

## Forages and Pastures: Forage Production and Quality

**M133 Dry matter yield and chemical composition of twenty-eight alfalfa cultivars grown in Brazil.** P. R. Meirelles\*, C. Costa, M. A. Q. Vieira, M. A. Factori, and E. A. R. Santana, *College of Veterinary Medicine and Animal Science, UNESP, Botucatu, Sao Paulo, Brasil.*

An experiment was conducted at the forage sector of the College of Veterinary Medicine and Animal Science, Botucatu-SP, with the objective of evaluating 28 alfalfa cultivars in terms of dry-matter yield and crude protein (CP), neutral detergent fiber (NDF) and acid detergent fiber (ADF) contents. The cultivars were the Crioula, Monarca, BR 4, Alto Great, MH 4, SW 9210 A, P 5929, BR 1, El Grande, P 5715, MH 15, Valley Plus, BR 2, Rio, SW 8210, Maricopa, ICI 990, P 5888, P 30, Alfa-200, WL 516, SW 8112 A, BR 3, Florida 77, Araucana, Falcon, Semit 921 and Sutter. The soil chemical characteristics in the experimental area were: pH in water 4.3, Al=0.70 meq/100cm<sup>3</sup>, Ca=12.0 mmolc.dm<sup>3</sup>, Mg=10.0 mmolc.dm<sup>3</sup>, K=0.9 mmolc.dm<sup>3</sup>, P=4.0 mg/dm<sup>3</sup>. Lime was applied at the rate of 6 t/ha, followed by pre-planting fertilization, which consisted of 600 kg superphosphate/ha, and 150 kg potassium chloride/ha. The seeds were planted in rows 30 cm apart at the rate of 15 kg/ha. A randomized block design with three replicates was used. The Monarca cultivar was the most productive and its dry matter yield differed ( $P < 0.05$ ) from that of MH 15, Valley Plus and SW 8112. Crude protein content differed ( $P < 0.05$ ) among cultivars, with the highest value in Valley Plus (22.39%) and the lowest in Semit 921 (18.8). NDF content did not differ ( $P < 0.05$ ), but there were statistical differences for ADF; the highest value (36.01%) occurred in ICI 990 and the lowest (29.44%) in P 30, with no difference ( $P < 0.05$ ) detected among others treatments. The most promising cultivars for the ecological characters of Botucatu-SP are the following: Monarca, because of its higher dry matter yield, followed by Rio, Sutter, Alto and Crioula, due to their low decrease in dry matter yield over three harvest years.

**Key words:** neutral detergent fiber, *Medicago sativa* L., acid detergent fiber

**M134 Tillering pattern and dry matter production of Mombasa grass submitted to nitrogen fertilization during regrowth.** A. F. Garcez Neto<sup>1,3</sup>, K. F. Gobbi<sup>2,3</sup>, T. M. Dos Santos<sup>1</sup>, E. E. B. Baldasso<sup>1</sup>, and J. Da Silva<sup>1</sup>, <sup>1</sup>Federal University of Parana, Palotina, Parana, Brazil, <sup>2</sup>Agronomic Institute of Parana, Paranavai, Parana, Brazil, <sup>3</sup>Federal University of Vicosa, Vicosa, Minas Gerais, Brazil.

Increase in forage growth rate can be related to different factors, such as energy supply for photosynthesis process and tillering potential. This work was carried out with the aim to study how a tropical forage with extensive growth potential (*Panicum maximum* Jacq. 'Mombaça') responds to different levels of nitrogen (N) fertilization during its regrowth, in terms of its tillering capacity and forage yield. The tillering capacity was measured by the number of tillers and tiller weight. Three levels of N were used (N0 = 0 mg/dm<sup>3</sup>; N25 = 25 mg/dm<sup>3</sup> and N50 = 50 mg/dm<sup>3</sup>) and six regrowth times (1, 2, 4, 8, 16 and 32 days after an initial staging or standardization cut). Nitrogen was provided weekly from 30 days before the standardization cut up to the last regrowth cut. The statistical analyses were performed using a randomized block design with a 3 × 6 factorial treatment arrangement, with 3 replicates. At each harvest the number of tillers per plant were counted and all the aboveground biomass was weighed (g DM/plot). A significant interaction ( $P < 0.05$ ) between

