V yielded greater ( $P < 0.05$ ) than R (6.13 and 8.27 T/ha for R and V, respectively) for main effect of soybean, while seeding ratio main effect was similar [ $(P > 0.05)$ ; 7.91, 6.29, 7.81, and 6.77 T/ha for R1, R2, R3, and R4, respectively]. Yield of fresh digestible DM (DDM; 4.40 and 5.06 T/ha) and CP (1.04 and 1.22 T/ha) were similar ( $P > 0.05$ ) for corn, while V yielded greater ( $P < 0.05$ ) DDM (4.03 and 5.43 T/ha) and CP (0.97 and 1.29 T/ha) than R and seeding ratios were similar ( $P > 0.05$ ) in yield of DDM (5.20, 4.15, 5.08, and 4.50 T/ha) and CP (1.14, 1.05, 1.25, and 1.07 T/ha). A significant interaction ( $P < 0.05$ ) was detected for corn × soybean × seeding ratio for ensiled DDM yield at 60 and 90 d, while no other significant ( $P > 0.05$ ) interactions of main effects were detected. The combination of MG seed corn with V soybean hybrids at the ratio of 67:33 resulted in the greatest yield of DDM after 60 and 90 d of ensiling the forage. The mixed cropping of corn and soybeans holds great potential for increasing the production of forages to meet the nutrient requirements of lactating dairy cows.

**Key Words:** corn, soybean, yield

**W197 Climatic and management factors affecting the forage yield and quality of a high density mulberry forage bank established under low input tropical farming conditions.** Eliel González-García\*<sup>2</sup> and Giraldo Martín-Martín<sup>1</sup>, <sup>1</sup>*Estación Experimental de Pastos y Forrajes "Indio Hatuey," Matanzas, Cuba,* <sup>2</sup>*INRA UMR868, Systèmes d'Élevage Méditerranéens et Tropicaux (SELMET), Montpellier Cedex 2, France.*

Effects of year season (SEAS), organic fertilization (N) and harvest frequency (FREQ) on forage yield and composition were evaluated in a high density mulberry forage bank, established under low input tropical farming conditions. The experiment, replicated 2 consecutive years, was arranged in 18 treatments resulting from a 3 × 3 × 2 factorial design combining 3 FREQ (60, 90 and 120 d), 3 N rates (100, 300 and 500 kg N/ha/year) and the 2 seasons (RAIN and DRY). Forage yield, leaf to stem ratio, the edible fraction (EDIB, %), nutrient content by plant fraction (PFR; i.e., leaves, tender and ligneous stems) and the maturity indexes were monitored. Either forage yield or nutrient content was strongly affected by SEAS, FREQ, PFR, N rate and, in some cases, by their interactions. Total forage yield increased ( $P < 0.0001$ ) with FREQ (26.5, 31.2 and 40.6 t for 60, 90 and 120 d, respectively), irrespective of the SEAS (44.7 and 21.1 t for RAIN and DRY, respectively), PFR (19.2, 3.0 and 10.7 t for LEAF, TST and LST, respectively) or N (28.1, 32.0 and 38.5 t for 100, 300 and 500 kg N/ha/year, respectively). The EDIB yield was higher in RAIN (25.3 vs. 13.2 t; RAIN vs. DRY) and diminished while increasing FREQ, irrespective of SEAS or N. This decrease in EDIB yield was directly related to the decrease in the LEAF proportion and the concomitant increase of the LST fraction with FREQ. Harvesting at 60 and 90 d in RAIN and DRY, respectively, with a N rate of 300 kg N/ha/year seems the best agronomic choice as a most optimal condition between forage yield and nutritive value.

**Key Words:** forage yield and composition, harvest frequency, organic fertilization

**W198 Response to using rumen inoculum from high and low feed efficient cows on in vitro fermentation of alfalfa ensiled with different additives.** Francisco E. Contreras-Govea\*<sup>1</sup>, Richard E. Muck<sup>2</sup>, Paul J. Weimer<sup>2</sup>, and Ursula C. Hymes-Fecht<sup>2</sup>, <sup>1</sup>*Department of Dairy Science, University of Wisconsin-Madison, Madison, WI,* <sup>2</sup>*USDA-Dairy Forage Research Center, Madison, WI.*

