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Pasture recovery with the application of agricultural gypsum associated with nitrogen fertilization

Recuperação de pastagem com a aplicação do gesso agrícola associado à adubação nitrogenada

Recuperación de pastos con aplicación de yeso agrícola asociado a fertilización nitrogenada

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Abstract

The presence of toxic aluminum in the soil and N deficiency are one of the main causes of degradation of cultivated pastures, mainly of the *Urochloa* genus. The use of agricultural gypsum for restoring soil fertility is one of the ways to recover the productive capacity of degraded areas. Given the above, the work aims to assess pasture recovery with the application of agricultural gypsum associated with nitrogen fertilization. The experimental design was randomized blocks in a 3x4 factorial arrangement, that is, absence of nitrogen, 50 kg ha^{-1} in the form of ammonium nitrate and 50 kg ha^{-1} urea, interacting with four doses of agricultural gypsum, namely: 0 ; 750; 1500 and 3000 kg ha^{-1} and with four replications, totaling 48 plots. The use of urea as a source of N resulted in a higher plant height (PH) when compared to the use of ammonium nitrate, representing a relative increase of approximately 12% in relation to the control. Dose of 1730.8 kg ha^{-1} of agricultural gypsum resulted in a maximum production of 4.97 t ha^{-1} of dry pasture. The linear interaction of the use of ammonium nitrate with gypsum doses shows an extremely interesting synergistic potential with this source. For dry mass of culms (CDM), the use of urea had a PMTE of 1730.8 kg ha^{-1} of agricultural gypsum resulting in 2.38 t ha^{-1}. The culms dry mass of (CDM) represented 47.9% of the total dry mass of the pasture.

Keywords: *Urochloa humidicola*; Forage; Plant nutrition; Dry mass.

Resumo

A presença de alumínio tóxico no solo e deficiência de N são uma das principais causas de degradação de pastagens cultivadas, principalmente do gênero *Urochloa*. A correção com gessagem e reconstituição da fertilidade do solo é um dos caminhos para recuperar a capacidade produtiva das pastagens degradadas. O objetivo desse trabalho foi à recuperação de uma área de pastagem com a aplicação do gesso agrícola associado à adubação nitrogenada. Foi instalado um experimento em blocos casualizados em esquema fatorial 4x3, envolvendo quatro doses de gesso agrícola, associadas ou não com adubação nitrogenada com 50 kg ha^{-1} na forma de nitrato de amônio ou ureia; com quatro repetições, totalizando 48 parcelas. As parcelas tiveram 25,0 m^{2}. A utilização de ureia como fonte de N resultou uma plant height (PH) superior quando comparado ao uso de nitrato de amônio, representando um incremento relativo de aproximadamente 12% em relação à testemunha. O ponto de eficiência técnica (PMTE) para a massa seca total (TDM) foi com o uso da ureia. Dose de 1730,8 kg ha^{-1} de gesso agrícola acarretou na produção máxima de 4,97 t ha^{-1} de matéria seca de pastagem. A interação linear do uso de nitrato de amônio com doses de gesso denota um potencial sinérgico extremamente interessante com essa fonte. Para a massa seca de colmos (CDM), o uso de ureia teve um PMTE de 1730,7 resultando em 2,38 t ha^{-1}. A dose máxima para essa variável corrobora com a massa seca total (TDM). E a massa seca de colmos (CDM) representa 47,9% do total de massa seca da pastagem.

Palavras-chave: *Urochloa decumbens*; Forragem; Nutrição de plantas; Massa seca.

