http://dx.doi.org/10.1590/1678-4162-12827

Arq. Bras. Med. Vet. Zootec., **v.74, n.6, p.1151-1160, 2022**

Productivity and nutrient extraction by Paiaguás palisadegrass, single and intercropping with pigeon pea, submitted to doses of nitrogen

[*Produtividade e extração de nutrientes pelo capim paiaguás submetido a doses de nitrogênio em cultivo solteiro e consorciado com feijão guandu*]

P.R. *Rezende*[1], L.M. *Rodrigues*[1], C. *Backes*[1], A.G. *Teodoro*[1], A.J.M. *Santos*[1], P.B. *Fernandes*[2*], P.R. *Giongo*[1], A.A. *Ribon*[1], S.V. *Bessa*[1]

[1]Universidade Estadual de Goiás, *campus* Oeste, sede São Luís dos Montes Belos, GO, Brasil
[2]Universidade Federal de Mato Grosso do Sul, MS, Brasil

ABSTRACT

The objective of this work was to evaluate the productivity and extraction of macronutrients by *Urochloa brizantha* cv. BRS Paiaguás (*Syn*. *Brachiaria brizantha* cv. BRS Paiaguás) single and intercropped with pigeon pea (*Cajanus cajan* cv. BRS Mandarim), subjected to four doses of nitrogen applied in topdressing (0, 80, 160 and 240 kg ha^{-1}). The experiment was carried out in São Luís de Montes Belos, GO, in soil classified as dystrophic red latosol, under Cerrado conditions. Plant height and dry mass of pigeon pea, plant height, number of tillers, dry mass, and macronutrient extraction by Paiaguás palisadegrass were evaluated. Higher mass production was observed in the pasture intercropped with the legume, requiring a lower amount of N. Based on the results exposed, the cultivation of Paiaguás palisadegrass reaches higher productivity when intercropped with a legume such as pigeon pea, in addition to providing greater efficiency in the use of nutrients such as N, P and K. Nitrogen fertilization has a negative influence on the production of dry mass and height of pigeon pea plants.

Keywords: biological nitrogen fixation, intercropping, legume, nitrogen fertilization

RESUMO

Objetivou-se, com o trabalho, avaliar a produtividade e a extração de macronutrientes pelo capim-solteiro e consorciado com feijão-guandu, submetidos a quatro doses de nitrogênio aplicadas em cobertura (0, 80, 160 e 240kg ha^{-1}). O experimento foi conduzido em São Luís de Montes Belos, GO, em solo classificado como Latossolo Vermelho Distrófico, sob condições de Cerrado. Foram avaliados a altura de plantas e a massa seca do guandu, a altura de plantas, os números de perfilhos, a massa seca e a extração de macronutrientes pelo capim-paiaguás. Foi observada maior produção de massa na pastagem consorciada com a leguminosa, demandando menor quantidade de N. Com base nos resultados expostos, o cultivo de capim-paiaguás atinge maiores produtividades quando consorciado com uma leguminosa, como o feijão-guandu, além de proporcionar maior eficiência no uso de nutrientes, como N, P e K. A adubação nitrogenada tem influência negativa sobre a produção de massa seca e a altura das plantas de feijão-guandu.

Palavras-chave: adubação nitrogenada, consórcio, fixação biológica de nitrogênio

INTRODUCTION

The degradation of areas with pastures is still a major problem found on properties in Brazil, an obstacle faced by livestock that directly and negatively affects the animal production chain (Kichel *et al*., 2011). According to MapBiomas (2020), the area with pasture in Brazil is approximately 167 million hectares, and it is estimated that more than 40% of these areas are in a medium or advanced level of degradation.

To reverse this degradation process, direct actions are necessary, capable of restoring the good productive capacity of forages. Conservation and management techniques and

*Corresponding author: zoo.patrick@hotmail.com
Submitted: June 27, 2022. Accepted: September 20, 2022.

soil fertility restoration are the main tools to reverse a reality that is still intrinsic in some properties (Cruz *et al.*, 2021). Nutrient replacement via fertilization is the conventionally established technique for supplying nutrients, making up one of the main forms of availability of these elements. Moreover, nitrogen fertilization, especially of grasses, is considered essential, as nitrogen (N) is directly related to the productive capacity and nutritional characteristics of the pasture (Domingues *et al.*, 2021).

However, nitrogen fertilization requires a significant resource demand, since conventional fertilizers used as sources of N are expensive and vary according to the international market, and this can influence their use. Nitrogen fertilization can be responsible for up to 80% of the cost with topdressing fertilization and is the main component of expenditure on pasture maintenance and the most limiting one (Cabral *et al.*, 2021). Thus, the adoption of more efficient production techniques and the replacement of conventional fertilization are considered well-regarded practices, with the aim of reducing costs and maintaining satisfactory productivity results.

An alternative to minimize these costs is the use of legumes in intercropping with grasses, with the objective of enriching the medium with N through biological fixation, and as a highlight, pigeon pea (*Cajanus cajan*), which can produce expressive amounts of mass and still with high concentrations of N in the aerial part of the plant (Cavalcanti *et al.*, 2021).