levels of N and the regrowth times was found for all variables studied. No effect was found for regrowth time to the number of tillers for N0. A lower number of tillers was found for N25 compared to N50 during all regrowth times ( $Y=64.8408+0.7771x$ ,  $R^2=0.795$ ;  $Y=67.4411+1.5982x$ ,  $R^2=0.854$ , respectively for N25 and N50). In N0, the increase in tiller weight (g DM/tiller) occurred linearly during regrowth times, but at very low intensity ( $Y=0.2+0.175x$ ,  $R^2=0.979$ ) compared to N25 and N50. The tiller weight responded quadratically to N in N25 and N50 treatments ( $Y=0.2752+0.259x+0.0006x^2$ ,  $R^2=0.996$ ;  $Y=0.2946+0.0093x+0.0014x^2$ ,  $R^2=0.997$ , respectively to N25 and N50). The aboveground biomass production also followed the same pattern found for tiller weight during regrowth times between N levels ( $Y=11.366+0.8546x$ ,  $R^2=0.986$ ;  $Y=17.993+1.7056x+0.0789x^2$ ,  $R^2=0.995$ ;  $Y=18.4238+1.1575x+0.1674x^2$ ,  $R^2=0.999$ , respectively to N0, N25 and N50). The highest N fertilization can be supplied to the grass from 16 days after regrowth.

**Key words:** grass, partition, tiller

**M135 Effects of growing conditions on alfalfa hay quality and production.** A. Palmonari\*, M. Fustini, G. Canestrari, and A. Formigoni, *Dipartimento Scienze Mediche Veterinarie, Universita degli Studi di Bologna, Bologna, Italy.*

Alfalfa hay is one of the most utilized forages in Italy. Its growth is ensured by environmental and climate conditions, which usually allow farmers to obtain 5 or sometimes more cuts per year. Numerous studies have shown that yield and quality of forages are affected by growth stage, forage species, cultivar, climate (e.g., rainfall, temperature), and growing condition. In alfalfa, growth conditions are probably the main factors responsible for changes in quality, due to the physiological modification of several tissues. This study focused on the quantification of these changes in fibrous and protein fractions and changes in fiber digestibility as a consequence of increased maturity. Within one field, 6 plots were designed and then paired in 3 treatments (A,B,C,A,B,C). Each treatment was harvested at 3 cutting intervals; trt A every 21 d (pre bloom), trt B every 28 d (first bloom) and trt C 35 d (full bloom) for 4 times each during 2008 spring and summer. Rainfall, temperature and yield were recorded for each cut and each pair of treatments during the trial. Fibrous and protein fractions, along with in vitro NDF digestibility at 24h were evaluated. Statistical analysis was performed among treatments using the ANOVA model with repeated measures of the software STATISTICA. CP, along with SolP and NPN, was significantly higher ( $P < 0.01$ ) for trt A (20.8% DM) than trt B or C (17.3% DM and 17.0% DM respectively). Similar results were observed for ADL and in vitro NDF digestibility at 24 h (trt A = 44.0% DM, trt B = 37.8% DM, trt C = 34.1% DM respectively;  $P < 0.01$ ). Increased maturity resulted in increased lignin deposition and loss of protein. This situation is reflected in fiber digestibility, which was compromised as maturity increased. Moreover, treatment A yielded similar amount of dry matter as treatment C (103.8 kg and 116.5 kg respectively), while the lower production was obtained from treatment B (96.2 kg). Together with analytical fractions, production results indicated that quantity of product is not always related to days of growth, which are typically correlated inversely with forage quality.