Resumen

La presencia de aluminio tóxico en el suelo y la deficiencia de N son una de las principales causas de degradación de los pastos cultivados, principalmente del género Urochloa. La corrección con yeso y la reconstitución de la fertilidad del suelo es una de las formas de recuperar la capacidad productiva de los pastos degradados. El objetivo de este trabajo fue recuperar un área de pasto con la aplicación de yeso agrícola asociado a la fertilización nitrogenada. Se realizó un experimento en bloques al azar en un esquema factorial 4x3, involucrando cuatro dosis de yeso agrícola, asociado o no a fertilización nitrogenada con 50 kg ha^{-1} en forma de nitrato de amonio o urea; con cuatro repeticiones, totalizando 48 parcelas. Las parcelas tenían 25,0 m^{2}. El uso de urea como fuente de N resultó en una mayor altura de planta (PH) en comparación con el uso de nitrato de amonio, lo que representa un aumento relativo de aproximadamente 12% en relación al testigo. El punto de máxima eficiencia técnica (PMTE) para la masa seca total (TDM) fue con el uso de urea. La dosis de 1730,8 kg ha^{-1} de yeso agrícola resultó en una producción máxima de 4,97 t ha^{-1} de materia seca de pastos. La interacción lineal del uso de nitrato de amonio con dosis de yeso denota un potencial sinérgico extremadamente interesante con esta fuente. Para la masa seca de culmos (CDM), el uso de urea tuvo un PMTE de 1730.7 resultando en 2.38 t ha^{-1}. La dosis máxima para esta variable corrobora la masa seca total (TDM). La masa seca de los culmos (CDM) representa el 47,9% de la masa seca total del pasto.

Palabras clave: *Urochloa decumbens*; Forraje; Nutrición vegetal; Materia seca.

1. Introduction

In the Brazilian agricultural scenario, the ruminant production systems absorb a lot of technology and innovation in order to raise the zootechnical indexes related to animal quality and productivity. In systems qualified as extensive, these being predominant in the national territory (Dias *et al*, 2015), great part of the initial investment is destined to the implantation of pastures with forages that present nutritional quality aiming to supply the needs of the herds (Dim *et al*, 2015), since this represents the largest portion of the animal food tract due to the practicality of cultivation (Porto *et al*, 2017).

In the Brazilian cerrado, approximately 53 million hectares are considered as pasture for livestock. However, part of the pastures cultivated in Central Brazil is in some state of degradation, it is estimated that 80% of these are evolutionary process of loss of vigor. The description of soil degradation is linked to soil quality, that is, from negative changes in characteristics, a process of degradation is associated. The loss of chemical nutrients in the soil, responds to the fall of its fertility, due to the reduction of macro and micronutrient contents and by the contents and quality of organic matter. The loss of chemical nutrients in the soil, responds to the fall of its fertility, due to the reduction of macro and micronutrient contents and by the contents and quality of organic matter (Bilibio, 2010).

Usually, there is an increase in the levels of Mn and Al, due to the reduction in pH. To obtain good indicators of soil quality, a combination of physical, chemical and biological attributes will occur, which together, hypothetically, would represent an ideal combination in order to provide optimal conditions for plant development and maximum expression of their biological potential (Colodel *et al*, 2018). In this sense, alternatives should be sought in management that are simple, economically viable and that contain technologies accessible to producers, where they seek less impact and movement in the soil structure, among them, the application to the surface of agricultural corrective products becomes a strategy to mitigate these damages to the soil (Neves Junior *et al*, 2013)

The substantial increase in the levels of exchangeable aluminum in the soil solution can cause several morphophysiological disorders for most cultivated plants (Freitas *et al*, 2015), mainly affecting the root system, altering or even impeding water and nutrient absorption patterns (Pezzopane *et al*, 2015; Fidelis *et al*, 2018). These disorders also manifest deleterious effects on the aerial part of the plant body, such as reduced size and dry mass and leaf deformity (Derré *et al*, 2013).

In addition to choosing the appropriate method, it is important to correct the mineral deficiencies of the soil, in specific cases, the application of limestone and gypsum plays an important role in correcting the acidity of the soil, in addition to providing calcium (Ca), magnesium (Mg) and sulfur (S). Gypsum, which acts in the supply of S, also supplies Ca to the soil-plant system, which allows for a greater export of these elements in the DM of pastures. And this phenomenon is due to the deeper rooting, provided by gypsum that acts as soil conditioner (Mesquita *et al*, 2002).