Alfalfa from 2 consecutive harvests (H1, H2) was treated with *Lactobacillus plantarum* (LP, 10<sup>6</sup> cfu/g alfalfa), formic acid (FA, 5.4 kg/Mg), and no additive (control), ensiled in mini-silos, fermented for 60-d at room temperature (22°C), and analyzed for nutritive value and fermentation profile. Silages were wet ground to a particle size of 2–3 mm using a food processor for in vitro true DM digestibility (IVTDMD). High (HE) and low efficient (LE) groups of 3 cannulated cows each were identified based on 2 lactations and had an average energy corrected milk/dry matter intake (ECM/DMI) ratio of 1.88 and 1.61, respectively. In each in vitro run, 12 silos from a harvest were analyzed simultaneously with 6 rumen inocula, one from each cow, for 24 h. Data analysis was conducted using the MIXED procedure of SAS, as a split plot design. For silage fermentation, harvest was the whole plot and alfalfa treatment as subplot. For the in vitro, HE and LE groups were main plot and treated alfalfa as sub-plot. In both cases mean differences were declared significant at  $P < 0.05$ . Across harvests, LP had lower pH (4.47) and greater lactic acid concentration (64.3 g/kg DM) than control (4.77, 52.1) and FA (4.70, 33.9). Moreover, ammonia-N was lower in LP (3.8% total N) and FA (4.2) than control (5.4) in both harvests. IVTDMD of the H1 silages was greater with the HE cows (79.6%) than LE cows (75.13%), but there was no difference at H2 ( $P = 0.310$ ). The IVTDMD

was not different among silage treatments at H1 ( $P = 0.078$ ), but at H2 control had greater IVTDMD (79.8%) than did LP (78.1) and FA (77.6). Rumen fluid from HE cows produced greater acetate and butyrate than did LE on H1 silages, with no differences on H2. In vitro acetate and propionate were contrasting between H1 and H2 by silage treatment. At H1, LP and FA had greater acetate and propionate than control, but it was opposite at H2. It is concluded that LP and FA decrease ammonia-N during fermentation of alfalfa silage, and rumen inocula from HE cows displayed numerically higher IVTDMD, but the effect was only significant with the earlier harvested silage.

**Key Words:** alfalfa silage, additive, feed efficiency

**W199 Ruminal degradability of a *Musa sp.* fodder bank located in the central part of Costa Rica.** Pablo Chacón Hernández\*, Carlos Boschini Figueroa, and Ricardo Russo Andrade, *Universidad de Costa Rica, San Pedro, San José, Costa Rica.*

When bananas are grown for fruit, the bigger part of the plant gets wasted. In tropical areas, producers use the pseudo-stems and leaves as feed for cattle. An experiment was performed to determine the potential value of the banana plant nutrient availability for ruminants. Fifteen adult plants were randomly harvested from a fodder bank located at the University of Costa Rica's Alfredo Volio Mata Experimental Station during the rainy season of 2012. Each plant was harvested at 20–25 cm above ground and divided into 5 sections for sampling (base, center and tip of the pseudo-stem and lamina and petioles of the leaves), all 15 samples from each portion were dried, ground and incubated by duplicate within 2 Jersey-Reyna ruminally fistulated cows with results analyzed using the Marquadt algorithm. Values ranging from 18.38% to 47.43% were found for the percentage of soluble fraction, from 33.45% to 45.76% for the degradable fraction, from 1.65%/h to 7.51%/h for the degradation speed and from 64.14% to 82.86% for the potentially degradable percentage, depending on the plant part. According to the obtained results, pseudo-stems have better degradability values than leaves and may be used as a feed source on cattle diets where the material is available.

**Table 1 (Abstr. W199).** Ruminal degradability constants on a *Musa sp.* fodder bank

Plant section	Soluble fraction, %	Degradable fraction, %	Degradation speed, %/h	Potentially degradable fraction, %
Pseudo-stem base	47.43 <sup>a</sup>	35.43 <sup>b</sup>	0.07518 <sup>a</sup>	82.86 <sup>a</sup>
Pseudo-stem center	42.51 <sup>a</sup>	34.13 <sup>b</sup>	0.06512 <sup>ab</sup>	76.64 <sup>a</sup>
Pseudo-stem tip	44.77 <sup>a</sup>	33.45 <sup>b</sup>	0.05824 <sup>abc</sup>	78.22 <sup>a</sup>
Petiole	33.34 <sup>b</sup>	38.85 <sup>ab</sup>	0.06689 <sup>ab</sup>	72.19 <sup>b</sup>
Lamina	18.38 <sup>c</sup>	45.76 <sup>ab</sup>	0.01653 <sup>d</sup>	64.14 <sup>c</sup>

<sup>a-c</sup>Indicate statistical differences ( $P < 0.05$ ) within a column.

**Key Words:** degradability, *Musa*, fodder bank

**W200 Purple prairie clover (*Dalea purpurea* Vent) reduces fecal shedding of *Escherichia coli* in pastured cattle.** Yuxi Wang<sup>\*1</sup>, Long Jin<sup>1,2</sup>, Alan Iwaasa<sup>3</sup>, Yuanheng Li<sup>3,5</sup>, Zhong Xu<sup>1</sup>, Mike Schellenberg<sup>3</sup>, Xiuli Liu<sup>1,6</sup>, Tim McAllister<sup>1</sup>, and Kim Stanford<sup>4</sup>, <sup>1</sup>Lethbridge Research Centre, Agriculture and Agri-Food Canada, Lethbridge, AB, Canada, <sup>2</sup>Department of Animal Science, Northeast Agricultural University, Harbin, China, <sup>3</sup>Semiarid Prairie Agricultural Research Centre, Agriculture & Agri-Food Canada, Swift Current, SK, Canada, <sup>4</sup>Alberta Agriculture and Rural Development, Lethbridge Agriculture Centre, Lethbridge, AB, Canada, <sup>5</sup>Institute

of Grassland Research, Chinese Academy of Agricultural Sciences, Hohhot, China, <sup>6</sup>Inner Mongolia Academy of Agricultural and Animal Husbandry Sciences, Hohhot, China.

