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SHOOT DRY WEIGHT YIELD, BROMATOLOGICAL COMPOSITION, AND NUTRITIONAL STATUS OF ALFALFA CULTIVARS IN TROPICAL CONDITIONS

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ABSTRACT

Improvement to animal genetics requires the supply of superior quality forage, such as alfalfa (*Medicago sativa* L.). Under tropical and subtropical conditions in Brazil, alfalfa cultivation has been restricted to the 'Crioula' cultivar, although studies have indicated that other cultivars have excellent potential of yield. The objective of this work was to evaluate the adaptation and longevity of 92 alfalfa cultivars to the tropical edaphoclimatic conditions by assessing shoot dry weight yield (SDWY), crude protein content (CP), neutral detergent fiber (NDF), acid detergent fiber (ADF), and nutrient content in SDWY. The 'Crioula', 'P 105', 'Rio Grande', and 'Springfield' cultivars were the most promising owing to their higher yield and lower reduction in SDWY. Crude protein (CP) content varied among cultivars, with the highest value found in 'Pro INTA Lujan' (24.5%) and the lowest found in 'Pecos' (18.8%). NDF content ranged from 25.8% ('Key II') to 38.7% ('California 50'), while ADF content ranged from 16.4% ('F 708') to 24.8% ('Diamond'). Nutrient levels of all cultivars were within the levels considered appropriate for tropical conditions.

Keywords: *Medicago sativa*, mineral nutrition, crude protein, neutral detergent fiber, acid detergent fiber

PRODUÇÃO DE MATÉRIA SECA, COMPOSIÇÃO BROMATOLÓGICA E ESTADO NUTRICIONAL DE CULTIVARES DE ALFAFA EM CONDIÇÕES TROPICAIS

RESUMO

A melhoria da genética animal exige o fornecimento de uma forragem de qualidade superior como a alfafa (*Medicago sativa* L.), que nas condições brasileira se restringe a cultivar ‘Crioula’. O objetivo deste trabalho foi avaliar a adaptação e longevidade de 92 cultivares de alfafa para as

condições edafoclimáticas dos trópicos quanto às produções de matéria seca da parte aérea (MSPA), teor de proteína bruta (PB), fibra em detergente neutro (FDN), fibra em detergente ácido (FDA) e teores de nutrientes na MSPA. As cultivares 'Crioula', 'P 105', 'Rio Grande' e 'Springfield' foram as mais promissoras por apresentarem maior produção e menor índice de redução na produção de MSPA. O teor de proteína bruta variou entre os cultivares, com valor maior para 'Pro INTA Lujan' (24,5%) e menor para 'Pecos' (18,8), enquanto para os teores de FDN e FDA variaram de 25,8% ('Key II') a 38,7% ('Califórnia 50') e de 16,4% ('F 708') a 24,8% ('Diamond'). Independentemente da cultivar, os teores dos nutrientes na matéria seca ficaram dentro dos níveis considerados adequados para o cultivo da alfafa.

Palavras-chave: *Medicago sativa*, nutrição mineral, proteína bruta, fibra detergente neutro, fibra detergente ácido

INTRODUCTION

Alfalfa (*Medicago sativa* L.) is a legume rich in minerals, protein, and vitamins A and C; it has broad phenotypic plasticity and can be grown in both tropical and temperate regions (MOREIRA et al., 1996). Despite this adaptation to different latitudes, photoperiod is one factor that may limit the introduction of new accessions, a limitation common in legumes. Photoperiod is considered a limiting factor in the choice of materials selected for programs at different latitudes worldwide (NUERNBERG et al., 1992; REZENDE et al., 2007).

Alfalfa is excellent quality forage, producing more protein than white clover (*Trifolium repens* L.) or corn (*Zea mays* L.) silage (RASSINI et al., 2007). The cultivar selection process, the photoperiod sensitivity is a characteristic that varies between cultivars and/or species; each cultivar/species may have a different critical photoperiod, above which flowering may or not occur. Other factors, such as temperature, soil moisture, nutritional status, weed presence, and planting density can influence grain or SDWY (SEDIYAMA, 1989; MOREIRA et al., 2007).

Forage species with morphological, physiological, and agronomic characteristics that maximize forage yield and quality are desirable (FERREIRA et al., 1999). To identify the alfalfa cultivars best adapted to a given environment, periodic evaluations by means of cuts are necessary to assess the relevant principal phenotypic characteristics (FREITAS et al., 2008). Thus, one can estimate both the genotypic variability of the available material and the repeatability of performance for each cultivar or progeny (FERREIRA et al., 2004).