In addition to the use of correctives in the pasture recovery process, the use associated with nitrogen fertilization is an important strategy in the production system, since the use of nitrogen is fundamental for the increase in the production of biomass and in the recovery process of pastures (Silva, 2013). The N compound in the soil, resulting from the mineralization of organic matter, does not meet the demand of grasses with high productive potential (Fagundes *et al*, 2005).

The behavior of N in the soil is dynamic and complex different from other nutrients. It has greater mobility in the soil, undergoes several modifications mediated by microorganisms, has high movement in depth with low residual effect and is lost by volatilization. Therefore, part of the N distributed in the pasture is lost within the system, decreasing its efficiency, due to nitrogen fertilizers being commonly applied in cover, where there is no incorporation into the soil. Two aspects are fundamental in the management of nitrogen fertilization; the source to be used and the installment of the doses, therefore, in order to decrease mainly the losses by volatilization and leaching. This results in a better use of nitrogen by the plant, reduction of losses and maintenance of dry mass accumulation rates (Costa *et al*, 2010).

Given the above, the work aims to assess pasture recovery with the application of agricultural gypsum associated with nitrogen fertilization.

2. Material and methods

2.1. Location

The experiment was carried out in January 2018 in a pasture area of *Urochloa humidicola* of the Veterinary Hospital of FEA - Fundação Educacional de Andradina, located in the municipality of Andradina State of São Paulo, located at Longitude 20°51'14.397 "South and Latitude 51°20'59.424" West and at 388 meters altitude.

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2.2. Climate

The local climate, according to the Koppen classification, is of the Aw type, characterized by the seasons of hot weather in summer and dry winter, with the months from November to March having the highest rainfall. The annual averages of temperature, precipitation and relative humidity are, respectively, 30ºC of maximum, 19ºC of minimum, accumulated rainfall of 1311 mm and average humidity of 78%.

2.3. Soil description

The area's soil was classified according to Embrapa (2013). The chemical analysis was carried out in the laboratory of the Faculty of Engineering of Ilha Solteira, of a soil sample collected at a depth of 0-20 cm where the following chemical attributes were determined: P, K, Ca, and Mg the ion exchange resin method, pH in $CaCl_2$, was used; organic matter by calorimetry; H+Al with SMP buffer solution; Al in KCl (Raij *et al*, 2001). As shown in Table 1.

Table 1. Chemical attributes of the soil at the beginning of the experiment. Andradina, 2019.

pH	OM	P	K	Ca	Mg	H+Al	Al	SB	CEC	V%	m%
$CaCl_2$	g dm^{-3}	mg dm^{-3}	------------------------------ $mmol_c$ dm^{-3} ------------------------------								
4.6	13	7.0	1.8	10	6.0	22	2.0	17.8	39.8	45	10

OM: Organic matter; SB: Sum of bases; CEC: Cation exchange capacity; V%: Base saturation; m%: Saturation by aluminum. Source: Authors.

2.4. Experimental design and treatments

The experimental design was randomized blocks in a 3x4 factorial arrangement, that is, absence of nitrogen, 50 kg ha^{-1} in the form of ammonium nitrate and 50 kg ha^{-1} urea, interacting with four doses of agricultural gypsum, namely: 0; 750; 1500 and 3000 kg ha^{-1} and with four replications, totaling 48 plots.

The plots were 16.0 m^2 (4.0m x 4.0m), adopting a 0.5m border on each side, making a useful area of 9.0 m^2 and a distance equivalent to 1.0 m between blocks and parcels. The supply of phosphorus and potassium was uniform in all treatments according to Raij *et al*, (1996).

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2.5. Assessments

2.5.1. Plant height (PH)

At 120 days after installation of the experiment, the plant height (PH) was determined using a ruler graduated in millimeters, with which six random points were measured per experimental unit. The average of the six points comprised the average height of the plot.

