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Nitrogen and Phosphate Fertilization Maximize Grass BRS Zuri Performance

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Abstract

The low nutrients levels available in pasture formation reduces the forage yield. Soil correction and fertilization practices are considered priorities in the planning, renovation or recovery of pastures. The aimed of this experiment was to evaluate the effect of nitrogen and phosphate fertilization rate in productivity of the *Panicum maximum* cv. BRS Zuri. The experimental design was a randomized block design in a 3×4 factorial arrangement, with three doses of superphosphate (0.0, 80.0 and 160.0 kg.ha^{-1}) and four doses of ammonium nitrate (0.0; 20.0; 40.0 and 60.0 kg.ha^{-1}), with three replicates. The following parameters were evaluated at 120 days after implantation: green mass and dry matter yield, plant height, number of plants and tillers per square meter. The doses of 80.0 and 160.0 kg.ha^{-1} of P_2O_5 and 60.0 kg.ha^{-1} of nitrogen combined to each other showed the best results for forage yield.

Keywords: *Panicum maximum*, pasture formation, plant nutrition

1. Introduction

The agribusiness is an important economic activities in Brazil, being the livestock production a representative activity. Brazilian commercial flock bovine is 214.9 million heads, being considered the largest in the world. However, Brazil is considered the second largest beef consumer (38.6 kg per person / year) and the second largest exporter (1.9 million tons carcass equivalent weight) (Silva et al., 2009; Dupas et al., 2016; Galindo et al., 2017). The food supply for these animals are based on native or cultivated pasture (Vitor et al., 2014), with an occupation of 180 to 200 million hectares of lands. Pasture is the most economical system for animal protein production to human consumption (Fernandes et al., 2015). This is possible due to edaphoclimatic factors help the forage production in different locations and times of year (Galindo et al., 2018).

According to Embrapa (2014), the BRS Zuri grass (*Panicum maximum*) is a caespitosus vegetable of upright and high size. Your leaves are dark green, long wide and arched. This forage grass have qualities related to yield, vigor, animal performance, resistance to leafhoppers (*Deois flavopicta*) and the *Bipolaris maydis* fungus. Beyond a great output in well-drained soil, being an option to diversify Amazon and Cerrado pastures.

Despite the extensive areas pasture, there is a lack of production of this type of grass yet. Because the real potential is below ideal. It is occurs because production systems are heterogeneous in the technologies incorporation and most of these areas presents a status of soil degradation related to fails in the soil correction.

The fertilizers supply lack, especially nitrogen (N), that is the most demanded, and phosphorus (P), damages soil conservation (Benett et al., 2008; Silveira et al., 2010; Silveira et al., 2015). This situation to restrict cultivation yield, mainly in tropical areas.

According to Dupas et al. (2016) and Castagnara et al. (2011) the amount of N present in soil doesn't supply the demand of the grass. However, with nitrogen fertilization, there is bigger regrowth, maximizing dry mass production rate, and also pasture height and number of plants (Galindo et al., 2017). Then, nitrogen fertilization is recommended in productions system because of its high efficiency in pastures (Silva et al., 2009; Fernandes et al., 2015).

The availability of P in soil is also important to pasture setting, as in the formation as in the recovery, since as P influences directly nitrogen fertilization efficiency. This nutrient is part of the ATP, ADN/ARN molecules, participates in the cell duplication and in the photosynthesis being directly tied to plant development and to the aerial part and root of the plant. Therefore, phosphorus addition, in adequate amount, period of time and place, ensures an increase in the metabolic and physiologic plant activity (Duarte et al., 2016).

There are many works studying the effect of nitrogen and phosphate fertilization related to agronomic traits in *Panicum* (Martuscello et al., 2009; Monteiro et al., 2014). However, cv. BRS Zuri, launched by EMBRAPA in 2014 is a not very explored forage, being necessary to study its nutrition to better recommendations of fertilization use. In view of the above, the present study is based on the hypothesis that the application of the highest dose of nitrogen with the highest phosphorus dose guarantees the highest biomass production in the BRS Zuri grass. The aim of this study was to determine the better nitrogen and phosphorus doses to increase morpho agronomic performance of *Panicum maximum* cv. BRS Zuri grass in the central-west area of São Paulo state.