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Interest in alfalfa crops has led to several studies evaluating cultivars, taking into consideration not only yield, but also adaptability and quality of forage (MOREIRA et al., 1996; BOTREL et al., 2002; FERREIRA et al., 2004; RASSINI et al., 2007). These studies aimed to obtain new cultivation options and/or genotypes that are more productive than the 'Crioula' cultivar. This cultivar is practically the only cultivar planted in Brazil, despite the excellent adaptability of alfalfa under different edaphoclimatic conditions.

The objective of this work was to evaluate the shoot fry weight yield (SDWY), bromatological qualities (acid detergent fiber [ADF], neutral detergent fiber [NDF], and crude protein [CP]), and nutritional status of 92 alfalfa accessions (cultivars), in addition to the 'Crioula' cultivar, for tropical conditions.

MATERIAL AND METHODS

A field trial was conducted at the Embrapa Pecuaria Sudeste located in São Carlos, São Paulo State, Brazil (21°57′42″ LS, 47°50′28″ LW, 860 m altitude). Ninety-two alfalfa cultivars were planted in a Typic Oxisol with the following chemical attributes at the 0-20 cm depth: pH ($CaCl_2$) = 5.2, soil organic matter (SOM) = 17.0 g dm^{-3}, phosphorus (P) available (ion exchange resin) = 13 mg kg^{-1}, potassium (K^+) = 2.3 $cmol_c$ kg^{-1}, calcium (Ca^{2+}) = 1.3 $cmol_c$ kg^{-1}, magnesium (Mg^{2+}) = 0.4 $cmol_c$ kg^{-1}, aluminum (Al^{3+}) = 0,3 $cmol_c$ kg^{-1}, potential acidity (H+Al) = 2.4 $cmol_c$ kg^{-1}, and cation exchange capacity (CEC) = 6.4 $cmol_c$ kg^{-1}. The alfalfa cultivars were evaluated at three separate times, during three cuts.

Thirty days before alfalfa planting 5.0 Mg ha^{-1} of dolomite limestone (MgO> 13%; CARVALHO et al., 1994) was applied to the site, and at sowing time 80 kg ha^{-1} of P_2O_5 (simple superphosphate, 20% of P_2O_5), 100 kg ha^{-1} of K_2O (potassium chloride, 60% K_2O), and 30 kg ha^{-1} of fritted trace, FTE BR12® (boron [B], 1.8%; copper [Cu], 0.8%; iron [Fe], 3.0%; manganese [Mn], 2.0%; molybdenum [Mo], 0.1%; and zinc [Zn], 9.0%) were applied. The seeds were inoculated with *Shinorhizobium meliloti* strains, and planting density was 20 kg ha^{-1}. After each cut, at the time of sowing basal fertilizer rate used was the potassium chloride (KCl, 60% of K_2O) according to Moreira et al. (2008a). The alfalfa was irrigated using a central pivot, following an irrigation schedule according to Rassini (2007).

The experiment was set up as a randomized block design, with two replicates per cultivar, and repeated measures over time (FREITAS et al., 2011). The plot dimensions were 5.0 m × 2.5

m, with a usable area of 3.6 m^2. Five successive cuts based on the stage of plant development were made after two years of cultivation (14 previous cuts) in the usable area of each plot. Due to variation among cultivars, the time at which cuts were made varied with each cultivar. Cuts were made at 5.0 cm from the soil whenever each cultivar either had 10% of plants that were flowering or when the plants began to develop basal shoots. The characteristics of shoot dry weight yield (SDWY), crude protein (CP) content in SDWY, neutral detergent fiber (NDF), acid detergent fiber (ADF) and total phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), sulfur (S), boron (B), copper (Cu), iron (Fe), manganese (Mn), and zinc (Zn) were evaluated. Nutrient analyzes were performed according to the methodologies described by Malavolta et al. (1997), while the NDF and ADF analyzes were in accordance with AOAC (1995).

Results were analyzed as repeated measures (FREITAS et al. 2011) analysis of variance (ANOVA, *F*-tests), with means compared by Scott-Knott cluster test at 5% probability.

RESULTS AND DISCUSSION

There were significant differences between cultivars in relation to SDWY, CP, NDF, and ADF (Table 1). The 'Crioula', 'P 105', 'Rio Grande', and 'Springfield' cultivars had the highest cutting longevity in SDWY and produced, on average, more than 1000 kg ha^{-1} per cut. Yields of all cultivars ranged from 1092.4 kg ha^{-1} for the 'Crioula' cultivar to 287.3 kg ha^{-1} for 'Eterna', and an average 728.7 kg ha^{-1}, indicating that the selection procedures based on which ‘Crioula’ was identified as a cultivar adapted to tropical and subtropical edaphoclimatic conditions successfully produced a high-yield, long-lasting cultivar in terms of SDWY.