2.5.2. Forage production

At 90 days after the installation of the experiment, manual cuts were made at 15 cm from the soil surface in a sample area of 1.0 m^2, all material collected in the sample area was weighed immediately and a homogeneous and representative sub-sample was collected that passed through the separation morphological and then dried in an oven with forced ventilation at 65ºC until they reach constant weight, to determine the following variables: total dry mass (TDM); total dry mass of green leafs (TDMGL); total dry mass of yellow leafs (TDMYL); total dry mass of dead leafs (TDMDL) dry mass of culms (DMC); inflorescence dry mass (IDM) and weed dry mass (WDM) was measured by visual sample separation and weighed separately. All variables were converted to t ha^{-1} by converting the dry mass in relation to the forage weight of the sampled area.

2.6. Statistical analysis

All variables were subjected to the F test ($p < 0.05$) and regression analysis was applied to the gypsum doses, where their linear and quadratic models were tested. To determine the best nitrogen source, the Tukey test was applied at a 5% probability of the event occurring. The point of maximum technical efficiency (PMTE) was obtained through the first order derivative of the quadratic regression equation between the doses where the mathematical model was employed $y= -b/2c$ (Banzatto & Kronka, 2013). The statistical program was used RStudio (R Core Team, 2015).

3. Results and Discussion

The plant height (PH) was influenced by the application of nitrogen (N), where the absence demonstrated lower values compared to both sources as shown in Table 2. In relation to the sources, the use of urea as an N supplier resulted in a higher mean PH when compared to the use ammonium nitrate as shown in Figure 1.

Table 2. Mean values and analysis of variance of the regressions where the models were tested: linear, quadratic and cubic, of plant height (PH); total dry mass (TDM); total dry mass of green leafs (TDMGL); total dry mass of yellow leafs (TDMYL) and total dry mass of dead leafs (TDMDL) of forage after cultivation with nitrogen sources and doses of agricultural gypsum. Andradina, 2019.

Nitrogen (N)		PH (cm)	TDM (t ha^{-1})	TDMGL (t ha^{-1})	TDMYL (t ha^{-1})	TDMDL (t ha^{-1})
Absence		52.566b	2.577b	0.996b	0.182a	0.096b
Ammonium nitrate		55.633ab	4.285a	1.366a	0.250a	0.214a
Urea		59.783a	4.358a	1.395a	0.231a	0.196a
MSD		6.622	0.505	0.232	0.101	0.079
CV%		11.532	15.569	21.429	52.814	53.855
OA		55.994	3.740	1.252	0.221	0.169
F the Nitrogen (N)		3.78*	47.90**	10.97**	1.42NS	7.90**
Gypsum (G)						
Absence	p value	0.0095	0.6776	0.8704	0.2284	0.2617
	Regression	Q**	LNS	NS	NS	NS
Ammonium nitrate	p value	0.2001	0.0062	0.1344	0.6620	0.4109
	Regression	NS	L**	NS	NS	NS
Urea	p value	0.2196	0.0095	0.0897	0.8652	0.6522
	Regression	NS	Q**	NS	NS	NS
F the NxG		1.97NS	2.71*	0.61NS	0.35NS	0.67NS

MSD: Minimum significant difference. CV: Coefficient of variation. OA: Overall average. Ns $p = 0.05$; * $0.01 \leq p < 0.05$; ** $p < 0.01$. The averages in the column followed by the same letter do not differ statistically from each other in the Tukey test at the 5% probability level. L: Polynomial of the 1st degree. Q: Polynomial of the 2nd degree. Source: Authors.

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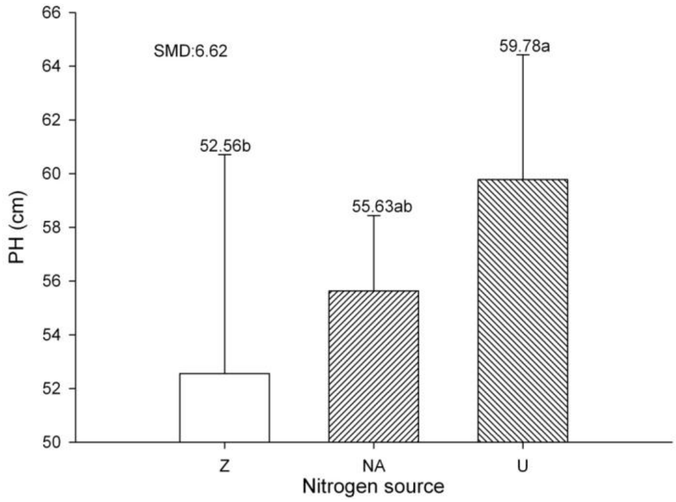
Figure 1. The plant height (PH) of forage after cultivation with nitrogen sources and doses of agricultural gypsum. Andradina, 2019. NA= Ammonium nitrate; U= Urea; Z= Absence of Nitrogen. Ns p= 0.05; * 0.01=<p<0.05; ** p<0.01.