**Key words:** alfalfa, maturity, chemical composition

**M136 Nutritional value and silage fermentation parameters of elder (*Sambucus nigra*) as a supplement for dairy cattle in the Colombian Tropics.** L. Reyes, L. C. Bernal\*, and A. Conde, *Universidad de La Salle, Bogotá, Colombia*.

The aim of this study was to determine the nutritional value and fermentation parameters of an ensiled mixture of elder with corn bran and potato by-products. Elder leaves were cut after 90 days of regrowth and 2 years of establishment. Eight treatments and four replicates per treatment were evaluated. The elder leaves were chopped and mixed with either corn bran or potato bran, at inclusion levels of 20, 40, 50 and 60% for the respective brans. These mixtures were stored in a microbag (1 kg capacity) for 42 days. At the end of the fermentation period, samples were taken for analysis of nutritional quality (dry matter DM, crude protein CP and Gross Energy GE) and fermentation parameters (pH, ammonia nitrogen and its relation with total nitrogen). The experimental design was a  $2 \times 4$  factorial, (Factor a. corn bran vs. potato bran; factor b. 20, 40, 50 and 60% inclusion level of corn bran or potato bran). Data were analyzed using the GLM procedure of SAS. Inclusion of corn bran resulted increased ( $P < 0.001$ ) dry matter DM (60.83 vs. 19.38%) and gross energy GE concentrations (4.4 vs. 3.9 Mcal/Kg) as compared to inclusion of potato bran. Inclusion of potato bran resulted in increased ( $P < 0.001$ ) CP (16 vs. 12%) as compared to inclusion of corn bran. The ratio of ammonia nitrogen/total nitrogen was greater for the potato bran treatments (14.4 vs. 6.8%). There was no difference in pH ( $P > 0.001$ ) but the critical value of pH and water activity required for stabilizing a silage were not achieved in the elder leaves with potato bran silage because the DM values were low (DM 19% and pH 4.47). In the elder leaves with corn bran, the DM values were high (DM 60% and pH 4.39) which indicates the silage was stabilized. The DM, CP and GE values increased ( $P < 0.05$ ) with inclusion level of corn bran in the silage whereas those variables decreased ( $P < 0.05$ ) with increasing inclusion level of potato bran. Finally, the results of fermentation and nutritional quality showed that use of elder leaves mixed with corn bran at 50% is a good option and may be a viable alternative as a dietary supplement for dairy cows.

**Key words:** *Sambucus nigra*, corn bran, silage

**M137 Organic fertilization improves growth of *Paulownia* spp.** V. M. Llamas-Rodríguez\*, R. Luevano-Escobedo, V. Gallardo-Santillan, A. S. Juárez-Reyes, and M. A. Cerrillo-Soto, *Universidad Juárez del Estado de Durango, Durango, México*.

The genus *Paulownia* exhibits rapid juvenile growth with excellent characteristics for timber, fodder, ornamental and medicinal uses. A study was conducted to estimate the effect of applying either organic or inorganic fertilizer to plants of *P. tomentosa* maintained in field conditions. The study area is located in a semiarid region of Northern Mexico at an altitude of 1921 m above sea level and temperature ranging from  $-18$  to  $35^\circ\text{C}$ . Five treatments were applied to plants of 15 d of age. Two fertilizers; inorganic (based on N, P, K with doses of 20%, 8% and 4%, respectively in 100 mL of solution) and organic humic acid ( $n = 11.5\%$ ,  $P = 9.5\%$ ,  $K = 10.0\%$ ,  $\text{Ca} = 0.9\%$  and  $\text{S} = 0.8\%$ ) and 2 types of application (foliar and radicular) and a control (water) were evaluated. One hundred milliliters of solution was mixed in 1 L of water and applied every 15 d during 13 weeks. Height of the trees and amount of leaves were recorded. Data were analyzed according to a completely randomized design with 20 replications using ANOVA while mean comparison were performed using Tukey's test. Radicular application of inorganic fertilizer resulted in higher heights, while no effects were recorded due to inorganic foliar application. On the contrary, organic

fertilization in both ways of application resulted in positive effects. The amount of leaves was positively affected by the inorganic fertilizer applied in soil (radicular), whereas the organic humic acid favored this variable after both radicular and foliar applications ( $P < 0.01$ ). No differences were recorded between the foliar application of inorganic fertilizer and the control (water). Foliar and radicular application of organic fertilizer improved growth of *Paulownia* spp. compared to no treatment. Therefore, use of organic fertilizers might promote growth with less chance of soil contamination.