Costa et al. (2006) quantified the SDWY of 28 alfalfa cultivars in Botucatu, São Paulo State, Brazil, and reported significant differences between cultivars, with a mean of 1620 kg ha^{-1} of SDWY per cut, 55.1% higher than that found in the present study (Table 1). This difference in productivity is mainly due to the evaluation period of the harvesting season since the data of the present work were obtained after two years of cultivation and successive cuts. Rassini et al. (2007) report the results of this initial two-year period. Verifying the longevity of alfalfa cuts is a major factor in the material selection process; according to Nuernberg et al. (1992) and Ferreira et al. (1999), well-managed alfalfa can be economically viable for up to four successive cutting years (MOREIRA et al., 1996).

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Table 1. Shoot dry weight yield (SDWY), crude protein (CP), neutral detergent fiber (NDF), and acid detergent fiber (ADF) content in alfalfa cultivars. São Carlos, São Paulo State, Brazil.

Cultivars	SDWY kg ha^{-1}	CP %	NDF %	ADF %
5683	934.8c	22.7b	34.4a	21.1a
5929	960.8c	24.1a	36.9a	21.8a
5939	869.5d	20.7c	37.3a	22.4a
13 RR SUPREME	629.6i	19.8d	31.4b	22.9a
5683 L	964.1c	21.5c	35.4a	21.1a
58 N 58	775.8f	21.6c	34.4a	22.5a
ACA 900	658.3i	19.2d	38.5a	21.6a
ACA 901	626.1i	19.2d	33.9a	22.0a
ACTIVA	719.2g	22.2c	33.5a	20.8a
ALFA 200	813.2e	20.4d	33.4a	22.1a
AMERIGRAZE 701	809.8e	20.1d	34.7a	23.2a
AURORA	707.6h	22.6b	33.7a	21.7a
BACANA	718.4g	19.3d	33.0b	23.9a
BÁRBARA SP INTA	816.0e	22.7b	30.7b	18.1b
CALIFORNIA 50	820.2e	21.3c	38.7a	21.9a
CALIFÓRNIA 60	730.0g	21.7c	32.4b	23.3a
CANDOMBE	744.4g	23.1b	32.6b	22.2a
CORONADO	787.7f	21.5c	32.1b	19.3b
COSTERA SP INTA	560.2k	23.4b	32.2b	17.7b
CRIOULA	1092.4a	22.7b	35.2a	24.7a
CUF 101	564.2k	23.6b	35.2a	22.3a
DIAMOND	945.2c	21.9c	38.5a	24.8a
DK 166	824.0e	22.1c	32.8b	21.5a
DK 167	743.3g	21.0c	35.8a	23.6a
DK 177	578.0j	23.6b	33.4a	20.2b
DK 181	974.8c	20.8c	35.7a	21.2a
DK 187 RR	405.1n	20.8c	33.2b	20.7a
DK 193	727.9g	24.8a	36.4a	17.4b
DK 194	709.7h	21.2c	35.7a	20.8a
ESMERALDA SP INTA	441.8m	23.6b	33.7a	22.3a
ETERNA	287.3o	24.6a	32.7b	17.0b
EXPRESS	860.4e	22.3b	36.6a	21.5a
F 686	594.2j	22.2c	31.9b	20.8a
F 708	507.5l	23.4b	27.6b	16.5b
FLÓRIDA 77	817.1e	22.7b	32.8b	23.8a
GALA	602.8j	22.7b	31.5b	21.0a
GAPP 969	652.4i	21.6c	31.2b	18.2b
GT 13 RR PLUS	857.1	22.3b	29.1b	16.9b
HUNTERFIELD	765.5f	24.7a	30.5b	23.5a
KERN	422.6n	25.2a	26.8b	17.4b
KEY II	630.4i	24.2a	25.8b	17.4b
LE SEMIT 711	549.0k	22.8b	34.2a	21.0a
LE N 1	452.7m	20.9c	36.7a	22.1a
LE N 2	936.6c	20.8c	35.7a	21.7a
LE N 3	924.5d	22.2c	37.5a	23.4a
LE N 4	728.8g	20.6c	33.9a	19.8b
LE SEMIT 711	898.9d	22.0c	28.7b	19.1b
LUJAN	730.2g	24.6a	31.0b	19.8b
MARICOPA	948.7c	20.5d	34.2a	23.5a

Continue…

Table 1. Shoot dry weight yield (SDWY), crude protein (CP), neutral detergent fiber (NDF), and acid detergent fiber (ADF) content in alfalfa cultivars. São Carlos, São Paulo State, Brazil. (continue…)