Source: Authors.

The relative increase in urea when compared to a control was approximately 13%. This fact can probably be explained by the higher concentration of N in the composition of urea, which, despite the higher potential volatilization rate presented by this fertilizer, provides a greater amount of N in the easily absorbable soil (Costa *et al*, 2008).

A statistical difference was observed for the F test in the variables: total dry mass (TDM), total dry mass of green leafs (TDMGL), e total dry mass of dead leafs (TDMDL) as a function of the N application factor. In the vast majority, Pearson correlations were observed between the variables analyzed in the *Urochloa humidicola* after using gypsum associated with two sources of nitrogen as shown in Figure 2.

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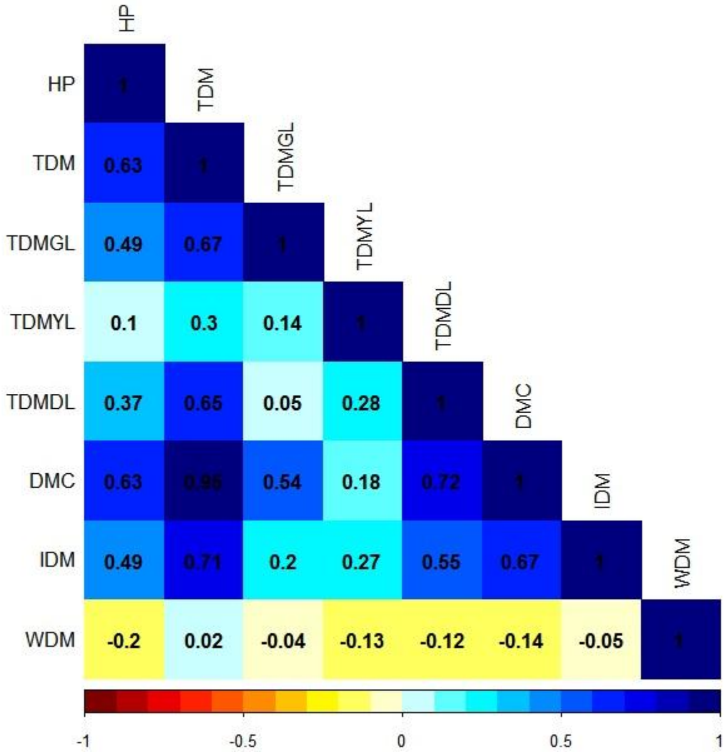
Figure 2. Pearson's correlations between the variables analyzed in the *Urochloa humidicola* of forage after cultivation with nitrogen sources and doses of agricultural gypsum. Andradina, 2019. Plant height (PH); total dry mass (TDM); total dry mass of green leafs (TDMGL); total dry mass of yellow leafs (TDMYL); total dry mass of dead leafs (TDMDL) dry mass of culms (DMC); inflorescence dry mass (IDM) and weed dry mass (WDM).



Source: Authors.

It was possible to observe that the total dry mass (TDM) presented the largest number of positive correlations, this result was already expected, because with the increase in other dry masses, total dry mass (TDM), it is also worth mentioning that larger plants tend to have more dry mass which corroborates these results. It is worth highlighting the positive correlation between TDMDLxIDM, proving that the presence of inflorescence shows that the plants were in the senescence phase, which leads to an increase in the amount of dead leaves in the plant. The positive correlations between the variables evaluated are notorious, as shown in Table 3.