Considering the benefits of intercropping between grasses and legumes, *Urochloa brizantha* cv. BRS Paiaguás (*Syn*. *Brachiaria brizantha* cv. BRS Paiaguás), which is characterized by developing in soils of medium fertility, adapting well to integration systems and standing out for its productive potential during the dry period (Pereira *et al*., 2017; Euclides *et al.*, 2016), has important characteristics for its wide use in the Midwest, it is an option of choice to work in a intercropping or exclusively.

The objective of this work was to evaluate the productivity and extraction of macronutrients by single Paiaguás palisadegrass and intercropped with pigeon pea, subjected to nitrogen doses.

MATERIAL AND METHODS

The experiment was carried out in Universidade Estadual de Goiás, West Campus of São Luís de Montes Belos, GO (16° 32' 30" S, 50 o 25' 21" W and 569 m). The region has an Aw climate according to the Köppen classification, with an average temperature of 23.5^{o}C and an average annual rainfall of 1785 mm, concentrated between the months of October and March (Alvares *et al.*, 2013).

The forage species used were *Urochloa brizantha* cv. BRS Paiaguás [syn. *Brachiaria brizantha* (Hochst. ex A. Rich.) Stapf cv. BRS Paiaguás] and the pigeon pea *Cajanus cajan* cv. BRS Mandarin.

The experimental design used was randomized blocks in a 2x4 factorial scheme, with four replications. The treatments consisted of two types of pasture (grass and grass + pigeon pea) and four doses of N applied in topdressing (0, 80, 160 and 240kg ha^{-1}). Nitrogen fertilization was divided into three seasons during the rainy season, right after the evaluation and lowering of the forage.

The soil of the experimental area is a dystrophic Red Latosol (Santos *et al*., 2018) and is inserted in a smooth wavy relief. The soil of the tested area has the following initial characteristics: pH ($CaCl_2$) of 5.1; 30 g dm^{-3} of M.O.; 4 mg dm^{-3} of P (resin); 32; 1.3; 32 and 6 mmolc dm^{-3} of H+Al, K, Ca and Mg, respectively; base saturation (V%) of 55%. Soil granulometric composition was 260, 450 and 290g kg^{-1} of sand, clay, and silt, respectively, for the 0-0.20m layer.

The pasture was established in November 2015: The grass was sown in rows and pigeon pea between the rows, in the amount of 10 seeds per meter. The experiment comprises the second cycle of forages, where a new sowing of pigeon pea was carried out between the rows, in the respective treatments, with 10 seeds m^{-1} and the N doses were reapplied.

The evaluation periods were as follows: January, February, April, and June 2017. For pigeon pea, the stand, number of plants m^{-2}; plant height and shoot dry mass. The stand was determined by counting all plants in the useful area of each plot. The height of plants was obtained, measuring from the ground level to the insertion of the highest leaf, and the dry mass of the aerial part, by randomly collecting 10 plants per plot, with a cut starting at 0.30 m from the soil surface.

In Paiaguás palisadegrass, plant height, tiller density, shoot dry mass and nutrient extraction were determined. The height of the plants was determined using a tape measure with the aid of a leaf. This variable was measured from the ground level to the highest leaf, in five points of the useful area of each plot.

The measurements of tiller density were carried out with metal frames measuring 0.25 m^2 (0.5x0.5). These squares were allocated at points representative of pasture conditions (average height) at the time of sampling. With the data obtained from the count of tillers present in the area of the metal frame, the density of tillers m^{-2} was extrapolated.

To determine the productivity, the forage plant was collected with the aid of an iron structure measuring 1.0x0.30m and cut with steel scissors at a height of 0.15m from the soil surface. Then the material was weighed (fresh mass) and only one sample was placed in paper bags and dried in a circulation oven and forced air renewal for 72 hours at a temperature of 65°C.

After this period, the dry mass of the sample was determined. After drying, the samples were ground and sent to the laboratory for the determination of nutrients according to the methodology described by Malavolta *et al*. (1997). Nutrient extraction was calculated by multiplying the dry mass of the aerial part of the forage (kg ha^{-1}) by the nutrient content (g kg^{-1}), considering the mean corresponding to the four cuts performed.

The data obtained were subjected to an analysis of variance. The means from the intercropped treatments were compared using Tukey's test (DMS) at the 5% probability level, and the effects of N rates were evaluated by regression analysis using the magnitude of the regression coefficients (significant at 5% probability) as a criterion for the choice of the model. The software Sisvar version 5.6 (Ferreira, 2019) was used for statistical analyses.