Cultivars	SDWY kg ha^{-1}	CP %	NDF %	ADF %
MAXIDOR	603.7j	23.4b	36.2a	22.1a
MEDINA	998.5b	22.0c	31.2b	22.0a
MONARCA	664.2i	22.9b	27.8b	16.5b
MONARCA SP INTA	379.8o	21.1c	33.0b	18.1b
N 910	675.3i	21.8c	34.4a	23.5a
P 105	1073.3a	24.3a	30.1b	18.5b
P 30	581.3j	22.9c	32.4b	19.8b
P 5715	535.9k	21.7c	35.1a	21.8a
PATRICIA	656.2i	22.5c	34.8a	22.3a
PECOS	892.2d	18.6d	35.3a	23.5a
PERLA	612.3j	24.0a	29.5b	19.2b
PERLA SP INTA	662.1i	21.2c	34.5a	20.7a
PINTO	924.9d	20.3d	37.0a	22.7a
PLATINO	824.4e	23.6b	41.1a	26.3a
PRIMAVERA 1	662.6i	23.7b	33.3a	20.4b
PRIMAVERA 2	822.8e	23.4b	29.9b	17.6b
PRO INTA LUJAN	552.8k	24.5a	28.7b	18.1b
PRO INTA PATRICIA	661.4i	22.7c	31.1b	22.1a
RIO GRANDE	1032.6b	22.1c	30.2b	19.8b
ROCIO	772.3f	22.9c	32.0b	17.7b
SEQUEL	842.9e	18.7d	35.4a	20.3b
SEQUEL 2	868.1e	23.3c	36.9a	21.3a
SEQUEL HR	670.1i	22.2c	33.4a	20.5b
SIRIVER	374.0n	21.7c	33.0b	19.0b
SIRIVER 2	905.1d	22.1c	34.7a	17.9b
SPRINGFIELD	1004.5b	23.0c	36.4a	19.1b
SPS 6550	751.3g	20.0d	35.0a	22.5a
SUNDOR	951.0c	21.0c	36.1a	18.9b
SUTTER	599.9j	23.9a	33.8a	22.3a
TAHOE	399.3n	23.0c	31.6b	17.4b
TANGO	393.5n	24.3a	26.9b	16.9b
TOPPER	985.6b	23.6b	33.5a	21.0a
TRINIDAD 87	928.0b	20.8c	37.0a	24.5a
VICTORIA	675.6i	24.2a	35.0a	18.9b
VICTORIA SP INTA	705.7h	21.3c	36.1a	22.2a
WINTER	509.9l	22.0c	30.7b	19.2b
WL 414 a	657.9i	22.4c	33.3a	19.9b
WL 414 b	425.8n	23.7b	33.0b	19.1b
WL 442	787.3f	21.5c	31.1b	19.5b
Mean	728.7	22.2	33.5	20.8
CV (%)	12.11	15.56	10.64	13.80

*Means followed by distinct letters in the same column are statistically significant at the 5% probability level by Scott-Knott test. CV – coefficient of variation.

Crude protein content in SDWY ranged from 18.6% in 'Pecos' to 24.5% in 'Pro INTA Lujan', with an average of 22.2% among all cultivars (Table 1). However, when converted into protein content in SDWY ([CP × SDWY]/100), the highest values were observed in cultivar 'P

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105', with 259.9 kg ha^{-1} of CP, and the lowest in 'Monarca SP INTA', with 79.9 kg ha^{-1} of CP. Despite this variability, CP levels are well above those obtained in two previous studies. Moreira et al. (1996) studied nine alfalfa cultivars in four growing seasons and obtained an average of 17.7% of CP in SDWY. Moreira et al. (1997) studied sulfur (S) sources and rates and found an average CP content of 21.5%. Differences in protein composition between cultivars can be attributed to the development cycle and differing environmental conditions, in which cultivars with lower CP content have higher growth rates (Costa et al. 2006). This corroborates the findings of Baligar et al. (2001) and Moreira et al. (2016), who reported that nutritional composition might vary between species and cultivars or varieties within the same plant species.

The NDF values, which ranged from 25.8% ('Key II') to 38.7% ('California 50'), with an average content among cultivars of 33.5% (Table 1), were lower than the data obtained by Costa et al. (2006), who evaluated 28 alfalfa cultivars and obtained NDF values between 43.1% and 47.0% in the SDWY. The proportion of NDF of forage is important not only for the evaluation of its chemical composition, but also because the NDF is related to the maximum dry weight intake (COSTA et al., 2006); i.e., plants with higher NDF levels have lower consumption potential. According to Monteiro et al. (1998), there is a slight tendency for the most productive cultivars to exhibit lower NDF content, which can be inferred from our results, since, except for 'Crioula', the cultivars 'P 105', 'Rio Grande', and 'Springfield' had values below the average (33.5%).