**Table 1. Effect of type of fertilizer on height and number of leaves in *Paulownia tomentosa***

Concept	Treatments					SEM
	Inorganic		Organic		Control	
	Radicular	Foliar	Radicular	Foliar	Radicular	
Height (cm)	21.5 <sup>a</sup>	11.9 <sup>c</sup>	18.2 <sup>b</sup>	16.0 <sup>b</sup>	12.6 <sup>c</sup>	14.16
Number of leaves	12.5 <sup>a</sup>	7.9 <sup>b</sup>	11.5 <sup>a</sup>	11.2 <sup>a</sup>	9.3 <sup>b</sup>	3.19

<sup>abc</sup>Means within rows with different superscripts differ ( $P < 0.01$ ); SEM = standard error of the mean.

**Key words:** *Paulownia*, fertilization, growth

**M138 Ruminal degradability of crude protein of Marandu grasses.** A. J. D. Pacheco Junior\*<sup>1</sup>, F. A. P. Santos<sup>1</sup>, C. M. M. Bittar<sup>1</sup>, L. R. D. Agostinho Neto<sup>1</sup>, R. A. M. Vieira<sup>2</sup>, L. O. Tedeschi<sup>3</sup>, B. C. Matos<sup>1</sup>, and G. B. Mourão<sup>1</sup>, <sup>1</sup>University of São Paulo, University of Sao Paulo, USP/ESALQ, Piracicaba, SP, Brazil, <sup>2</sup>State University of North Fluminense Darcy Ribeiro, State University of North Fluminense Darcy Ribeiro, Campos dos Goytacazes, RJ, Brazil, <sup>3</sup>Texas A&M University, Texas A&M University, College Station.

This study aimed to characterize the degradation rates of degradable fractions of CP (in situ methods) in samples of Marandu grass (*Brachiaria brizantha* cv. Marandu) managed with high stocking rates and variable intervals of grazing according 95% of light interception (LI) during spring, summer and fall. The study was conducted in University of São Paulo, Piracicaba, São Paulo, Brazil. We used 3 paddocks of 0.26 ha each, which were fertilized with 260 kg N/ha between the months of evaluation. The criterion for entry of animals in the paddocks was when they reached 25 cm in height and the stubble was 15 cm. Samples of Marandu grass to determine the rate of degradation of CP (in situ), represented the mean value from 20 sampling points per paddock. We collected the entire canopy above the height of stubble (15 cm). The samples were incubated in the rumen for 0, 3, 6, 12, 18, 24, 30, 36, 48, 60, 72, 96 and 120 hours. The data analyses were performed using Generalized Compartmental Model of Digestion and PROC MIXED of SAS. Estimation of in situ degradability of CP did not differ ( $P < 0.1$ ) among seasons (Table 1). Crude protein contained approximately 50% of soluble protein (Fraction A) and 40% of potentially degradable fraction of protein (Fraction B), respectively. The rates of degradation of fraction B were low and effective degradability was approximately 69%.

**Table 1.** Composition of crude protein fractions (in situ) in samples of Marandu grass along spring, summer and fall

Fraction <sup>1</sup> (%)	Season			SE	Pr >  t
	Spring	Summer	Fall		
A	54.5	44.2	50.4	4.4	0.3
B	33.3	45.4	38.3	3.5	0.1
C	12.2	10.4	11.3	1.4	0.7
Kd (%/h)*	6.3	7.6	8.0	1.3	0.5
λ (%/h)**	4.4	5.5	5.9	1.1	0.4
Effective degradability (%/h)	63.1	71.3	72.5	4.3	0.2

<sup>1</sup>A = soluble fraction; B = potentially degradable fraction; C = undegradable fraction.