RESULTS AND DISCUSSION

The doses of N applied in topdressing had a negative influence on the accumulated productivity of pigeon pea intercropped with Paiaguás palisadegrass. The effect was linear decreasing with the highest response when N was not applied (Figure 1). Bessa *et al.* (2018) in the same area with no history of legume cultivation found that pigeon pea intercropped with corn and grass responded up to the estimated dose of 166kg ha^{-1} of N, demonstrating that biological fixation was not sufficient to meet the plant's demand. In the second experiment, pigeon peas were replanted in the same area, with the addition of N left in the soil by the decomposition of the crop residues that remained from the previous crop cycle.

There is evidence showing the inefficiency of nitrogen fertilization in legumes (Martha Júnior *et al.*, 2007; Dent and Cocking, 2017), since this group of plants can meet the demand of N by biological fixation (Boddey *et al*., 2020).

Pigeon pea dry mass production had an average stand of 71,400 plants ha^{-1} was 9215 and 6935kg ha^{-1} of DM for the doses, 0 and 240kg of N ha^{-1}, respectively. Spósito *et al*. (2018) found lower results in the productivity of pigeon pea *Cajanus cajan* cv. BRS Mandarim, but similar behavior, in which the treatment that did not receive fertilization expressed higher values of phytomass 5290kg ha^{-1} of DM while the treatments that received chemical fertilization with Simple Super Phosphate and organic fertilization with cattle manure produced 4740 and 4090kg ha^{-1}. Neres *et al.* (2012), when evaluating the cultivation of Pigeon pea cv. Super N single and intercropped with BRS Piatã and Tifton 85 grasses during three cuts, observed accumulated productions of 9380, 9907 and 9613kg DM ha^{-1}, respectively, these values close to those found in this experiment (Figure 1).

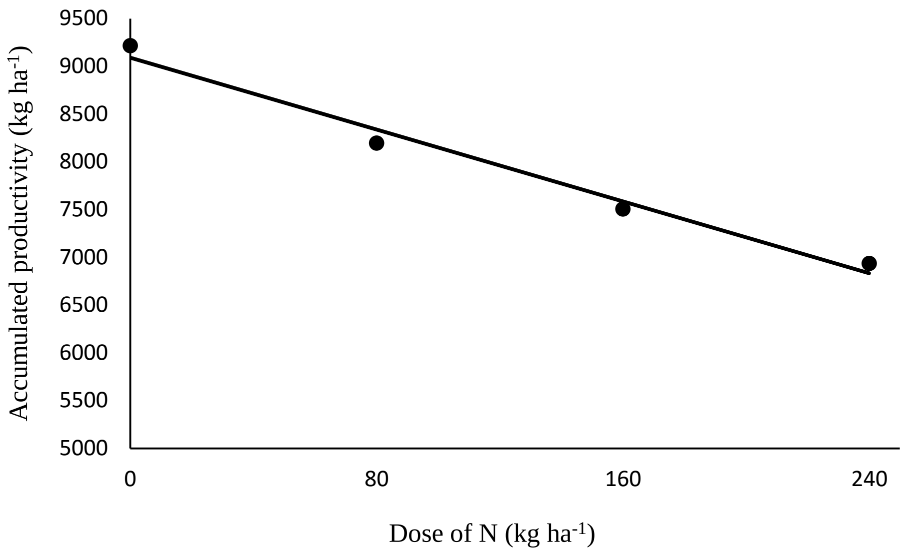

Figure 1. Accumulated productivity of pigeon pea intercropped with Paiaguás palisadegrass as a function of the application of N doses in coverage.

Regarding the height of pigeon pea plants, there was an effect of N doses only on the 3rd and 4th cuts (Table 1). In the 3rd cut, this effect was linear decreasing, in which the greatest height was expressed at the dose of 0 kg ha^{-1} of N with 140.6cm. In the 4th cut, the response was quadratic, with a greater height of 82.25cm also at the dose of 0kg Nha^{-1}. Plant height had a similar effect on dry mass production, in which treatments that did not receive nitrogen fertilization expressed higher values, thus demonstrating positive effects of biological fixation, to supply the plant's needs. Bomfim-Silva *et al.* (2014, 2016) both with the culture of *Cajanus cajan* cv. Mandarin at 72 days of single cultivation, observed plant heights with 62.82 and 100cm, respectively, the same cultivar, in similar edaphic conditions, although in single system they exposed values close to the observed.

Table 1. Pigeon pea height (cm) as a function of the application of N doses in top dressing, in the four evaluated seasons

	Doses of N				F	R²	Equation
Cut	0	80	160	240			
1st	35.25	37.45	36.15	32.75	ns	-	-
2nd	87.65	82.50	81.85	74.50	ns	-	-
3rd	140.60	127.50	122,40	107.80	**	0.97	$y = -0.1294x+140.1$
4th	82.25	72.55	67.25	70.35	*	0.99	$y = 0.0005x^2- 0.1713x+82.45$

*, ** and ns: significant at 5%, 1% and not significant respectively. F: Fisher's test. R²: coefficient of determination.