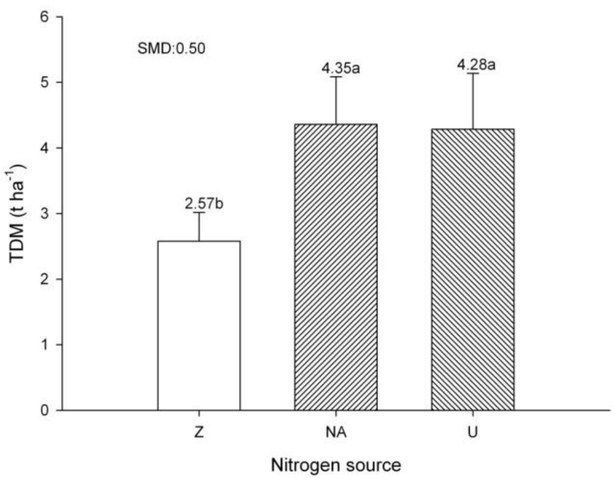
Table 3. Significant linear regressions after Pearson's correlation of *Urochloa humidicola* after using two nitrogen sources. Andradina, 2019.

Variable	Y = βo + βiI + βjJ + ... + βnN	p valor	R^2
TDM ($t\ ha^{-1}$)	TDM = -1.8971733 + 0.09875886 HP	<0.0001**	0.3928
	TDM = 1.10178387 + 2.10623520 TDMGL	<0.0001**	0.4515
	TDM = 3.12367708 + 2.78593224 TDMYL	0.0378*	0.0882
	TDM = 2.63241354 + 6.54877023 TDMDL	<0.0001**	0.4256
	TDM = 1.15877718 + 1.54788161 DMC	<0.0001**	0.8951
	TDM = 2.54111907 + 4.13983636 IDM	<0.0001**	0.5058
TDMGL ($t\ ha^{-1}$)	TDMGL = -0.1449207 + 0.02448589 HP	0.0005**	0.2373
	TDMGL = 0.78396168 + 0.28114005 DMC	<0.0001**	0.2901
TDMDL ($t\ ha^{-1}$)	TDMDL = -0.1641965 + 0.00584079 HP	0.0079**	0.1385
	TDMDL = -0.0264244 + 0.11730083 DMC	<0.0001**	0.5179
	TDMDL = 0.07648112 + 0.32010890 IDM	<0.0001**	0.3047
DMC ($t\ ha^{-1}$)	DMC = -1.7981117 + 0.06071667 HP	<0.0001**	0.3975
	DMC = 0.97587900 + 2.38868827 IDM	<0.0001**	0.4508
IDM ($t\ ha^{-1}$)	IDM = -0.4644744 + 0.01321209 HP	0.0003**	0.2382

Plant height (PH); total dry mass (TDM); total dry mass of green leafs (TDMGL); total dry mass of yellow leafs (TDMYL) and total dry mass of dead leafs (TDMDL). Source: Authors.

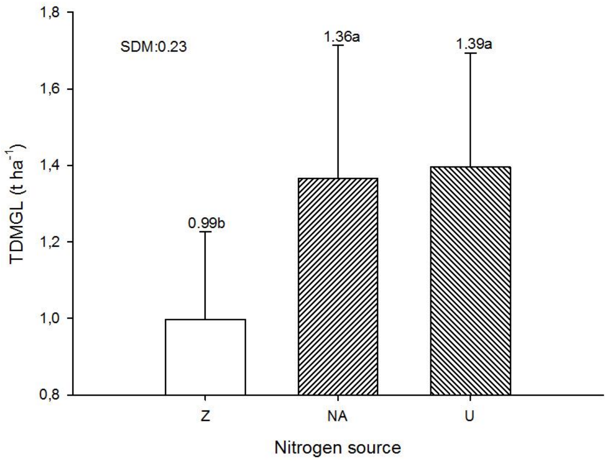
Note that for these parameters, with respect to the means separation test, no difference was found for the sources used, however, the absence of N application resulted in lower values of phytomass accumulation and reduced plant size as shown in the Figures 3; 4 and 5.