2. Material and Methods

2.1 Experimental Area Characterization

The experiment was conducted in 2018 year in Bauru, central-west area of São Paulo State. Occurred in an experimental area located at 22°11' 49" south latitude, 48°58' 21" longitude

West and 518 m of altitude. The area's soil is classified as clay podzolic yellow reddish soil with medium Sandy texture, whose chemical characteristics are reported in Table 1.

Table 1. Result of chemical analysis of the soil in the experimental area for 0-20 cm soil layer

pH	O. M.	P_{resina}	Al^{+3}	H+Al	K	Ca	Mg	SB	CTC	V (%)
	($g.dm^{-1}$)	($mg.dm^{-1}$)	--------------($mmol_c.dm^{-3}$)-------------							
4.3	9	3	-	22	0.2	12	4	16	38	43

pH: soil pH; O.M.: organic matter; Ca: calcium; Mg: magnesium; Al: aluminum; K: potassium; P: phosphorus; CTC: capacity of cations exchange; V%: bases saturation

The region climate is the "Cfa" type, hot and temperate according to Köppen e Geiger classification, with 1,170 mm mean annual rainfall and 21.6 ℃ for average temperature (CNPM, 2019). The climate characteristics during the experiment season is shows in the Figure 1.

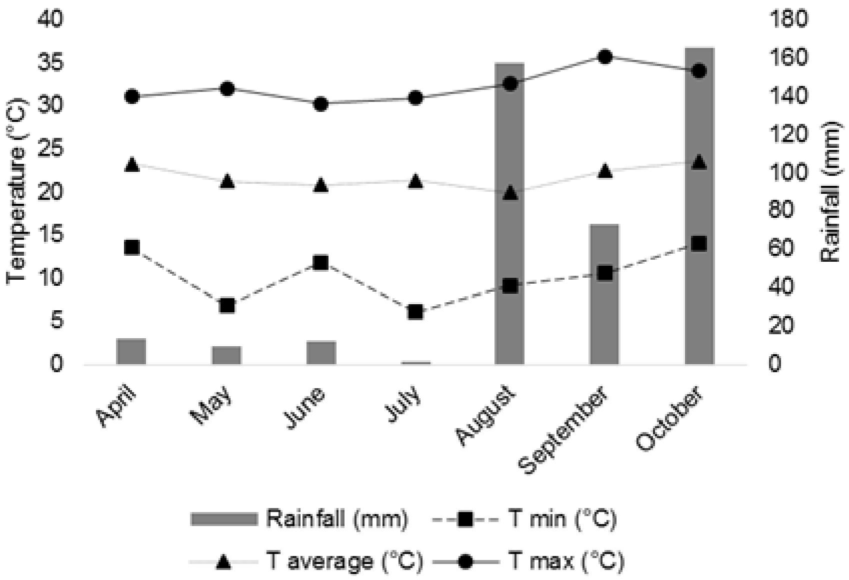


Figure 1. Climate characteristics of Bauru - SP, during the experiment season

2.2 Genetic Material Used and Seeding Details

It was utilized *Panicum maximum* cv. BRS Zuri grass, which has a high adaptation to the climate conditions of that area. The seeding was done by the broadcast method, with an equipment coupled with an agricultural tractor. The experiment was conducted in 2018, from April 1^{st} to 31 October 2018, in an isolated area of 1,600 m^2 with *Brachiaria decumbens* pasture in initial degradation process. The experimental design was divided into 36 randomized blocks with 25 m^2 each. A randomized-complete blocks with 12 treatments and 3 replicates, were used (Table 2.)