Acid detergent fiber (ADF) represents the least digestible portion of the forage cell wall (cellulose and lignin) (van SOEST et al., 1991). ADF content varied from 16.4% ('F 708') to 24.8% ('Diamond'), with an average of 20.8%, and ADF content did not correlate with SDWY and CP content (Table 1). The ADF values found in alfalfa cultivars are well below those reported by Monteiro et al. (1998) and Costa et al. (2006), who obtained average levels of 31.7% and 32.4%, respectively. In nutritional terms, Machado et al. (1998) and Monteiro et al. (1998) reported that the highest FDA content in SDWY is found in plants with the highest levels of cellulose and lignin, due to the higher conversion rates of photosynthetic products into structural tissues.

The relative magnitude of P, K, Ca, Mg, and S content in the SDWY was as follows: K > Ca > P > Mg > S. The content of these macronutrients varied between cultivars from 2.9 ('Sequel') to 3.9 g P kg^{-1} ('Siriver'); 31.5 ('Siriver') to 39.8 g K kg^{-1} ('Maxidor'); 6.7 ('Barbara SP INTA') to 11.2 g Ca kg^{-1} (5939); 2.4 ('Florida 77') to 3.3 g Mg kg^{-1} ('F 686'); and 1.7 ('P5715') to 2.9 g S kg^{-1} ('Le Semit 711'), respectively (Table 2). These are like those obtained by Moreira et al. (2008a)

and Moreira et al. (2008b) within the ranges indicated by them as adequate levels for alfalfa cultivation in tropical conditions. The relative magnitude of micronutrient content was as follows: Fe > Mn > Zn > B > Cu (Table 3), with content ranging from 15.8 ('Monarch') to 33.4 mg B kg^{-1} ('Springfield'); 11.7 ('Siriver 2') to 22.2 mg Cu kg^{-1} ('Springfield'); 229.2 ('DK 193') to 608.5 mg Fe kg^{-1} ('Barbara SP INTA'); 24.8 ('WL 414 b') to 36.9 mg Mn kg^{-1} ('Patricia'); and 20.2 ('5939') to 35.0 mg Zn kg^{-1} ('Siriver'), respectively. Despite of the yield, these are, independently of cultivar, within the appropriate levels for the cultivation and use of alfalfa in the tropics (MOREIRA et al., 2000; MOREIRA et al., 2008a).

Table 2. Macronutrients (P, K, Ca, Mg, and S) content of shoot dry weight in alfalfa cultivars. São Carlos, São Paulo State, Brazil.

Cultivars	P	K	Ca	Mg	S
	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}
5683	3.3b	36.7a	10.0a	2.7a	2.5a
5929	3.6a	35.3a	10.2a	3.0a	2.2a
5939	3.3b	31.8b	11.2a	3.2a	2.1a
13 RR SUPREME	3.1b	33.8b	9.4a	3.1a	2.2a
5683 L	3.4a	32.2b	8.1b	2.7a	2.1a
58 N 58	3.3b	34.7a	9.1a	3.0a	2.4a
ACA 900	3.4a	34.3a	8.6a	2.9a	2.1a
ACA 901	3.4a	33.1b	7.1b	2.7a	2.2a
ACTIVA	3.3b	35.2a	8.6a	2.9a	2.3a
ALFA 200	3.3b	34.4a	7.5b	3.0a	2.3a
AMERIGRAZE 701	3.0b	38.1a	9.6a	3.1a	2.1a
AURORA	3.3b	33.8b	10.0a	2.8a	2.1a
BACANA	3.3b	34.1a	7.1b	2.8a	2.2a
BÁRBARA SP INTA	3.7a	36.8a	6.7b	2.9a	2.4a
CALIFORNIA 50	3.2b	33.9b	9.3a	3.2a	1.9a
CALIFÓRNIA 60	3.2b	34.3a	9.4a	2.8a	2.1a
CANDOMBE	3.3b	38.7a	9.6a	2.9a	2.6a
CORONADO	3.3b	36.4a	8.6a	3.0a	2.2a
COSTERA SP INTA	3.4a	33.8b	8.5a	3.4a	2.3a
CRIOULA	3.1b	34.5a	10.3	3.1a	2.1a
CUF 101	3.8a	35.9a	8.7a	3.0a	2.3a
DIAMOND	3.1b	36.9a	8.8a	2.9a	2.4a
DK 166	3.0b	36.0a	9.3a	2.7a	2.0a
DK 167	2.9b	32.9b	7.9b	2.9a	2.2a
DK 177	3.6a	37.2a	10.5a	2.9a	2.3a
DK 181	3.0b	35.1a	10.5a	2.9a	2.4a
DK 187 RR	3.3b	38.6a	8.1b	3.1a	2.2a
DK 193	3.4a	35.2a	9.7a	3.2a	2.4a
DK 194	3.3b	35.9a	8.3a	2.8a	2.0a
ESMERALDA SP INTA	3.2b	34.3a	9.6a	3.2a	2.4a
ETERNA	3.8a	37.9a	7.5b	3.2a	2.2a
EXPRESS	3.0b	37.3a	10.3a	2.7a	2.5a
F 686	3.3b	32.9b	10.5a	3.3a	2.3a
F 708	3.4a	31.7b	8.5a	2.9a	2.3a
FLÓRIDA 77	3.2b	33.2b	8.3a	2.4a	2.3a

Continue...