A 3-year (2009–2011) grazing study was conducted to assess the effects of purple prairie clover (PPC, *Dalea purpurea* Vent) on fecal shedding of total *Escherichia coli* in cattle. Three pasture types were used in the experiment; bromegrass (Check), mixed cool season grasses with PPC (Simple) and mixed cool and warm grasses with PPC (Complex). Pastures were rotationally grazed (5, 10 and 10 cattle for Check, Simple and Complex) during a summer and fall grazing period. Purple prairie clover was grazed in summer at the vegetative/early flower stage and at the flower/early seed stage during the fall. Weekly and biweekly fecal samples were collected from each animal for enumeration of *E. coli* and chemical analyses. Forage samples were collected throughout the season for analysis. Condensed tannins (CT) were only detected in Simple and Complex pastures that contained PPC, with concentrations being higher in the fall than in the summer. Fecal counts of *E. coli* in cattle grazing Simple and Complex pastures linearly decreased ( $P < 0.05$ ) over summer to fall in all 3 years, an outcome not observed in cattle grazing the Check pasture. Across the 3 grazing seasons, fecal *E. coli* was lower ( $P < 0.05$ ) in cattle grazing Simple and Complex pastures than Check during the fall. During the fall, feces collected from cattle grazing the Check pasture had higher ( $P < 0.05$ ) pH, N, NH<sub>3</sub>-N, total volatile fatty acids (VFA) and branched-chain VFA, but a lower ( $P < 0.05$ ) acetate: propionate ratio than that collected from cattle grazing Simple or Complex pastures. In a second experiment, 2 strains of *E. coli* were cultured in M9 medium containing 25 to 200 µg/mL of PPC CT. Growth of *E. coli* was linearly ( $P < 0.01$ ) reduced by increasing levels of PPC CT. The scanning electron micrographs showed electron dense filamentous material associated with the outer membrane of *E. coli* cells exposed to CT. Incorporation of PPC into forage reduced the fecal shedding of *E. coli* from grazing cattle, likely due to the anti-*E. coli* properties of PPC CT.

**Key Words:** grazing pasture, purple prairie clover, *Escherichia coli*

**W201 Yield, chemical composition, and efficiency of use of nitrogen by Marandu grass.** Tadeu Silva de Oliveira<sup>\*1</sup>, Ricardo Augusto Mendonça Vieira<sup>1</sup>, Alberto Magno Fernandes<sup>1</sup>, Danielle Ferreira Baffa<sup>2</sup>, and José Carlos Pereira<sup>2</sup>, <sup>1</sup>Universidade Estadual do Norte Fluminense-Darcy Ribeiro, Campos dos Goytacazes, Rio de Janeiro, Brazil, <sup>2</sup>Universidade Federal de Viçosa, Campus Universitário, Viçosa, Minas Gerais, Brazil.

The objective of this study was to evaluate the effect of 5 nitrogen levels on the yield and quality characteristics and the use efficiency of *Brachiaria brizantha* 'Marandu' grass. The soil, classified as a Red-Yellow Acrisol, was sampled at a depth of 0 to 0.20 m, for analyses. Soil analyses results were follows: pH in water = 5.6; CEC (T) = 8.17; H + Al = 4.21; sum of bases = 3.96; Ca = 2.8; Mg = 1.1 cmolc dm<sup>-3</sup>; P = 66.6 mg dm<sup>-3</sup>; K = 123 mg dm<sup>-3</sup>; and 1.49 dag kg<sup>-1</sup> organic matter. The area was prepared by plowing followed by disking two times and then fertilized with 300 kg/ha of N-P-K formulation (8-28-16). The *Brachiaria brizantha* 'Marandu' was sown at a rate of 3 kg/ha of pure viable seeds in a row spacing of 0.45m. Because of the uniformity of the area, we adopted a completely randomized design with four replicates. The treatments consisted of four levels of nitrogen (0, 60, 120, 180 and 240 kg/ha). Samples of the material were collected to analyze productivity variables, concentrations of neutral detergent fiber, crude protein and neutral detergent insoluble nitrogen, and in vitro dry matter digestibility. The nitrogen use efficiency, recovery of the applied nitrogen (RAN) and agronomic efficiency of the applied nitrogen (AE) were calculated. The



statistical analyses involved the application of procedure PROC MIXED. To select the regression models the criteria utilized was Akaike's information criterion. Dry mass production increased ( $P < 0.001$ ) by 1,624.67 (kg/ha) as the nitrogen doses were increased. The doses of nitrogen affected ( $P < 0.05$ ) the concentrations of neutral detergent fiber (from 294.6 to 381.4 g/kg, in the leaf), crude protein (from 86.1 to 99.6 g/kg, in the leaf) and neutral detergent insoluble protein (from 402.9 to 396.2 g/kg CP, in the leaf). Nitrogen use efficiency increased, whereas RAN and AE were not affected ( $P > 0.05$ ) by the nitrogen doses. In conclusion, nitrogen fertilization promotes improvement in productivity and chemical composition of Marandu grass, also improving the efficiency with which the grass utilizes the nitrogen.