In the first evaluation, there are low heights of pigeon pea, with an average of 35.40cm, which can be explained by the slow initial growth (Reddy *et al.*, 2016), and by the effect of competition between plants, considering that the Guandu was introduced in the area with the pasture already installed. According to Silva *et al.* (2020), there is an increase in intra-specific competition, associated with the presence of larger plants in the intercropping, which reduces the availability mainly of solar radiation, in addition to water and nutrients.

The effect of N doses on grass plant height influenced the 2nd growth for the averages between C (Paiaguás palisadegrass) and C+G (Paiaguás palisadegrass + pigeon pea)) with quadratic behavior and the estimated dose of 125kg ha^{-1} of N providing the greatest height and in the 3rd growth period, an effect was observed only for single grass, with an increasing linear behavior (Table 2). Expected behavior for grass, since the effect of N on grasses is proven to be beneficial and may have a positive effect of N doses on the variables of plant mass and height productivity, as highlighted by studies (Canto *et al.*, 2013; Gbenou *et al.*, 2018; Leite *et al.*, 2019).

Table 2. Height (cm) of Paiaguás palisadegrass as a function of intercropping and application of N doses in coverage, in the four evaluated periods

Canopy	Dose of N (kg ha^{-1})				Mean	F	R²	Equation
	0	80	160	240				
1st cut								
C	54.35	56.15	57.13	56.20	55.96b	ns	-	-
C+G	59.65	60.30	60.33	58.08	59.59a	ns	-	-
Mean	57.00	58.23	58.73	57.14		ns	-	-
2nd cut								
C	58.85	62.35	64.75	62.93	62.22	ns	-	-
C+G	62.70	63.60	64.76	62.23	63.33	ns	-	-
Mean	60.78	62.98	64.76	62.58		**	0.92	$y = -0.0002x^2+0.0501x+60.597$
3rd cut								
C	42.10b	47.00b	48.85b	50.85b	47.20	**	0.94	$y = 0.0351x+42.985$
C+G	56.70a	57.25a	58.90a	58.10a	57.74	ns	-	-
Mean	49.40	52.13	58.88	54.48				
4th cut								
C	40.68	43.88	44.27	43.90	43.18	ns	-	-
C+G	44.55	43.95	44.60	44.75	44.46	ns	-	-
Mean	42.61	43.91	44.44	44.33		ns	-	-

C: Paiaguás palisadegrass. G: Pigeon pea. *, ** and significant at 5%, 1% and not significant respectively; equal letters in the column do not differ from each other by Tukey's test at 5% probability. F: Fisher's test. R²: coefficient of determination.

To produce dry mass of Paiaguás palisadegrass, there was a significant interaction between the intercropping and N doses in the first cut and in the accumulated (Table 3). For the second and third cuts, there was an effect of N doses, and the response was linear for the means between exclusive pasture and intercropped pasture; however, in the fourth cut, which corresponds to the dry period, there was no effect of any of the treatments (Table 3). In the third cut, in addition to the doses, the averages of the combinations showed a significant difference, where the C+G intercropping was higher in dry matter production in relation to only the grass.

The intercropping of grass with legume provided higher productivity than the single crop and still requiring less N (Table 3), as verified by Pacheco *et al*. (2011) that the practiced intercropping has a high potential for the accumulation of nutrient-rich mass. It is verified that for the productivity of the accumulated dry mass in the doses of 80, 160 and 240kg ha^{-1} of N applied in the intercropping C + G provided increases of 3.8, 10.4 and 8.0%, respectively, when compared to the treatment that did not receive N.

Bessa *et al.* (2018) in the same area found that in the off-season, at 72 and 245 days after the corn harvest, pigeon peas reduced grass dry matter by 32 and 18%, respectively, due to competition for space, since after the first harvest of the pigeon pea sprouts appeared, occupying a larger area. The contribution of N in the soil fixed by the legume does not occur immediately and is due to the decomposition of the dry matter that remains in the area.

Table 3. Dry mass (kg DM ha^{-1}) production of Paiaguás palisadegrass as a function of intercropping and application of N doses in topdressing, in the four evaluated seasons

Canopy	Dose of N (kg ha^{-1})				Mean	F	R²	Equation
	0	80	160	240				
1st cut								
C	3.368b	4.544a	4.787a	4.466a	4.291	**	0.99	$y=-0.0585x^2 + 18.456x + 3386.3$
C+G	4.412a	4.530a	5.204a	4.633a	4.633	*	0.53	$y=-0.0366x^2 + 9.529x + 4309.8$
Mean	3.890	4.537	4.996	4.425	-			
2nd cut								
C	3.708	4.332	4.319	5.078	4.373	-	-	-
C+G	4.111	4.215	4.376	4.853	4.374	-	-	-
Mean	3.910	4.273	4.347	4.965	-	**	0.91	$y=4.051x + 3887.8$
3rd cut								
C	3.209	3.806	4.172	4.336	3.881b	-	-	-
C+G	4.417	4.710	4.922	4.864	4.728a	-	-	-
Mean	3.813	4.258	4.547	4.600		**	0.90	$y=3.3131x + 3906.9$
4th cut								
C	1.088	1.310	1.356	1.352	1.277	ns	-	-
C+G	1.169	1.207	1.306	1.236	1.229	ns	-	-
Mean	1.128	1.259	1.331	1.294	-	ns	-	-
Accumulated								
C	11.373b	13.991a	14.692b	15.232a	13.822	**	0.98	$y=-0.0812x^2 + 34.833x + 11640$
C+G	14.109a	14.663a	15.750a	15.337a	14.965	**	0.87	$y=-0.0378x^2 + 15.036x + 14007$
Mean	12.741	14.327	15.221	15.285				