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Table 2. Macronutrients (P, K, Ca, Mg, and S) content of shoot dry weight in alfalfa cultivars. São Carlos, São Paulo State, Brazil (continue...).

Cultivars	P	K	Ca	Mg	S
	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}
GALA	3.5a	38.9a	8.6a	3.2a	2.7a
GAPP 969	3.2b	33.2b	9.3a	2.9a	2.3a
GT 13 RR PLUS	3.4a	34.4a	7.9b	3.0a	2.4a
HUNTERFIELD	3.4a	34.9a	8.3a	2.8a	2.8a
KERN	3.6a	33.4b	6.9b	2.8a	2.4a
KEY II	3.8a	33.9b	6.8b	3.0a	2.4a
LE SEMIT 711	3.8a	38.0a	8.2a	2.7a	2.9a
LE N 1	3.5a	36.1a	8.3a	2.7a	2.4a
LE N 2	3.2b	35.9a	7.8b	2.7a	2.6a
LE N 3	3.3b	37.7a	10.4a	3.2a	2.5a
LE N 4	3.0b	31.9b	7.3b	2.7a	2.1a
LE SEMIT 711	3.6a	35.3a	9.2a	3.1a	2.3a
LUJAN	3.4a	37.5a	7.7b	3.0a	2.3a
MARICOPA	3.0b	33.2b	10.2a	3.2a	2.3a
MAXIDOR	3.2b	39.8a	8.5a	2.5a	2.4a
MEDINA	3.3b	34.5a	9.0a	2.9a	2.3a
MONARCA	3.5a	37.8a	8.1b	3.0a	2.5a
MONARCA SP INTA	3.5a	34.7a	7.7b	3.2a	2.3a
N 910	3.2b	34.4a	8.1b	3.0a	2.0a
P 105	3.4a	33.8b	9.3a	3.0a	2.5a
P 30	3.9a	37.5a	7.4b	3.0a	2.0a
P 5715	3.4a	35.5a	7.4b	3.0a	1.8a
PATRICIA	3.6a	32.0b	8.5a	3.0a	2.3a
PECOS	3.1b	35.3a	9.1a	3.0a	2.4a
PERLA	3.4a	34.4a	6.8b	2.8a	2.4a
PERLA SP INTA	3.1b	33.7b	10.2a	3.1a	2.7a
PINTO	3.1b	36.0a	7.4b	3.0a	2.0a
PLATINO	3.3b	35.8a	8.0b	2.8a	2.3a
PRIMAVERA 1	3.6a	35.7a	9.6a	2.8a	2.5a
PRIMAVERA 2	3.5a	35.0a	9.6a	3.3a	2.1a
PRO INTA LUJAN	3.1b	36.0a	8.8a	2.9a	2.4a
PRO INTA PATRICIA	3.4a	37.2a	8.4a	2.7a	2.4a
RIO GRANDE	3.3b	33.2b	7.3b	3.0a	2.4a
ROCIO	3.5a	35.4a	7.3b	3.1a	2.5a
SEQUEL	3.2b	36.2a	8.5a	3.3a	1.8a
SEQUEL 2	3.1b	33.9b	9.2a	3.1a	2.6a
SEQUEL HR	3.3b	35.7a	8.4a	2.9a	2.2a
SIRIVER	3.9a	31.5b	7.3b	3.0a	2.4a
SIRIVER 2	2.9b	35.3a	10.2a	2.6a	2.3a
SPRINGFIELD	3.6a	35.5a	9.9a	2.9a	2.4a
SPS 6550	3.0b	35.5a	8.5a	2.6a	2.4a
SUNDOR	3.2b	32.0b	8.8a	2.8a	2.2a
SUTTER	3.4a	36.9a	7.7b	2.6a	2.5a
TAHOE	3.4a	34.1a	8.8a	2.7a	2.5a
TANGO	3.7a	35.1a	7.7b	3.0a	2.3a
TOPPER	3.7a	35.9a	8.4a	2.9a	2.6a
TRINIDAD 87	3.1b	37.2a	9.3a	3.1a	2.2a
VICTORIA	3.4a	33.4b	7.7b	2.9a	2.5a
VICTORIA SP INTA	3.2b	37.0a	8.5a	3.1a	2.0a
WINTER	3.5a	35.3a	8.3a	2.9a	2.8a

Continue…

Table 2. Macronutrients (P, K, Ca, Mg, and S) content of shoot dry weight in alfalfa cultivars. São Carlos, São Paulo State, Brazil (continue...).