Table 2. Treatments used in the experiment for evaluating *Panicum maximum* cv. BRS Zuri morphological characteristics under nitrogen and phosphate fertilization in Bauru – SP, 2018

Treatments	P_2O_5	N	K_2O
	---------------------------	(kg ha^{-1})	---------------------------
T 1	0	0	50
T 2	0	20	50
T 3	0	40	50
T 4	0	60	50
T 5	80	0	50
T 6	80	20	50
T 7	80	40	50
T 8	80	60	50
T 9	160	0	50
T 10	160	20	50
T 11	160	40	50
T 12	160	60	50

Liming was done according to soil's need and treatment with fertilizers were based on fertilization recommendations suited to forage grass (grass for an exclusive pasture, Group II), as outlined in Werner et al. (1997) methodology. Fertilization was applied manually.

2.3 Nitrogen

Treatments used were doses of 0, 20, 40 e 60 kg.ha^{-1} of N; from ammonium nitrate, containing 34% of N, applied for 30 days after emergence.

2.4 Phosphorus

Treatments used were doses of 0, 80 e 160 kg.ha^{-1} de P_2O_5; from single superphosphate, containing 18% of P_2O_5, 16% of calcium (Ca) and 8% of sulphur (S), applied in the crop sowing.

2.5 Potassium

It was applied 50 kg.ha^{-1} of K_2O all over the experimental area, from potassium chloride, containing 60% of K_2O, during the in the crop sowing.

2.6 Assessed Parameters

It was assessed at 120 days after the sowing, the parameter:

- Green matter production (GM) – collected by 1.0 m^2 wood templates, randomly launched on each portion. The material was removed with the help of pruning shears and packaged in plastic bags to determine the weight of the collected material in analytical balance (0.000g).

- Dry matter production (DM) – it was take out a small sample from the material collected to detect green matter (200 g approximately). The weighing was in analytical balance and put on air forced circulation oven (65 ℃) for 72 hours and then, it was weighed one more time to determine dry matter.

- Plant height (PH): it was selected by random three points in each 1.0 m^2 square and measured with graduated scale from soil to the last leaf curve completely expanded.

- Number of plants by square meter (N ºP): the number of plants ($unit.m^{-2}$), was evaluated by the manual counting of them in each plot, using a 1.0 m^2 wood templates, randomly launched in each plot.

- Number of tillers (N ºT): tillers ($unit.m^{-2}$), were manually counted in each plot, using a 1.0 m^2 wood templates, randomly launched in each portion.

2.7 Data Statistical Analysis

Data were examined by analysis of variance and regression ($p \leq 0.05$) by Sisvar® statistical software and by the principal component analysis from software Minitab 17® software.

3. Results and Discussion

Fertilization with different doses of phosphorus and nitrogen influenced on morphological characteristics and on *Panicum maximum* cv. BRS Zuri yield.

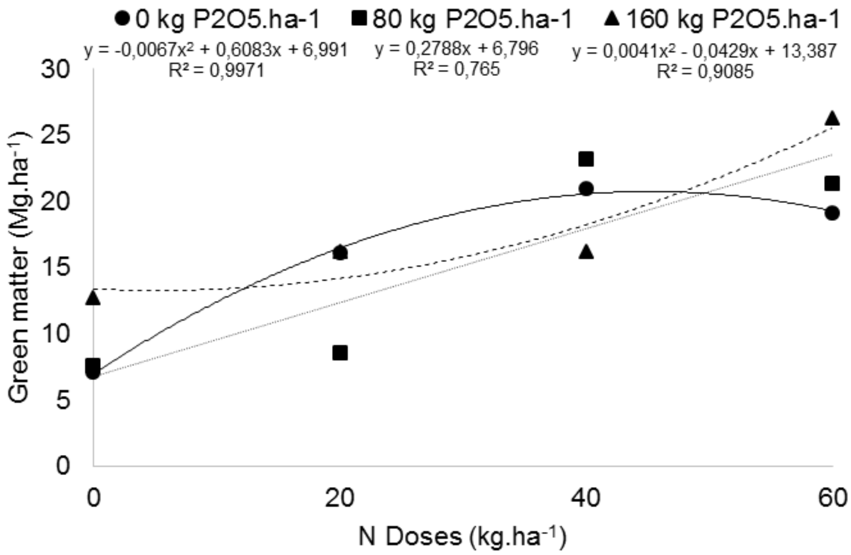
The analysis of variance showed a significant interaction between N and P doses for all the characteristics that were evaluated (Table 3), and for N and P doses (except for PH and N ºT) individually analyzed.