C: Paiaguás palisadegrass. G: Pigeon pea. *, ** and significant at 5%, 1% and not significant respectively; equal letters in the column do not differ from each other by Tukey's test at 5% probability. F: Fisher's test. R²: coefficient of determination.

Regarding N doses, in splitting, the effect was quadratic for both C and C+G systems. The effect of N on the increase in pasture mass production is a conventionally established fact, but there is also the knowledge that there is a limit of response to this nutrient by plants (Johnson *et al.*, 2011; Enriquez-Hidalgo *et al.*, 2016; Valkman *et al*., 2016).

Corroborating the results, Domingues *et al*. (2021) presented the exclusive Paiaguás grass fertilized with five doses of N 0, 75, 150, 300 and 600kg ha^{-1} adjustment to a quadratic regression model to produce dry mass. With maximum productivity in the first cycle for the 1st, 2nd, 3rd, and 4th period of 5449, 6334, 5652 and 3832kg DM ha^{-1} for doses of 123, 216, 299 and 321kg of N ha^{-1}, respectively.

As for the tillering of Paiaguás palisadegrass, there was only an effect of nitrogen rates in the 3rd cut, in which the response was linear with the highest density of 750 tiller m^{-2} at the rate of 240kg ha^{-1}. The intercropping did not influence grass tillering, so there was no limiting effect of the legume on grass propagation in the experimental period (Table 4).

Table 4. Number of tillers (m²) of Paiaguás palisadegrass as a function of intercropping and application of N doses in topdressing, in the four evaluated seasons

Canopy	Dose of N (kg ha^{-1})				Mean	F	R²	Equation
	0	80	160	240				
1st cut								
C	513.75	599.75	602.50	580.50	574.13	ns	-	-
C+G	563.75	583.50	608.50	613.75	592.38	ns	-	-
Mean	538.75	591.63	605.50	597.13		ns	-	-
2nd cut								
C	680.50	708.00	744.50	747.25	720.06	ns	-	-
C+G	664.00	722.25	733.50	722.00	710.44	ns	-	-
Mean	672.25	715.13	739.00	734.63		ns	-	-
3rd cut								
C	628.00	757.25	768.50	826.75	745.13	-	-	-
C+G	700.00	718.25	772.00	808.50	749.69	-	-	-
Mean	664.00	737.75	770.25	817.63		**	0.97	Y = 0.6167x+673.4
4th cut								
C	691.75	711.25	708.50	747.25	714.69	ns	-	-
C+G	677.75	711.25	719.25	733.50	710.44	ns	-	-
Mean	684.75	711.25	713.88	740.38		ns	-	-

C: Paiaguás palisadegrass. G: Pigeon pea. *, ** and significant at 5%, 1% and not significant respectively; equal letters in the column do not differ from each other by Tukey's test at 5% probability. F: Fisher's test. R²: coefficient of determination.

It was found that during the establishment of the Paiaguás palisadegrass there was an increase in the density of tillers as a function of the time of culture, according to the work by Santos *et al*. (2016), Costa *et al*. (2016) and other cultivars of *Urochloa brizantha* cv. Marandu by Portes *et al.* (2017). Therefore, in this phase, the number of tillers increases as a function of time due to the need of the plant to establish itself, since by concept the tiller is the unit that forms the pasture, so after the soil cover the tiller population is limited by the area. already occupied, a fact that justifies the non-influence of the tested factors on this variable.

As for the effect of nitrogen fertilization on tillering, Caminha *et al.* (2010) in a test with Marandu palisadegrass with doses of up to 450kg N ha^{-1}, concluded that this increases the renewal of tillers, however it does not compromise the number of these as a function of time, a phenomenon that justifies the non-effect of the doses tested in the 1st, 2nd and 4th cuts.

Regarding the extraction of macronutrients, there was only interaction between the sources of variation for N, for P and K there was an effect of the association of doses of N, without interaction, for Ca and S the effect was only of the doses of N and in Mg there was no effect of no treatment (Table 5).

In the extraction of N, in the splitting of doses in the intercropped, there was a quadratic response in the single system, with maximum extraction at the estimated dose of 216kg ha^{-1} of N, and linear in the intercropped system. On the other hand, in the splitting of the intercrops in the doses, it only had a statistical influence at zero dose with greater extraction of N in the pasture intercropped with pigeon pea, which shows the potential to provide nutrients to the grass, with emphasis on N (McElroy *et al.*, 2017; Paris *et al.*, 2009), and the absence of N due to the lack of fertilization and the unavailability through the absence of the legume provided a lower concentration and extraction of this element, which directly reflects on the nutritional content of the grass.