Cultivars	P	K	Ca	Mg	S
	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}
WL 414 a	3.3b	32.9b	8.3a	2.8a	2.3a
WL 414 b	3.4a	38.1a	8.9a	2.7a	2.6a
WL 442	3.4a	36.5a	7.3b	2.9a	2.1a
Mean	3.2	36.9	8.0	2.8	2.2
CV (%)	12.44	13.51	12.44	11.93	16.17

*Means followed by distinct letters in the same column are statistically significant at the 5% probability level by Scott-Knott test. CV – coefficient of variation.

Table 3. Micronutrients (B, Cu, Fe, Mn, and Zn) content of shoot dry weight in alfalfa cultivars. São Carlos, São Paulo State, Brazil.

Cultivars	B	Cu	Fe	Mn	Zn
	mg kg^{-1}	mg kg^{-1}	mg kg^{-1}	mg kg^{-1}	mg kg^{-1}
5683	21.2c	12.5b	320.3a	28.2a	25.9b
5929	27.1b	19.0a	368.2a	31.0a	24.8b
5939	27.3b	19.0a	299.4b	29.4a	20.2b
13 RR SUPREME	20.4c	12.0b	331.3a	35.7a	26.5b
5683 L	28.3a	20.5a	458.4a	27.1a	27.5a
58 N 58	22.3c	19.8a	302.3a	26.6a	23.0b
ACA 900	22.6c	16.7b	280.1b	26.3a	23.3b
ACA 901	32.6a	17.1a	373.7a	30.8a	29.9a
ACTIVA	23.9c	16.6b	359.3a	30.3a	26.7a
ALFA 200	24.7b	17.5a	472.1a	30.4a	30.2a
AMERIGRAZE 701	22.2c	13.0b	327.2a	31.2a	22.6b
AURORA	26.2b	21.5a	298.5b	24.3a	22.3b
BACANA	29.3a	18.9a	386.5a	30.2a	28.8a
BÁRBARA SP INTA	20.5c	18.1a	608.5a	37.2a	31.3a
CALIFORNIA 50	26.9b	17.5a	276.5a	26.7a	22.1b
CALIFÓRNIA 60	24.5b	12.8b	318.1a	25.3a	25.1b
CANDOMBE	26.0b	18.9a	313.2a	26.6a	22.7b
CORONADO	22.9c	17.7a	314.9a	33.6a	28.8a
COSTERA SP INTA	21.6c	18.8a	436.6a	28.8a	29.0a
CRIOULA	18.4c	16.1b	346.9a	29.0a	27.8a
CUF 101	22.3c	18.9a	344.2a	32.0a	29.2a
DIAMOND	24.5b	19.9a	311.9a	26.7a	24.7b
DK 166	24.4b	20.5a	316.5a	24.6a	21.1b
DK 167	28.6a	12.7b	352.8a	28.7a	26.3b
DK 177	19.0c	12.5b	299.8b	29.8a	27.6a
DK 181	17.1c	12.8b	268.9b	29.6a	23.1b
DK 187 RR	23.5c	16.9b	325.9a	30.4a	25.4b
DK 193	16.7c	19.5a	229.2b	30.6a	24.6b
DK 194	25.8b	17.3a	297.1b	30.5a	26.2b
ESMERALDA SP INTA	21.5c	14.9b	324.6a	28.6a	27.2a
ETERNA	19.2c	20.3a	407.7a	26.4a	29.8a
EXPRESS	18.9c	13.0b	345.4a	29.7a	22.8b
F 686	21.1c	16.3b	376.0a	31.3a	25.5b
F 708	18.3c	15.3b	324.5a	30.4a	28.8a
FLÓRIDA 77	24.1c	13.8b	289.0b	30.7a	28.5a
GALA	21.4c	17.2a	427.0a	33.3a	28.8a
GAPP 969	33.2b	19.2a	370.0a	34.7a	29.1a

Continue…

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Table 3. Micronutrients (B, Cu, Fe, Mn, and Zn) content of shoot dry weight in alfalfa cultivars. São Carlos, São Paulo State, Brazil (continue...).