Table 3. Summary of analysis of variance for characteristics evaluated in *Panicum maximum* cv. BRS Zuri in Bauru – SP

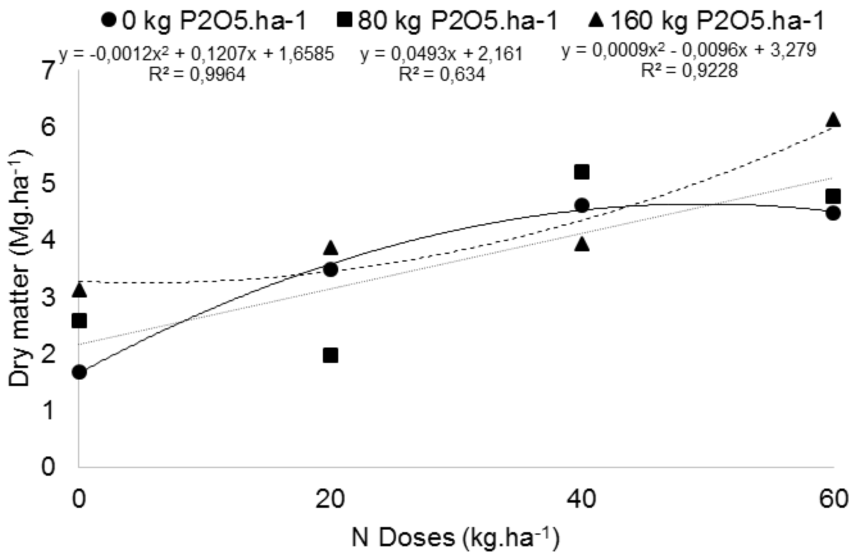
FV	DF	GM	DM	PH	N ºP	N ºT
N Dose	3	274.96*	13.88*	1882.84*	325.66*	581.15*
P Dose	2	14.50*	1.78*	88.44^{ns}	16.58*	33.36^{ns}
N × P	6	49.30*	2.11*	575.26*	33.99*	335.84*
Replicates	2	0.61	0.10	56.69	1.08	43.36
Error	22	3.00	0.18	30.82	7.66	60.85
CV (%)		10.45	11.25	7.37	10.75	12.71

FV: variation source; DF: degree of freedom; GM: green matter production; DM: dry matter production; PH: plant height; N°P: number of plants per square meter; N°T: number of tiller per square meter; * significant on 5% by F ($P<0.05$); ^{ns} test: not significant

For green matter production variation, it was found a higher response when it was applied the 160 kg.ha^{-1} of P_2O_5, dose combined to 60 kg.ha^{-1} of N (26.28 Mg.ha^{-1}) dose, with an ascendant quadratic behavior. When the application of P_2O_5 and N did not happen, it was obtained a lower green mass production (7.12 Mg.ha^{-1}). For the 80 kg.ha^{-1} of P_2O_5 dose, it was observed a linear behavior, with an increase of green matter when it was used higher doses of N (Figure 2-A).



(A)



(B)

Figure 2. Green matter (A) and dry matter (B) yield in *Panicum maximum* cv. BRS Zuri grass in Bauru – SP

Similar results were found by Rezende et al. (2015), which obtained higher responses using phosphate fertilizer comparing to the use of non-phosphate fertilizers. Phosphorus is essential to the establishment and maintenance of pastures in tropical soils, requiring being promptly available and in sufficient doses to the forage (Rezende et al., 2011). This nutrient is a cellular constituent of plant, assisting the division and the development of meristematic tissue, taking action on photosynthesis (Taiz et al., 2017). Combined with phosphorus, nitrogen is an important building block for many proteins. It is absorbed by plants and associated to carbon chains, facilitating an increase on cellular components and consequent rise of vigor and total green matter production, under favorable climatic conditions (Galindo et al., 2017).