Table 5. Macronutrient extraction (kg ha^{-1}) by Paiaguás palisadegrass as a function of intercropping and application of N doses in topdressing

Canopy	Dose of N (kg ha^{-1})				Mean	F	R²	Equation
	0	80	160	240				
Nitrogen								
C	199b	260a	284a	294a	259	**	0.99	$y = -0.002x^2 + 0.864+200.1$
C+G	257a	265a	301a	312a	284	*	0.93	$y = 0.251x + 253.6$
Mean	228	263	292	303	-	-	-	-
Phosphor								
C	17	22	21	23	21b	-	-	-
C+G	21	21	24	25	23a	-	-	-
Mean	19	21	22	24	-	**	0.97	$y = 0.0226x + 19.083$
Potassium								
C	77	108	113	118	104b	-	-	-
C+G	102	110	133	130	119a	-	-	-
Mean	90	109	123	124	-	*	0.99	$y = -0.0007x^2 + 0.3253x +89.229$
Calcium								
C	54	59	62	68	61	-	-	-
C+G	56	62	71	69	65	-	-	-
Mean	55	61	67	68		**	0.96	$y = 0.057x + 55.953$
Magnesium								
C	51	53	54	61	55	ns	-	-
C+G	56	59	64	54	58	ns	-	-
Mean	53	56	59	58	-	ns	-	-
Sulfur								
C	12	17	19	23	18	-	-	-
C+G	15	17	24	22	20	-	-	-
Mean	14	17	22	23		**	0.99	$y = 0.0438x + 13.846$

C: Paiaguás palisadegrass. G: Pigeon pea. *, ** and significant at 5%, 1% and not significant respectively; equal letters in the column do not differ from each other by Tukey's test at 5% probability. F: Fisher's test. R²: coefficient of determination.

The response in P extraction to nitrogen doses was linear, therefore 24kg ha^{-1} of P with the dose of 240kg ha^{-1} of N with potential response to higher doses. In K the response to N rates was quadratic, with maximum extraction of 127kg ha^{-1} of K at a rate of 232kg ha^{-1} of N. While in the pasture the highest nutrient extractions occurred in the intercropped with pigeon pea.

The extraction of Ca and S in response to N doses was linear, that is, with maximum extractions of 68 and 23kg ha^{-1}, respectively, at the dose of 240kg ha^{-1}, with a margin of response to doses higher than this.

Nitrogen fertilization positively influences pasture development and mass production (Teixeira *et al.*, 2014; Viana *et al.*, 2011). Although N plays an important role in production, the other macro and micronutrients are extracted to sustain the same production, as proven by Primavesi *et al.* (2004).

In the extraction of N, P and K in which there was greater extraction of these in the pasture intercropped with pigeon pea than in the single one, it indicates the benefits of the intercropping in the cycling of nutrients promoted by the legume through the fixation of N and decomposition of senescent material (Snapp *et al.*, 1998), since pigeon pea has the potential to accumulate about 360, 40 and 324kg ha^{-1} of N, P and K respectively (Pissinati *et al.*, 2018), this attests to the benefit of the legume use, soil fertility and, consequently, grass development (Hauggaard-Nielsen *et al.*, 2016).

CONCLUSION

The use of pigeon pea in intercropping allowed greater production of dry mass of Paiaguás grass in the third cut, in relation to exclusive pasture.

The Paiaguás + pigeon pea intercropping has a higher volume of P, K extraction and increased the limit of response to N in the extraction of its own.

REFERENCES

ALVARES, C.A.; STAPE, J.L.; SENTELHAS, P.C. *et al*. Köppen's climate classification map for Brazil. *Meteorol. Z.*, v.22, p.711-728, 2013.

BESSA, S.V.; BACKES, C.; SANTOS, A.J.M.; RODRIGUES, L.M. *et al*. Maize silage intercroped with Grass and pigeon peã subjected to diferente N rates and pasture development in the off season. *Semin. Cienc. Agrar*., v.39, p.2501-2516, 2018.

BODDEY, R.M.; CASAGRANDE D.R.; HOMEM B.G.C.; ALVES B.J.R. Forage legumes in grass pastures in tropical Brazil and likely impacts on greenhouse gas emissions: a review. *Grass Forage Sci.*, v.1, p.1-15, 2020.

BOMFIM-SILVA, E.M.; GUIMARÃES, S.L.; FARIAS, L.N.; OLIVEIRA, J.R. *et al*. Adubação fosfatada no desenvolvimento e produção de feijão guandu em Latossolo Vermelho do Cerrado em primeiro cultivo. *Biosci. J*., v.30, p.1380-1388, 2014.

BOMFIM-SILVA, E.M.; OLIVEIRA, J.R.; ANICESIO E.C.; SILVA, T.J.A. Teor de clorofila e desenvolvimento de feijão guandu adubado com fosfato natural reativo em Latossolo do Cerrado. *Rev. Agrar.*, v.9, p.248-253, 2016.