Figure 3. The total dry mass (TDM) of forage after cultivation with nitrogen sources and doses of agricultural gypsum. Andradina, 2019. NA= Ammonium nitrate; U= Urea; Z= Absence of Nitrogen. Ns p= 0.05; * 0.01=<p<0.05; ** p<0.01.



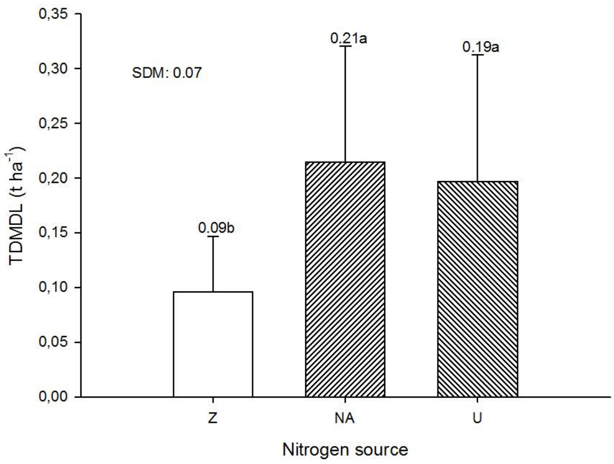
Source: Authors.

Figure 4. The total dry mass of green leafs (TDMGL) of forage after cultivation with nitrogen sources and doses of agricultural gypsum. Andradina, 2019. NA= Ammonium nitrate; U= Urea; Z= Absence of Nitrogen. Ns p= 0.05; * 0.01=<p<0.05; ** p<0.01.



Source: Authors.

Figure 5. The total dry mass of dead leafs (TDMDL) of forage after cultivation with nitrogen sources and doses of agricultural gypsum. Andradina, 2019. NA= Ammonium nitrate; U= Urea; Z= Absence of Nitrogen. Ns p= 0.05; * 0.01=<p<0.05; ** p<0.01.



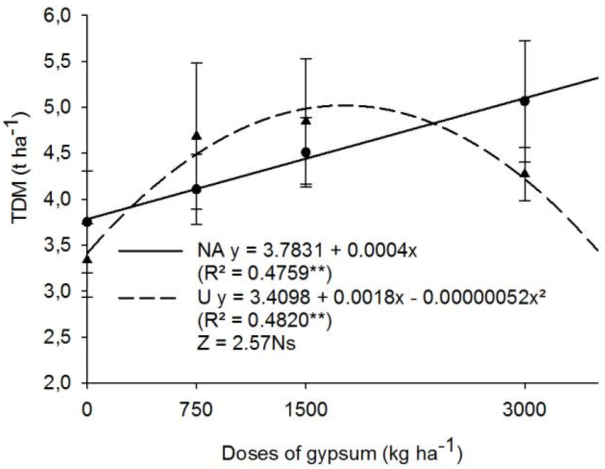
Source: Authors.

This is due to the important role of N directly in the metabolism, growth and development of the plant body, being a base component in the synthesis of amino acids, proteins, enzymes, nucleic acid and chlorophyll (Arnuti *et al*, 2017). According the Farias

Filho *et al*, (2018) when the plant's needs for the nutrient are well met, it causes a substantial increase in vegetative development, increasing the size and accumulation of dry matter in the plant body.

Also, for the parameter total dry mass (TDM) as shown in Figure 6, significant interaction was detected for the interaction of factors in studies (NxG). For gypsum doses, data on the use of urea and ammonium nitrate, respectively, adjusted to second and first degree polynomial regressions. The point of point of maximum technical efficiency (PMTE) for urea use, within the parameter in question, is shown in 1730,8 kg ha^{-1} of the gypsum, resulting in maximum production de 4.97 t ha^{-1} dry pasture, representing 93% greater than the control. The linear interaction of the use of ammonium nitrate with gypsum doses shows an extremely interesting synergistic potential with this source.