**Key Words:** nitrogen use efficiency, nutritional characteristics, urea

#### **W202 Effect of ensiling on kernel processing score in whole-plant corn silage harvested with varied processors and settings.**

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Two experiments were conducted to evaluate the impact of (1) ensiling on kernel processing score (KPS; % of starch passing through 4.75 mm sieve) of whole-plant corn silage (WPCS) of varied processors and settings; and (2) extended ensiling times on KPS of corn shreddage. In Experiment 1, samples from 2 self-propelled forage harvesters (SPFH) were collected at harvest. One SPFH was fitted with a conventional-type processor with greater (32% vs. 21%) roll-speed differential than normal. Samples collected were from 3 theoretical lengths of cut (TLOC; 19, 22 and 26 mm; 3-mm roll-gap setting) in 2 hybrid types (leafy and dual-purpose). The other SPFH was fitted with an intermeshing-disc processor and samples were from 3 TLOC (17, 19 and 26 mm) at 2 roll-gap settings (1.5 and 2.5 mm) in one hybrid. Samples for each processor and settings collected at harvest (12 samples total) were divided into 2 piles. The first pile was unfermented and analyzed for KPS in duplicate. The second pile was vacuum-sealed in 3 plastic bags and ensiled for 30 d. After fermentation, the 3 bags were composited and analyzed for KPS in duplicate. Data were analyzed using Proc Mixed of SAS with the fixed effect of fermentation and the random effect of sample. In Experiment 2, WPCS was harvested using a SPFH fitted with a shreddage processor with cross-grooved rolls set at 2.5 mm roll-gap and 32% roll speed differential and the SPFH set at 26 mm of TLOC. Samples were collected at harvest and vacuum-sealed in plastic bags and ensiled for 0, 30, and 120 d in triplicate. Samples from each bag were analyzed for KPS in duplicate. Data were analyzed using Proc Mixed of SAS with the fixed effect of ensiling time and the random effect of bag. In Experiment 1, ensiled samples had 10%-units greater ( $P = 0.01$ ) KPS than the unfermented samples (60.1% vs. 50.2%, respectively). In experiment 2, WPCS ensiled for 120 d tended ( $P = 0.07$ ) to have 7%-units greater KPS than 0 d (67.2% vs. 60.3%, respectively), but not 30 d (63.6%). These findings suggest that fermentation increases KPS.

**Key Words:** corn silage, ensiling time, corn silage processing score

#### **W203 Morphological responses and chemical composition of Tanzania grass subjected to two pasture-management strategies.**

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The objective of this study was to evaluate the morphogenetic traits and chemical composition of Tanzania grass using a fixed resting period (FR) or according to 95% light interception (LI, by accuparLP-80) for managing Tanzania-grass pastures. As the LI of the herbage mass reached 95%, the animals were allowed to graze each paddock for 3 d; and (2) 30 d defoliation interval with a 3 d grazing period (FR). Experimental unit consisted of 11 paddocks grazed by 5 Holstein-Gir cows allowing for 2 replicates per defoliation treatment in the first year with the same areas assigned to the same treatment the following year grazed by 4 Holstein-Gir cows per experimental unit. Six samples per paddock were taken on 2 crossed transect lines. Sward height, forage mass, and morphological components and their chemical composition were evaluated. The fixed effects were treatments (LI or FR), year (one or 2), and the interaction, whereas the random effect was area within treatment and the model was fitted as a mixed model with yearly repeated measures (using SAS). The interaction was significant only for senescent material ( $P = 0.026$ ). The treatments did not affect pasture mass, height, and the proportion of stems in the pre- ( $P = 0.455, 0.715, 0.457$ , respectively) and post-grazing ( $P = 0.199, 0.160, 0.457$ , respectively) conditions. However, the proportion of leaves and crude protein content of the herbage mass were greater in LI than FR paddocks ( $P = 0.031$ , and 0.018, respectively). The concentration of other nutrients were not affected by treatments ( $P > 0.05$ ). Therefore, LI might affect at least some quality traits of the paddock.