Cultivars	B	Cu	Fe	Mn	Zn
	mg kg^{-1}	mg kg^{-1}	mg kg^{-1}	mg kg^{-1}	mg kg^{-1}
GT 13 RR PLUS	27.3b	19.2a	356.9a	32.5a	28.6a
HUNTERFIELD	21.5c	13.6b	395.8a	26.2a	27.0a
KERN	18.7c	16.7b	409.2a	28.5a	28.2a
KEY II	24.0c	16.5b	564.6a	30.2a	31.3a
LE SEMIT 711	23.2c	17.4a	309.3a	32.6a	28.6a
LE N 1	22.0c	14.7b	349.5a	31.2a	26.8a
LE N 2	22.9c	14.9b	270.5b	27.5a	24.7b
LE N 3	24.3b	16.9b	331.1a	32.9a	23.7b
LE N 4	30.0b	14.8b	284.1b	29.3a	23.5b
LE SEMIT 711	21.6c	18.4a	511.0a	31.7a	23.5b
LUJAN	20.7c	16.5b	400.6a	29.5a	27.2a
MARICOPA	22.7c	14.0b	308.6a	27.4a	23.2b
MAXIDOR	20.8c	14.6b	414.2a	27.7a	25.6b
MEDINA	22.0c	19.8a	301.1a	25.8a	23.4b
MONARCA	15.8c	16.7b	379.3a	34.2a	30.7a
MONARCA SP INTA	26.1b	14.0b	374.6a	30.7a	26.0b
N 910	19.5c	18.6a	344.8a	26.4a	24.3a
P 105	23.7c	13.2b	372.0a	28.4a	26.2b
P 30	28.7a	18.1a	387.9a	31.4a	29.8a
P 5715	25.2b	18.5a	327.7a	30.9a	27.7a
PATRICIA	25.8b	15.0b	466.6a	36.9a	33.3a
PECOS	22.7c	11.9b	294.5b	29.8a	25.0b
PERLA	23.2c	16.9b	388.0a	26.9a	27.6a
PERLA SP INTA	20.4c	14.8b	346.4a	30.8a	26.9a
PINTO	24.5b	19.4a	370.0a	31.9a	26.7a
PLATINO	30.5a	14.8b	635.7a	34.3a	30.7a
PRIMAVERA 1	23.5c	13.6b	433.9a	32.8a	26.3b
PRIMAVERA 2	31.4a	18.4a	405.7a	29.1a	21.9b
PROINTA LUJAN	20.3c	15.4b	328.6a	30.5a	28.9a
PROINTA PATRICIA	22.7c	13.5b	319.3a	27.1a	28.0a
RIO GRANDE	21.0c	17.6a	424.3a	33.4a	29.3a
ROCIO	31.2a	18.0a	315.2a	27.5a	28.5a
SEQUEL	25.7b	19.2a	358.4a	30.8a	26.9a
SEQUEL 2	27.1b	19.5a	282.4b	27.1a	22.9b
SEQUEL HR	26.6b	18.6a	371.2a	30.6a	26.3b
SIRIVER	27.1b	21.8a	633.7a	40.1a	35.0a
SIRIVER 2	22.5c	11.7b	337.1a	36.7a	28.1a
SPRINGFIELD	33.4a	22.2a	309.0a	30.7a	25.9b
SPS 6550	21.8c	14.8b	290.0b	37.5a	25.0b
SUNDOR	24.7b	21.6a	301.9a	23.6a	23.0b
SUTTER	26.4b	13.0b	271.1b	25.2a	26.9a
TAHOE	22.7c	15.2b	383.8a	36.2a	31.0a
TANGO	20.3c	14.0b	369.9a	31.5a	28.8a
TOPPER	23.3c	18.5a	349.7a	29.0a	25.5b
TRINIDAD 87	22.4c	15.4b	336.9a	35.0a	24.3b
VICTORIA	25.4b	14.3b	352.4a	26.1a	26.2b
VICTORIA SP INTA	24.0c	17.0a	290.5b	31.7a	22.5b
WINTER	26.2b	14.4b	421.7a	39.3a	30.0a

Continue…

Table 3. Micronutrients (B, Cu, Fe, Mn, and Zn) content of shoot dry weight in alfalfa cultivars. São Carlos, São Paulo State, Brazil (continue...).

Cultivars	B	Cu	Fe	Mn	Zn
	mg kg^{-1}	mg kg^{-1}	mg kg^{-1}	mg kg^{-1}	mg kg^{-1}
WL 414 a	23.9c	18.5a	328.4a	33.5a	28.8a
WL 414 b	18.9c	13.5b	300.2a	24.8a	27.4a
WL 442	26.2b	14.6b	331.9a	32.4a	26.5b
Mean	23.3	15.1	376.3	40.9	32.8
CV (%)	17.07	15.98	19.21	17.58	14.43

*Means followed by distinct letters in the same column are statistically significant at the 5% probability level by Scott-Knott test. CV – coefficient of variation.

CONCLUSIONS

The 'Crioula', 'P 105', 'Rio Grande', and 'Springfield' alfalfa cultivars had high cutting longevity and SDWY.

The cultivars 'Eterna', 'Monarch INTA', 'Siriver', 'Tahoe', and 'Tango' had yields of less than 400 kg ha^{-1} per cut and were considered the least promising because of the lower SDWY.

In alfalfa cultivars, the bromatological composition (CP, ADF, and NDF) and nutritional status (macro and micronutrients) in SDWY were within the levels considered adequate in the literature for alfalfa cultivation in the tropics.

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