\*Degradation rate of fraction B; \*\*asymptotic age-dependent fractional availability rate of the fraction B.

**Key words:** protein fraction, in situ degradability, tropical grass

**M139 Effect of stage of maturity of alfalfa hay upon in vitro dry matter and crude protein digestibility.** R. Copado-García<sup>1</sup>, O. Serna<sup>2</sup>, C. Arzola<sup>1</sup>, O. Ruiz<sup>1</sup>, C. Rodríguez<sup>1</sup>, A. Corral<sup>1</sup>, and H. Gaytan<sup>1</sup>, <sup>1</sup>Universidad Autónoma de Chihuahua, Chihuahua, Chihuahua, Mexico, <sup>2</sup>INIFAP, Chihuahua, Chihuahua, Mexico.

Alfalfa (*Medicago sativa*) dry matter is readily fermented in the rumen. Even though this phenomenon has been extensively studied in relation to the effects of the conservation method, there are not many studies regarding the effect of maturity upon the rumen degradability of dry matter and protein of alfalfa hay. To evaluate the effect of maturity upon those traits, 2 varieties of alfalfa ('Cuff-101' and 'Excellent multileaf') harvested in 4 seasons (spring, early, late summer and fall), were sampled and dry matter (IVDMD) and protein digestibility (IVCPD) were determined in vitro using an Ankom digester. Eight, 4 square m plots were harvested over a range of sampling periods (0, 5, 10, 15, and 20 d following Stage 2, (when stem length was > 0.40 m, but no buds, flowers, or seedpods were visible). An enclosure was subdivided into 5 sections at each of 8 locations in Delicias, Chih., Mexico, and sampled within 5 d intervals after an initial cut. Data were analyzed with a subplot design, with variety and period as main effects and day of cutting as sub-plot term. Statistical analysis used the GLM procedure of SAS. Alfalfa maturity, expressed as the number of days of cut after alfalfa had attained stage 2, did not show a significant difference ( $P > 0.05$ ) on IVDMD. However, in late summer and fall the CP tends to increase, but in fall IVCPD decreased noticeably, likely as result of a more rapid maturation of the plant. Also, as the maturity of the plants increased, CP increased, and IVCPD decreased linearly ( $P < 0.01$ ). We concluded that it is useful to take in consideration the stage of maturity to manage the nutritional quality of alfalfa in terms of digestibility of protein.

**Key words:** alfalfa, IVDMD, IVCPD

**M140 Nutrient composition, metabolizable energy, in situ rumen degradation and in vitro fermentation characteristics of linted cottonseed hulls, delinted cottonseed hulls and cottonseed linter waste.** H. J. Yang\* and Y. K. Bo, State Key Laboratory of Animal Nutrition, College of Animal Science and Technology, China Agricultural University, Beijing, China.

Dietary supplementation with conventional linted cottonseed hulls (LCSH) is a common practice in livestock production all over the