**Key Words:** grass, grazing system, sward height

#### **W204 How does the chemical additive calcium oxide affect the in vitro growth of lactic acid bacteria and yeast? R. A. de Paula, O. G. Pereira\*, T. C. da Silva, K. G. Ribeiro, and H. C. Mantovani, Universidade Federal de Vicosa, Vicosa, Minas Gerais, Brazil.**

Sugarcane has a high concentration of sucrose, which is metabolized by yeasts during ensiling producing high concentrations of ethanol. Calcium oxide (CaO) has been used as a silage additive resulting in a reduction of yeasts, less ethanol and improved DM recovery. The objective of this study was to evaluate the effect of CaO on the in vitro growth of lactic acid bacteria (LAB) and yeast in an aqueous-extract of sugarcane. The aqueous-extract of sugarcane was made by blending fresh sugarcane and distilled water in the proportion 5:1 for 5 min. The extract was filtered through layers of cheesecloth and sterilized at 121°C for 15 min. The microorganisms evaluated were one yeast (*Saccharomyces cerevisiae*), and 3 LAB (*Lactobacillus brevis*, *L. plantarum*, and *Pediococcus pentosaceus*, isolated from alfalfa silage). The LAB and the yeast (initial population of 6 log cfu/mL) were grown in the sugarcane extract with levels of CaO: 0 (control), 0.5, 1, 1.5, and 2% (fresh basis) and incubated at 37 and 30°C for 48 h, respectively. Two tests were conducted, one with no pH adjustment and another adjusting the initial pH to 6 ± 0.13. The pH was evaluated before and after the incubation. In the first trial, the final pH of the control was 5.62 whereas the pH of the extracts containing CaO were higher than 11.6 for all microorganisms. In addition, there was inhibition of growth of all microorganisms at the concentration of 0.5% CaO. In the second test, the numbers of *L. brevis* and *P. pentosaceus* decreased from 7.94 and 7.82 log cfu/mL to 4.97 and 5.98 log cfu/mL with adding 1% CaO and no growth was observed for all LAB at 1.5% CaO, except for *L. brevis* (3.75 log cfu/mL at 1.5% CaO). Numbers of *S. cerevisiae* remained constant in all concentrations of CaO (average 7.82 log cfu/mL). The results indicate that the initial rise in the pH caused by the addition of CaO delays the fermentation process and thus controls the growth of yeasts and ethanol production.

In addition, other microorganisms other than those in the present study are responsible for lowering the pH in the early stages of fermentation.

**Key Words:** lactic acid bacteria, sugarcane silage, *Saccharomyces cerevisiae*

**W205 Application of *Pediococcus pentosaceus*, *Pichia anomala*, and chitinase to high moisture alfalfa hay at baling: Effects on chemical composition and conservation characteristics.** Long Jin<sup>1</sup>, Lysiane Dunière<sup>1</sup>, Joseph P. Lynch<sup>1</sup>, Eric Chevaux<sup>2</sup>, Tim A. McAllister<sup>1</sup>, John Baah<sup>3</sup>, and Yuxi Wang\*<sup>1</sup>, <sup>1</sup>*Agriculture and Agri-Food Canada, Lethbridge, AB, Canada*, <sup>2</sup>*Lallemand animal nutrition, Blagnac, France*, <sup>3</sup>*Best Environmental Technologies Inc., Edmonton, AB, Canada*.

The need to attempt to bale alfalfa hay at higher than optimum moisture level has increased in recent years due to unpredictable weather conditions driven by climate change. This often results in heating of the forage and a reduction in its nutritive quality. Although organic acids such as propionic acid (PA) are generally effective in preventing fungal growth in moist forage, the high rate of application and field handling costs coupled with environmental concerns makes hay producers reluctant to use them. The objective of this study was to assess the effects of applying *Pediococcus pentosaceus* (PED) and *Pichia anomala* (PIC) alone or in combinations with chitinase (CH) at baling on conservation characteristics of high moisture alfalfa hay. Alfalfa was harvested at the mid-bloom stage, wilted in the field to 73–77% DM (HMH) and baled without or with PED, PIC, PED+PIC, PED+CH, PIC+CH, and PA. Control (HMH), PED+CH, PIC+CH and PA and alfalfa hay baled at >85% DM (NMH) treatments were repeated over 3 yrs while other treatments were examined only within a single year. Interior temperature was recorded and samples were taken 90 d after baling for chemical and microbial assessment. Averaged over 3 yr, HMH had higher ( $P < 0.001$ ) temperature degree days (>30°C, HDD) than NMH. The HDD of PED+CH was lower ( $P < 0.001$ ) than that of other treatments in yr 1 and 3, but the max temperature achieved was lower ( $P < 0.05$ ) for PED+CH as compared with other treatments only in yr 3. The NDF and NH<sub>3</sub>-N contents were lower ( $P < 0.001$ ) for PED+CH and PIC+CH, but WSC was higher ( $P < 0.001$ ) for PED+CH than that of HMH and PA in yr 1. Mold and yeast counts did not differ among treatments, but CH+PED and CH+PIC had lower ( $P < 0.05$ ) total culturable bacteria than other treatments in yr 1. The results indicated that *P. pentosaceus* and *P. anomala* combined with chitinase applied at baling have the potential to improve the conservation of HMH alfalfa by preventing spontaneously heating.