CABRAL, C.E.A.; CABRAL, C.H.V.; SANTOS, A.R. M.; MOTTA, A.M. *et al*. Impactos técnico-econômicos da adubação de pastos. *Nativa*, v.9, p.173-181, 2021.

CAMINHA, F.O.; SILVA, S.C.; PAIVA, A.J.; PEREIRA, L.E.T. *et al*. Estabilidade da população de perfilhos de capim-marandu sob lotação contínua e adubação nitrogenada. *Pesqui. Agropecu. Bras*., v.45, p.213-220, 2010.

CANTO, M.W.; HOESCHL, A.R.; BONA FILHO, A. E. *et al*. Características do pasto e eficiência agronômica de nitrogênio em capim-tanzânia sob pastejo contínuo; adubado com doses de nitrogênio. *Ciênc. Rural*, v.43, p.682-688, 2013.

CAVALCANTI, A.C.; PARTELLI, F.L.; GONTIJO, I. *et al*. Establishment of leaf nutrient patterns for the nutritional diagnosis of Urochloa brizantha pastures in two seasons. *Acta Sci. Agron*., v.43, p.e50359, 2021.

COSTA, R.R.G.F.; COSTA, K.A.P.; SANTOS, C.B. *et al*. Production and nutritional characteristics of pearl millet and Paiaguas palisade grass under different forage systems and sowing periods in the off season. *Afr. J. Agric. Res*., v.11, p.1712-1723, 2016.

CRUZ, N.T.; DIAS, D.L.S.; FRIES, D.D. *et al*. Alternativas para recuperação e renovaçãõ de pastagens degradadas. *Pesqui. Agropecu. Gaúcha*, v.28, p.15-35, 2021.

DENT, D.; COCKING, E. Establishing symbiotic nitrogen fixation in cereals and other non-legume crops: the greenernitrogen revolution. *Agric. Food Security*, v.6, n.1, p.19, 2017.

DOMINGUES, A.A.; SANTOS, A.J.M.; BACKES, C. *et al*. Nitrogen fertilization of paiaguás grass: production and nutrition. *Rev. Agric. Neotrop.*, v.8, p.e5918, 2021.

ENRIQUEZ-HIDALGO, D.; GILLILAND, T.J.; HENNESSY, D. Herbage and nitrogen yields, fixation and transfer by White clover to companion grasses in grazed wards under different rates of nitrogen fertilization. *Grass Forage Sci*., v.71, p.559-574, 2016.

EUCLIDES, V.P.B.; MONTAGNER, D.B.; BARBOSA, R.A. *et al*. Animal performace and sward characteristics of two cultivars of Brachiaria brizantha (BRS Paiaguás and BRS Piatã). *Rev. Bras. Zootec*., v.45, p.85-92, 2016.

FERREIRA, D.F. SISVAR: a computer analysis system to fixed effects split plot type designs. *Rev. Bras. Biomed*., v.37, p.529-535, 2019.

GBENOU, B.; ADJOLOHOUN, S.; HOUNDJO, D.B.M. *et al*. Practical aspects of grass forage seed production and quality with particular reference to planting row spacing and nitrogen fertilization in tropical regions: a review. *Int. J. Biol. Chem. Sci*., v.12, p.508-518, 2018.

HAUGGARD-NIELSEN, H.; LACHOUANI, P.; KNUDSEN, M.T. *et al*. Productivity and carbón footprint of perennial grass-forage legume intercropping strategies with high or low nitrogen fertilizer input. *Sci. Total Environ*., v.541, p.1339-1347, 2016.

JOHNSON, C.R.; BEILING, B.A.; MISLEVY, P. *et al*. Effects of nitrogen fertilization and harvest date on yield, digestibility, fiber, and protein fractions of tropical grasses. *J. Anim. Sci*., v.79, p.2439-2448, 2011.

KICHEL, A.N.; COSTA, J.A.A.; VERZGINASSI, J.R.; QUEIROZ, H.P. *Diagnóstico para ao planejamento da propriedade*. Brasília: Embrapa Gado de Corte, 2011. 42p.

LEITE, R.D.C.; SANTOS, A.C.D.; SANTOS, J.G.D.D. *et al*. Mitigation of mombasa grass (*Megathyrsus maximus*) dependence on nitrogen fertilization as a function of inoculation with Azospirillum brasilense. *Rev. Bras. Cienc. Solo*, v.43, p.e01802342019, 2019.

MALAVOLTA, E.; VITTI, G.C.; OLIVEIRA, S.A. *Avaliação do estado nutricional das plantas*. 2.ed. Piracicaba: Potafos, 1997. 319p.

MAPBIOMAS. Qualidade da pastagem. Brasília, Brasil. 2020. Disponível em: https://plataforma.brasil.mapbiomas.org/. Acessado em: 4 jun. 2022.