world. However, supplementation with mechanically delinted cottonseed hulls (DCSH) and cottonseed linter waste (CSLW) has not been well accepted by local farmers in Xinjiang province of China. In this study, representative samples of DCSH, LCSH and CSLW were collected in different areas of Xinjiang and assessed by chemical analysis, in situ and in vitro degradation methods. The CP ( $N \times 6.25$ ) content of CSLW ( $302 \pm 3.2$  g/kg DM) was approximately 3 times that of LCSH and 5 times that of DCSH. The ether extract (EE) content was 3 times higher in CSLW ( $269 \pm 3.12$  g/kg DM) than that of LCSH and 4 times higher than that of DCSH. NDF ( $311 \pm 2.0$ ) and ADF ( $243 \pm 6.2$ ) contents of CSLW were less than half values of DCSH or LCSH. Metabolizable energy, based on in vitro gas production and chemical analyses, ranked: CSLW ( $12.58 \pm 0.65$  kJ/kg DM) > LCSH ( $6.81 \pm 0.61$  kJ/kg DM) > DCSH ( $5.90 \pm 0.60$  kJ/kg DM) ( $P < 0.05$ ). The in situ degradation of DM and CP were fitted to an exponential equation:  $Y = a + b \times (1 - e^{-c \times \text{time}})$ . CSLW showed the highest effective degradabilities for DM ( $0.36 \pm 0.01$ ) and CP ( $0.52 \pm 0.04$ ) ( $P < 0.05$ ). One step in vitro ruminal DM disappearance and 2 step Tilley and Terry 's digestibilities of DM, NDF and ADF ranked: CSLW > LCSH > DCSH ( $P < 0.05$ ). The 72-h batch culture experiment also showed the highest production of volatile fatty acids occurred in CSLW ( $P < 0.05$ ), but the maximum gas production did not differ among the 3 cottonseed by-products. Molar proportions of methane in the fermentation gases were 23.5%, 25.0% and 17.5% for DCSH, LCSH and CSLW with a pooled standard error of 2.5, respectively. Dietary inclusion of CSLW could be beneficial to host ruminants by providing more glucogenic precursors (e.g., propionate) than non-glucogenic acids (e.g., acetate and butyrate). In general, CSLW appears to be valuable as a substitute for conventional protein feed for ruminant animals, with less potential for greenhouse gas emission than either LCSH or DCSH.

**Key words:** cottonseed by-products, in situ degradation, cumulative gas production

**M141 Chemical composition and nutritional value of *Prosopis laevigata* harvested at three different maturation stage.** R. Rojo\*, E. Castelán, A. Z. M. Salem, J. F. Vázquez, B. Encarnación-Elizalde, M. Palma-González, and J. Cedillo-Monroy, Centro Universitario UAEM-Temascaltepec, Universidad Autónoma del Estado de México, Temascaltepec, Estado de México, México.

A experiment was carried out to evaluate chemical composition and nutritional value of *Prosopis laevigata* pods harvested at three different maturity stages (IMP=immature pods, SMP=semi-mature pods, MAP=mature pods). Chemical analyses were: CP, NDF, ADF and Total condensed tannins (TCT) and nutritional components were: in vitro dry matter degradability (IVDMD), gas production (GP24), fermentation kinetic parameters (b: asymptotic gas production, c: rate of gas production from the slowly fermentable feed fraction b (/h) and lag time), short chain fatty acids (SCFA), metabolizable energy (ME), net energy (NE) and partition factor (PF). The inoculum was obtained from two adult male goats fitted with a ruminal fistula, fed a 40:60 forage:concentrate diet. Data were submitted to variance analysis by the GLM procedure and mean effects were separated by the Tukey test. The content of CP (g/kg DM) was greater ( $P < 0.05$ ) in IMP (28.1%) pods ( $P < 0.01$ ) compared to SMP (11.0%) and MAP (11.4%). The NDF and ADF were greater ( $P < 0.05$ ) in MAP in comparison with IMP and SMP. The TCT (g/kg DM) (TCT) was greater ( $P < 0.05$ ) in MAP (37.08) and SMP (36.77) than IMP (12.63). The gas production at 24 hours and kinetic gas production parameters (b y c) were greater ( $P < 0.05$ ) in SMP and MAP compared with IMP; the oppo-

site occurred with the lag time, with IMP having the lowest value ( $P = 0.0001$ ). The SCFA production was greater in SMP and MAP ( $P = 0.0001$ ) than IMP. However; PF and IVDMD were greater in IMP ( $P < 0.05$ ). Measures of energy (i.e, ME and NE) were not affected by the maturity stage. Based on the results we conclude that MAP and

SMP of *Prosopis laevigata* are promising nutritional alternative food sources for small ruminants, especially in the dry season.

**Key words:** chemical composition, nutritive value, *Prosopis laevigata* pods