**Key Words:** high moisture alfalfa hay, additives, spontaneous heating

**W206 Nitrogenous compounds and fermentation characteristics of king grass-cassava tops silages.** Tyrone Clavero\*, *Universidad del Zulia, Maracaibo, Estado Zulia, Venezuela*.

To increase nitrogenous compounds and improve fermentation quality of King grass (*Pennisetum purpureum* × *Pennisetum typhoides*) silage, ensiling with *Manihot esculenta* was tested. The treatments for silage making were: 100% king grass (KG), 25% cassava (C):75% KG, 50% C:50% KG, 75% C:25% KG and 100% C. Fresh plant materials were chopped to 1 cm length, mixed according to treatments, ensiled in laboratory silos and stored at 25°C for 60 d. After opening silos, dry matter (DM), pH, total nitrogen content (TN), protein nitrogen (PN), soluble nitrogen (SN), PN/TN, ammonia nitrogen (AN), neutral detergent fiber

nitrogen of total nitrogen (NDF/TN), and acid detergent fiber nitrogen of total nitrogen (NADF/TN) were determined. The data were analyzed according to a completely randomized design with 3 replications, significance among mixing levels was determined by Tukey test. Silage DM increased ( $P < 0.01$ ) with the inclusion of cassava in the mixtures, reaching the highest values (25.95%) with 75%. The introduction of cassava significantly ( $P < 0.05$ ) decreased pH levels of the silages, showing the lowest value (3.88) with 100% cassava. The TN, PN, SN, and PN/TN contents increased linearly ( $P < 0.05$ ) as the percentage of cassava increased in the mixtures. Proportion of neutral and acid detergent nitrogen (NDF and NADF) to total nitrogen were not affected by treatments ( $P > 0.05$ ). A small amount of AN was detected in silage, however, there were not significant differences ( $P > 0.05$ ) between 50 and 100% mixing levels of cassava. In this study, the inclusion of cassava at the rate of 25% or more, increased nitrogenous compounds and improved silage fermentation.

**Key Words:** silage mixture, cassava, nitrogenous compound

**W207 Relationship between grinding energy and chemical composition and NDF digestibility in forages.** E. Prinsloo<sup>1</sup>, C. Anelich<sup>1</sup>, E. Raffrenato\*<sup>2</sup>, W. A. van Niekerk<sup>1</sup>, and L. J. Erasmus<sup>1</sup>, <sup>1</sup>*Department of Animal & Wildlife Sciences, University of Pretoria, Pretoria, South Africa*, <sup>2</sup>*Department of Animal Sciences, Stellenbosch University, Stellenbosch, South Africa*.

Objectives of our work were to assess the relationship between chemical components and forage fragility, when measured as grinding energy (GrE), and between fragility and digestibility of forages. In Experiment 1 28 forages were analyzed for DM, total N, starch, NDF, ADF, ADL, 24 h ivNDFd, total phenols (TP) and non-tannic phenols (NTP). Initial particle size (IPS) was determined after pre-grinding the samples with a 2 cm fitted screen knife mill. The GrE was measured using an ultra-centrifugal and a hammer mill, fitted with a 1 mm screen and final particle size (FPS) was determined. Difference between the 2 mills was determined using a *t*-test for 2 dependent samples. Multiple regressions were used to best predict observed GrE measurements from the set of parameters obtained. Energy measurements ranged from 34.9 to 356 J/g with the ultra-centrifugal mill consistently using less energy than the hammer mill ( $P < 0.001$ ). The independent variables selected were able to explain 77 to 89% of the GrE and IPS consistently accounted for most of the variation, showing the difficulty of having a homogenous IPS. Forage resistance to grinding did not depend on the fiber quantity alone, but on the different quality and interaction of its components. In Experiment 2 GrE was measured on 34 forages, including corn silages, alfalfa and eragrostis hays. In vitro NDF digestibility was obtained from 0 to 240 h. Correlations between GrE and NDFd at various time points and NDF rates of digestion (kd) were calculated and the best predictors among fiber, its components and digestibility values were selected. The results showed high negative correlations of NDFd and kd with GrE ( $P < 0.001$ ). In particular 18 and 24 h NDFd had the highest correlation values (−0.65 and −0.77) across samples and species, showing the important relationship between fragility and fiber digestibility. The IPS, FPS, cellulose (ADF-ADL) and kd explained up to 60% of the variation. Grinding energy can be used to rank forages to account for different fragility, but IPS represents a limitation. Forages with similar peNDF may then be adjusted to account for different GrE and fragility.