As observed in green matter, the dry matter yield (Figure 2-B) was better in 160 kg.ha^{-1} of P_2O_5 and 60 kg.ha^{-1} of N (6.13 Mg.ha^{-1}). Being aligned to quadratic regression model, where crescent doses of N and P, resulted in higher productions, while the lowest average found was when the application of P_2O_5 e of N (1.69 Mg.ha^{-1}) didn't occurred. This incident was expected, once a higher source of N helps on leaves elongation and on tillers release.

Martuscello et al. (2009), working with N doses and dry matter split in *Panicum maximum* x *Panicum infestum* cv. Massai, verified that nutrient is favorable to the aerial part of the plant development and consequential deposition of dry matter. Fabricio et al. (2010), verified that nitrogen fertilizations of up to 200 kg.ha^{-1} provided an increase in dry matter production of *Panicum maximum* cv. Tobiatã.

Fagundes et al. (2006) verified that N supply in soil, normally doesn't attend grass demands. However, when it occurs the nitrogen fertilization, it is observed alterations in dry mass accumulation taxes average in forage during seasonal periods of the year. Lugão et al. (2003) also checked that there is an increase in this variable with higher amounts of N and concluded that, to achieve forage grass maximum potential, nitrogen fertilization is extremely important.

The increase in dry matter production was observed due to the use of higher doses of phosphorus. In addition, happened an increment of 46% in the variable when used phosphorus. Comparing with ones that it is not applied P and N, this result was not observed.

In the condition of maximum N fertilization (60 kg.ha^{-1}), the increase in dry mass production was of 27% while using the maximum dose of P_2O_5. This indicates that P has a direct correlation with a higher leaves production, and consequently, a higher dry matter accumulation, resulting in a forage with a better quality (Camacho, 2015).

For plant height characteristic (Figure 3), treatment with 160 kg.ha^{-1} of P_2O_5 and 60 kg.ha^{-1} of N provided a higher average (101 cm). The lowest average (47 cm) was obtained with treatment without P_2O_5 and N application.

Confirming the results of this work, Silva Filho et al. (2014), studying *Brachiaria brizantha* cv. Marandu, fertilized with urea doses, verified a quadratic effect in plant height. Patês (2009), studying *Panicum maximum* cv. Atlas and cv. Tanzânia, checked a linear effect in N doses and in plant height that varied in 107.5 to 112.6 cm in Atlas grass and 71.5 to 95.5 cm in Tanzânia grass.