MARTHA JÚNIOR, G.B.; VILELA, L.; SOUSA, D.M.G. *Cerrado*: uso eficiênte de corretivos e fertilizantes em pastagens. Planaltina: Embrapa Cerrados, 2007. 224p.

McELROY, M.S.; PAPADOPOULOS, Y.A.; GLOVER, K.E. *et al*. Interactions between cultivars of legume species (Trifolium pratense L., Medicago sativa L.) and grasses (Phleum pratense L., Lolium perenne L.) under different nitrogen levels. *Can. J. Plant Sci*., v.97, p.1-12, 2017.

NERES, M.A.; CASTAGNARA, D.D.; SILVA, F.B. *et al*. Características produtivas, estruturais e bromatológicas dos capins Tifton85 e Piatã e do feijão-guandu cv. super N, em cultivo singular ou em associação. *Cienc. Rural*, v.42, p.862-869, 2012.

PACHECO, L.P.; LEANDRO, W.M.; MACHADO, P.L.O.A. *et al*. Produção de fitomassa e acúmulo e liberação de nutrientes por plantas de cobertura na safrinha. *Pesqui. Agropecu. Bras*., v.46, p.17-25, 2011.

PARIS, W.; CECATO, U.; BRANCO, A.F.; BARBERO, L.M.; GALBEIRO, S. Produção de novilhas de corte em pastagem de Coastcross-1 consorciada com Arachispintoi com e sem adubação nitrogenada. *Rev. Bras. Zootec*., v.38, p.122129, 2009.

PEREIRA, D.S.; LANA, R.P.; CARMO, D.L.; SOUSA, C.C.C.; GOMIDE, B.A. Produção de forragens de cana-de-açucar e feijão-guandu cultivados em monocultivo e consórcio. *Rev. Bras. Agropecu. Sustentável*, v.7, p.80-87, 2017.

PISSINATI, A.; MOREIRA, A.; SANTORO, P H. Yield components and nutrients content in summer cover plants used in crop rotation in no-tillage system. *Comm. in Soil Sci. Plant Anal.*, v.49, p.1604-1616, 2018.

PORTES, T.A.; FERREIRA, A.M.; PEIXOTO, M.M.; MELO, H.C. Growthand senescence of *Urochloa brizantha* under Brazilian Cerrado conditions. *Afr. J. Agric. Res.*, v.12, p.2625-2632, 2017.

PRIMAVESI, A.C.; PRIMAVESI, O.; CORRÊA, L.A. *et al*. Adubação nitrogenada em capim-coastcross: efeitos na extração de nutrientes e recuperação aparente do nitrogênio. *Rev. Bras. Zootec.*, v.33, p.68-78, 2004.

REDDY, A.S.; RAO, P.V.; BABU, J.S.; RAO, Y.K. Response of integrated weed management practices on growth and yield of pigeonpea (Cajanus cajan (L.) Mill sp.). *Int. J. Curr. Microbiol. Appl. Sci.*, v.5, p.610616, 2016.

SANTOS, C.B.; COSTA, K.A.P.; OLIVEIRA, I.P. *et al*. Production and nutritional characteristics of sun flowers and piaguas palisadegrass under different forage systems in the off season. *Biosci. J*., v.32, p.460-470, 2016.

SANTOS, H.G.; JACOMINE, P.K.T.; ANJOS, L.H.C. *et al*. *Sistema brasileiro de classificação de solos*. 5.ed. Brasília: Embrapa CNPS, 2018. 356p.

SILVA, P.C.G.; TIRITAN, C.S.; ECHER, F.R. *et al*. No-tillage and crop rotation increase crop yields and nitrogen stocks in sandy soils under agroclimatic risk. *Fields Crops Res.*, v.258, p.107947, 2020.

SNAPP, S.S.; MAFONGOYA, P.L.; WADDINGTON, S. Organic matter technologies for integrated nutrient management in small holder cropping systems of southern *Africa. Agric. Ecosyst. Environ.*, v.71, p.185-200, 1998.

SPÓSITO, T.H.N.; BARBOSA, L.P.; FRIZZEIRA, N.; FABRIS, L.B. Diferentes adubações na cultura do Feijão Guandu. *Colloq Agrar.*, v.14, nesp., p.13-20, 2018.

TEIXEIRA, F.A.; PIRES, A.J.V.; SILVA, F.F. *et al*. Estratégias de adubação nitrogenada, características morfogênicas e estruturais em pastos de Brachiaria decumbens diferidos por 95 dias. *Semin. Cienc. Agrar*, v.35, p.987-998, 2014.

VALKAMA, E.; RANKINEN, K.; VIRKAJÄRVI, P. *et al*. Nitrogen fertilization of grass leys: Yield production and risk of N leaching. *Agric., Ecosyst. Environ.*, v.230, p.341-352, 2016.

VIANA, M.C.M.; FREIRE, F.M.; FERREIRA, J.J. *et al*. *Rev. Bras. Zootec*., v.40, p.1497-1503, 2011.