**Key Words:** forage fragility, grinding energy, particle size

**W208 The effect of a bacteria inoculant on fermentation and aerobic stability of a brown-midrib and conventional corn silage.**

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Objective of this study was to test the effect of a forage inoculant (Bonsilage corn, Schaumann Inc., Mendota Heights, MN) containing *Lactobacillus buchneri*, (DSM16774) and *Lactobacillus plantarum*, (DSM12837) on fermentation and aerobic stability of corn silage. Brown-midrib and conventional corn (33.8% and 37.0% DM, respectively) were ensiled untreated or treated with inoculant at  $5 \times 10^5$  cfu/g of fresh forage in bags. Data were analyzed by proc GLM (SAS v.9.4) as a  $2 \times 2$  factorial with inoculant and corn silage as main effects. Ninety days after ensiling, the silages showed a similar response to the inoculant, except that BMR silage had a higher content of acetic acid and ethanol than conventional corn silage. The treated corn silages had less lactic acid compared with untreated silages and a greater concentration of acetic acid. The pH of treated silages was higher than untreated silages because of the decreased lactic acid and higher content of acetic acid. Untreated corn silages increased significantly in temperature after 95h of exposure to air, while treated silages did not increase in temperature during 168h of monitoring. Inoculating corn silage with  $5 \times 10^5$  cfu/g of the bacteria inoculant resulted in a more hetero fermentation and markedly improved the aerobic stability of corn silage.

**Table 1 (Abstr. W208).** The chemical composition and aerobic stability of corn silage<sup>1</sup> after 90 d of ensiling

Item	BMR		CS		P-value	
	Control	Treated	Control	Treated	Inoculant	Silage
DM, % as fed	32.8	31.2	37.5	36.2	0.92	<0.001
pH	3.80	4.23	3.80	4.20	<0.001	0.37
Lactic acid, % of DM	4.75	1.04	4.76	1.18	<0.001	0.57
Acetic acid, % of DM	1.69	3.81	1.58	3.17	<0.001	0.01
Total acids, % of DM	6.44	4.88	6.34	4.35	<0.001	0.12
Ethanol, % of DM	0.88	0.81	0.39	0.56	0.37	<0.001
L/A Ratio	2.82	0.27	3.02	0.37	<0.001	0.11
Aerobic stability <sup>2</sup>	98 h	ND	95 h	ND		

<sup>1</sup>BMR = brown-midrib; CS = conventional corn silage; treated with  $5 \times 10^5$  cfu/g of inoculant.

<sup>2</sup>Hours before temperature of silage increased 2° above ambient temperature.

**Key Words:** inoculant, buchneri, silage

**W209 Nutritional evaluation of leaves, twigs, and fruits of *Gmelina arborea* as feed resource for ruminants.** Ronke Y. Aderinboye\*, Olukayode O. Showunmi, Chryst F. I. Onwuka, and Victoria O. A. Ojo, Federal University of Agriculture, Abeokuta, Ogun, Nigeria.

Browse species have played major roles as feed alternatives particularly when grasses are of low nutritive quality serving as sources of crude protein in the tropics. Although, the leaves of some browses have been harvested for small ruminant feeding, the pods or fruits have not been extensively utilized. In this study, the nutritional value of the leaves, twigs and fruits of *Gmelina arborea* was evaluated through determination of their chemical composition, in vitro gas production and digestibility in a completely randomized design. Five hundred grams (n = 6) each of fresh *Gmelina* leaves, twigs and fruits was harvested from the different tree stands and oven-dried to constant weight for dry matter determination. Dried samples were used for chemical analysis and in

vitro studies. In vitro digestibility of leaves, twigs and fruits and their combinations were evaluated. Statistical analyses was done using one-way ANOVA procedure and means separated using Duncan's multiple range test. Results revealed that *Gmelina* leaves had higher dry matter (DM) and crude protein (CP) contents (39.07%DM; 15.54%CP) than the twigs (35.26%DM; 10.63%CP) and fruits (34.36%DM; 10.42%CP). Leaves and twigs were higher in calcium and phosphorus content than the fruits. Cell wall fractions were higher in the twigs than the leaves and fruits. The fruits had the highest nitrogen free extract content, higher ( $P < 0.05$ ) in vitro net gas production, dry matter degradability (63.4%) and short chain fatty acid content. The gas produced from degradable fraction; b was lower in twigs relative to the leaves and fruits while rate of degradation; c was similar for the leaves, twigs and fruits. The combination of leaves, twigs and fruits showed better nutritive value than sole twigs. Chemical composition of *Gmelina* leaves, twigs and fruits suggests them as a nutritive feed resources for ruminants. The leaves and fruits can serve as potential sources of crude protein and fermentable carbohydrate while the twigs can be a good source of fiber.

**Key Words:** *Gmelina*, aerial part, ruminant

**W210 Comparison of Ankom filter bag types for the determination of acid and neutral detergent fibers.** Chris D. Teutsch, Brian T. Campbell\*, and W. Mac Tilson, Virginia Tech, Blacksburg, VA.