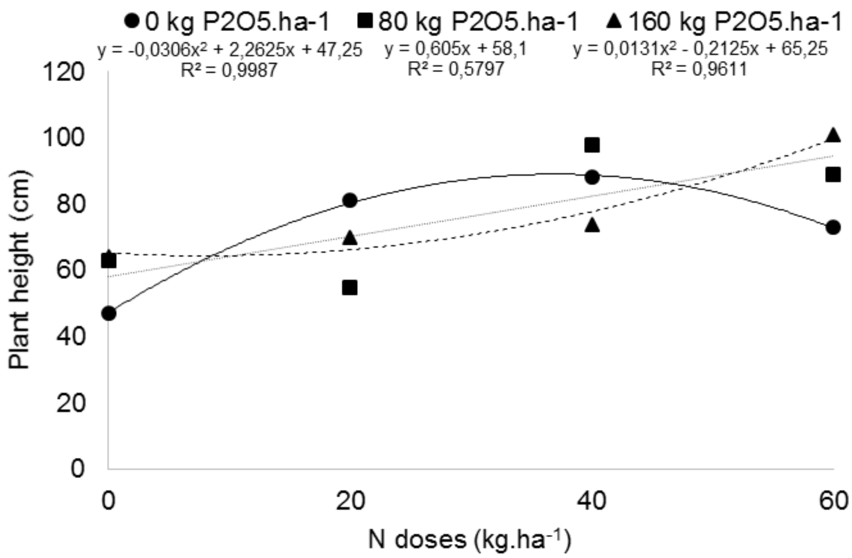


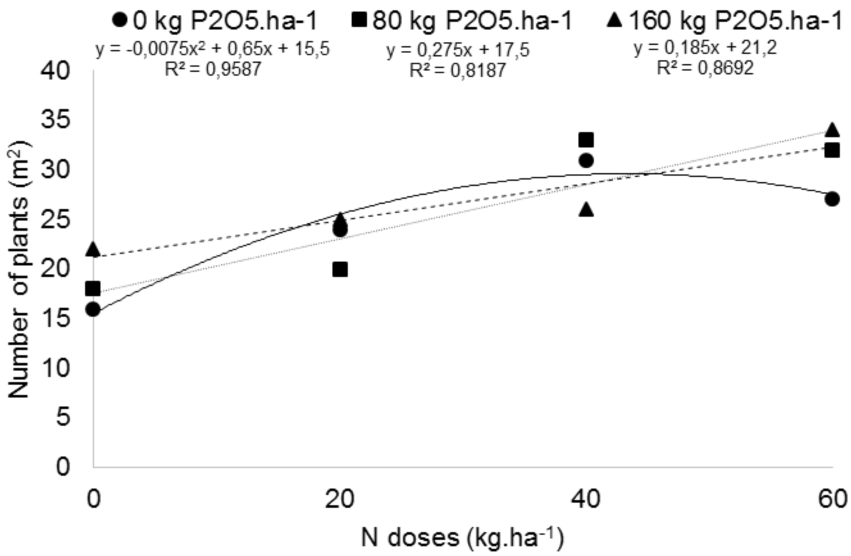
Figure 3. Plant height in *Panicum maximum* cv. BRS Zuri grass in Bauru – SP

According to Faria et al. (2015), top-dressing fertilization with nitrogen allied to natural residual phosphate promoted a significant quadratic answer in plant height in *Panicum maximum* cv. Mombaça grass. This indicates that the lack of top-dressing is a limiting factor to pasture development, even with a good amount of residual phosphorus, and leading to a decrease of 25% in plant height. The bigger height obtained by the authors was under nitrogen fertilization treatment (100.6 cm in 201 kg of P_2O_5 dose), while in their study, it was found plant height of 101 cm in 160 kg of P_2O_5 and 60 kg.ha^{-1} doses.

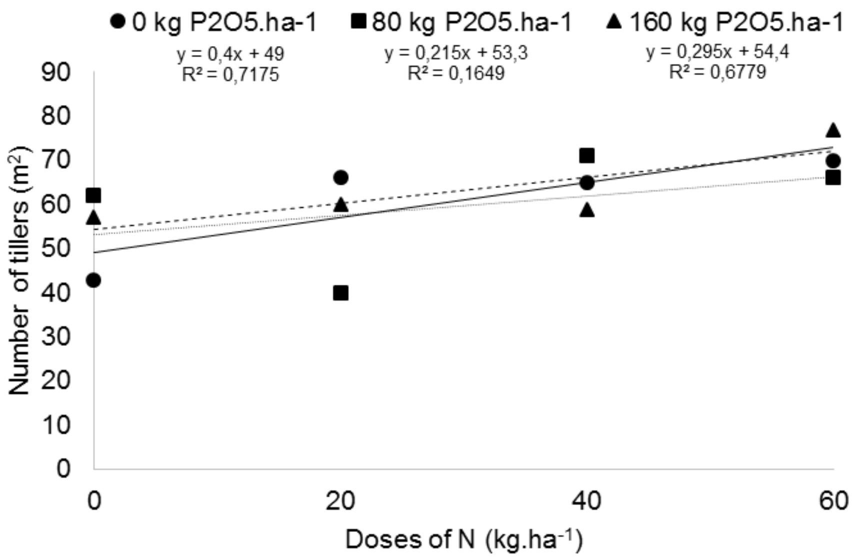
Overall, according to Fagundes et al. (2006), when the plant height is evaluated in a response to nitrogen fertilization, the growing can be explained by the increment of the number of cells in a divisive process and by the size of leaf fronds.

The application of 160 kg.ha^{-1} of P_2O_5 dose, without N application and in the maximum dose of N (60 kg.ha^{-1}) resulted in an increase of 26% in plant height comparing to the ones that didn't received P under the same N conditions. This indicates the importance of P in the vegetation growth and in the formation of leaves, being this characteristic, of extreme importance to forage production.