In the mid-1990s Ankom Technology developed a filter bag system for fiber determination. This system reduced labor and costs and simplified the operation. More recently, a new filter bag (F-58) was developed. This bag possesses reduced pore size and has been directed toward end users who utilize a finer grind size to support near infrared spectroscopy (NIRS). Little work has compared the older (F-57) and newer (F-58) bags. The primary objective of this study was to compare F-57 and F-58 filter bags for determination of ADF and NDF. Four forage species were collected, dried, and sequentially ground to pass through a 2 and 1 mm screen. These species included orchardgrass (*Dactylis glomerata* L.), bermudagrass (*Cynodon dactylon* L.), white clover (*Trifolium repens* L.), and sericea lespedeza (*Lepedeza cuneata* L.). Acid and NDF were determined using the Ankom 200 Fiber Analyzer. Trial x treatment interactions occurred for ADF ( $P < 0.01$ ). Therefore data are presented by trial. Within trials, significant forage x filter bag interactions occurred ( $P < 0.01$ ). In general, the use of the F-58 bag decreased ADF concentrations in all forages except bermudagrass ( $P < 0.01$ ) and had no effect on NDF concentrations ( $P > 0.05$ ). However, the impact on ADF concentrations was not consistent across forage species. Bermudagrass ADF concentrations did not differ between bags for either trial and orchardgrass differed in Trial I only where the % ADF was decreased from 38 to 35% for F-57 and F-58 bags respectively ( $P < 0.01$ ). At the current time our data indicate that the inconsistent performance across forage species and the increased cost does not justify the use of the F-58 bags.

**Key Words:** fiber, forage, detergent

**W211 Effect of corn planting density on yield and nutritional quality of corn silage when planted after ryegrass harvested for silage.** Gonzalo Ferreira\*<sup>1</sup>, Paul Hammock<sup>2</sup>, Mary Hammock<sup>2</sup>, Issac Hammock<sup>2</sup>, and Nathan Hammock<sup>2</sup>, <sup>1</sup>Department of Dairy Science, Virginia Polytechnic Institute and State University, Blacksburg, VA, <sup>2</sup>Hammock Dairy Inc., Museville, VA.

The objective of this study was to determine the effect of planting density on yield and nutritional composition of corn silage in a  $2 \times$ -crop



**Table 1 (Abstr. W211).** Effect of corn planting density (plants/ha × 1000) on yield and nutritional quality of corn silage

	Nonirrigated				Irrigated				SEM	<i>P</i> <		
	55	70	85	100	55	70	85	100		I	D	I×D
DM yield, kg/ha × 1000	18.9	18.2	19.2	21.5	18.9	20.5	20.1	21.6	0.13	0.44	0.23	0.80
Plant dry weight, g/plant	340	280	250	220	343	337	265	228	16	0.17	0.01	0.33
DM, %	27.7	27.4	27.7	26.7	27.8	27.7	27.6	25.5	0.53	0.10	0.36	0.46
CP, %	9.9	10.1	9.6	9.8	10.3	10.6	10.6	10.1	0.20	0.03	0.22	0.41
NDF, %	38.8	38.6	40.1	39.7	35.2	34.6	37.2	38.3	1.11	0.04	0.12	0.68
ADF, %	22.9	23.7	25.2	25.2	22.8	22.7	23.4	24.7	0.81	0.09	0.17	0.83
ADL, %	3.1	2.9	2.8	3.2	2.7	2.5	2.7	3.0	0.19	0.14	0.23	0.73
Starch, %	29.2	31.2	30.1	31.3	30.3	31.2	32.1	30.6	1.29	0.56	0.68	0.75
IVNDFD, %	55.1	55.5	56.0	53.9	55.1	55.9	56.3	54.3	0.78	0.60	0.08	0.99

rotation system. The study was performed at an 800-cow dairy farm located in south Virginia. Corn was planted in experimental plots within 2 cornfields, one of which was irrigated with a central-pivot irrigating system. Planting densities were 55, 70, 85, and 100 seeds/ha (×1000) in 4 replicates per cornfield (2 fields × 4 densities × 4 replicates = 32 plots). Plots were 12 25-m long rows separated by 76 cm. The irrigated cornfield was watered with 100 mm of water before tasseling. At the early-dent stage of maturity, 10 plants from each plot were cut (15 cm above ground), weighed, chopped, mixed thoroughly, and ensiled in bags for 60 d. Nutritional composition was performed by wet chemistry. The statistical model included the effects of irrigation (I), density (D),

the 2-way interaction (I×D), block, and field-by-block interaction. No interactions between irrigation and planting density were observed for any of the variables of interest. Dry matter yield was not affected by planting density. Increasing planting density reduced plant biomass. Planting density did not affect the concentrations of CP, NDF, ADF, ADL, and starch, but tended to affect IVNDFD quadratically. In conclusion, under a double-crop rotation system increasing planting density of corn does not increase DM yield and also does not affect the nutritional composition of corn silage when harvested at an early stage of maturity.

**Key Words:** plant density, corn silage, nutritional quality