For the number of plants per squares meter (Figure 4-A), it was found a higher answer in treatments with 160 kg.ha^{-1} of P_2O_5 and 60 kg.ha^{-1} of N; 80 kg.ha^{-1} of P_2O_5 and 40 kg.ha^{-1} of N and 80 kg.ha^{-1} of P_2O_5 and 60 kg.ha^{-1} of N. These treatments did not differed statistically into each other, with 34, 33 and 32 plants per square meter respectively.



(A)



(B)

Figure 4. Number of plants (A) and number of tillers (A) in *Panicum maximum* cv. BRS Zuri grass in Bauru – SP

The P_2O_5 doses of 80 kg.ha^{-1} and 160 kg.ha^{-1} showed a linear behavior, while treatment without P_2O_5 showed a quadratic behavior with maximum in 40 kg.ha^{-1} of N dose.

For the number of tillers for square meter variable (Figure 4-B), it was observed a linear ascendant behavior for all the P_2O_5 doses that were applied, being the biggest average obtained in the 160 kg.ha^{-1} of P_2O_5 and 60 kg.ha^{-1} of N doses (77 tillers). In addition, the lowest one for 80 kg.ha^{-1} of P_2O_5 and 20 kg.ha^{-1} of N doses (40 tillers).

Faria et al. (2015) verified a linear behavior for number of tillers in Mombaça grass, with the application of nitrogen in top-dressing and natural phosphate. They observed an increment of 29% comparing to plants that did not receive top-dressing fertilization. In Mesquita et al.

(2010) work, P doses increased the number of tillers in the grass that was being investigated (*Panicum maximum* cv. Tanzânia and Mombaça and *Brachiaria* hybrid cv. Mulato).

Forage grass tillage is important to the production of biomass and represent an important characteristic for plant establishment and for pasture productivity, as observed in this study. Evaluating the influence of phosphate and nitrogen fertilizing in *Panicum maximum* cv. Marandu production, Pereira (1997) reported that phosphate fertilizer showed a better effect in tillers number when compared to nitrogen fertilizer. This emphasizing the importance of phosphorus in tillage.

Allied to P, a higher N supply increase plants energy metabolism and the offer of photo-assimilated compounds that influences in forage morphological and structural characteristics, such as number of tillers (Vitor et al., 2009).

The result of the principal components analysis for morphological characters and for *Panicum maximum* cv. BRS Zuri grass yield is showed in Table 4 and Figure 5. The principal component 1 (CP1) represents 94% of the information and other components represent only 6% of the data.

Table 4. Principal components, eigenvalues (λ) and percentage of variance explained by components (%VCP) in evaluated characters in *Panicum maximum* cv. BRS Zuri grass in Bauru – SP

Principal component	λ	% VCP	%VCP (accumulated)
PC1	0.70	0.94	0.94
PC2	0.23	0.05	0.98
PC3	0.06	0.01	0.99
PC4	0.00	0.00	1.00
Variables	-	CP1	CP2
GM	-	0.46	-0.08
DM	-	0.46	-0.08
PH	-	0.45	-0.12
NºP	-	0.45	-0.51
NºT	-	0.42	0.84

GM: Green matter production; DM: dry matter production; PH: plant height; N °P: number of plants per square meter; N °T: number of tiller for square meter

For PC1, the highest factorial load was 0.46 for GM and DM variable (fact explained by the high correlation between this variables) and 0.45 for PH. Thus indicating that this characteristic was responsible for pasture performance, while for PC2, the highest performance contribution was observed in N °T (0.84).

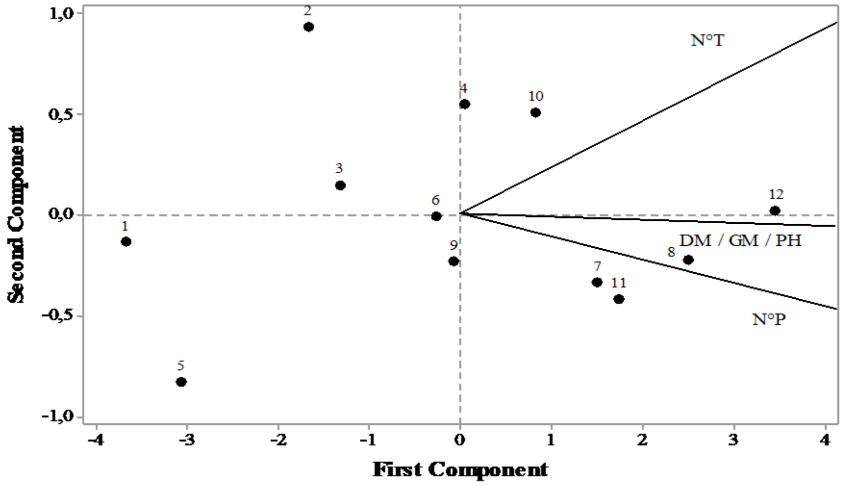


Figure 5. Principal component analyses for characteristics of: green matter yield (GM) (Mg.ha^{-1}), dry matter yield (DM) (Mg.ha^{-1}), plant height (PH) (cm), number of plants per square meter (N °P) and number of tiller per square meter (N °T) in *Panicum maximum* cv. BRS Zuri grass in Bauru – SP

1: 0 kg.ha^{-1} of P_2O_5 and 0 kg.ha^{-1} of N; 2: 0 kg.ha^{-1} of P_2O_5 and 20 kg.ha^{-1} of N; 3: 0 kg.ha^{-1} of P_2O_5 and 40 kg.ha^{-1} of N; 4: 0 kg.ha^{-1} of P_2O_5 and 60 kg.ha^{-1} of N; 5: 80 kg.ha^{-1} of P_2O_5 and 0 kg.ha^{-1} of N; 6: 80 kg.ha^{-1} of P_2O_5 and 20 kg.ha^{-1} and N; 7: 80 kg.ha^{-1} of P_2O_5 and 40 kg.ha^{-1} of N; 8: 80 kg.ha^{-1} of P_2O_5 and 60 kg.ha^{-1} of N; 9: 160 kg.ha^{-1} of P_2O_5 and 0 kg.ha^{-1} of N; 10: 160 kg.ha^{-1} of P_2O_5 and 20 kg.ha^{-1} of N; 11: 160 kg.ha^{-1} of P_2O_5 and 40 kg.ha^{-1} of N and 12: 160 kg.ha^{-1} of P_2O_5 and 60 kg.ha^{-1} of N

The principal component analysis (Figure 5) showed that fertilization with 160 kg.ha^{-1} of P_2O_5 and 60 kg.ha^{-1} of N doses followed by an *80* kg.ha^{-1} of P_2O_5 and 60 kg.ha^{-1} of N doses, assured better results for morphological and productive characteristics in *Panicum maximum* cv. BRS Zuri grass.

The absence of P in plants development resulted in smaller plants due to a lower stem elongation. The results of this work show that *Panicum maximum* cv. BRS ZURI grass is responsive to joint implementation of P and N, which promoted a rate of foliar elongation and, consequently, a higher green matter production and dry matter accumulation.

Although the maximum dose of P_2O_5 (160 kg.ha^{-1}) have showed better results in morphological and productive characteristics. 80 kg.ha^{-1} of P_2O_5 dose had a very small discrepancy compared to the maximum dose, showing that the indicative of economical dose of phosphorus (P_2O_5) for *Panicum maximum* cv. BRS Zuri grass setting is of 80 kg.ha^{-1} in soils with 43% of base saturation.

4. Conclusion

Phosphate and nitrogen fertilization improve the development of *Panicum maximum* cv. BRS Zuri grass.

Fertilization with doses of 160 kg.ha^{-1} of P_2O_5 and 60 kg.ha^{-1} of N showed a forage result of superior performance. However, doses of *80* kg.ha^{-1} of P_2O_5 and 60 kg.ha^{-1} of N is economically practicable to obtain a high yield in *Panicum maximum* cv. BRS Zuri grass.

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