Figure 6. The total dry mass (TDM) of forage after cultivation with nitrogen sources and doses of agricultural gypsum. Andradina, 2019. NA= Ammonium nitrate; U= Urea; Z= Absence of Nitrogen. Ns p= 0.05; * 0.01=<p<0.05; ** p<0.01.



Source: Authors.

The best performance of the pasture when cultivated in the presence of gypsum is presumably due to the beneficial effects of using it, among them the supply of S in the deeper layers, better root development, leaching of toxic elements (Fe^{3+}, Mn^{3+}, Al^{3+}), which improves the availability and absorption of bases, among others (Amaral *et al*, 2017). For research purposes and understanding of dynamics, higher doses of ammonium nitrate should be tested under the same study conditions, allowing a better understanding of the biological curve. Ammonium nitrate has less use in relation to urea due to its higher price, but it may prove to be advantageous in the production field as it presents greater efficiency and reduced volatilization and leaching losses (Balbinot Junior *et al*, 2019).

For the variables culms dry mass of (CDM) (Figure 7) and inflorescence dry mass (IDM) (Figure 8), a statistical difference was determined for the sources of N, where the results for treatments without fertilizer application showed lower ($p \leq 0.01$) (Table 4).

Table 4. Mean values and analysis of variance of the regressions where the models were tested: linear, quadratic and cubic, of culms dry mass of (CDM); inflorescence dry mass (IDM) e weed dry mass (WDM) of forage after cultivation with nitrogen sources and doses of agricultural gypsum. Andradina, 2019.

Nitrogen (N)		CDM ($t\ ha^{-1}$)	IDM ($t\ ha^{-1}$)	WDM ($t\ ha^{-1}$)
Absence		0.986b	0.149b	0.173a
Ammonium nitrate		1.985a	0.381a	0.160a
Urea		2.031a	0.339a	0.090a
MSD		0.354	0.128	0.173
CV%		24.463	51.227	141.177
OA		1.668	0.289	0.141
F the Nitrogen (N)		33.52**	11.07**	0.80NS
Gypsum (G)				
Absence	p value	0.9397	0.4789	0.0734
	Regression	LNS	LNS	LNS
Ammonium nitrate	p value	0.0327	0.0903	0.4902
	Regression	L*	LNS	LNS
Urea	p value	0.0475	0.4892	0.6714
	Regression	Q*	LNS	LNS
NxG of F		1.59NS	1.51NS	1.06NS

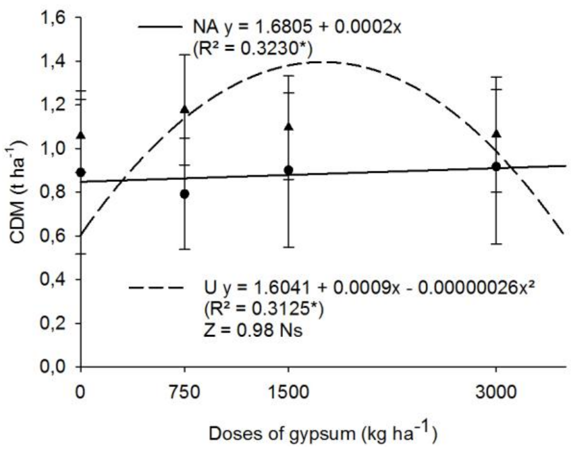
MSD: Minimum significant difference. CV: Coefficient of variation. OA: Overall average. Ns $p = 0.05$; * $0.01 \leq p < 0.05$; ** $p < 0.01$. The averages in the column followed by the same letter do not differ statistically from each other in the Tukey test at the 5% probability level. L: Polynomial of the 1st degree. Q: Polynomial of the 2nd degree. Source: Authors.

There were no differences between the sources for them. This fact explains the importance of nitrogen fertilization in agricultural systems as an indispensable practice when seeking to obtain high yields, regardless of the applied source, provided that it is carried out consciously and with a theoretical basis.

The CDM was also influenced by the application of gypsum doses, and, by studying the interaction (Figure 7), the polynomial behavior obtained was of quadratic adjustment for urea, linear for ammonium nitrate and not significant for the absence of application. For the use of urea, the data denote a PMTE of 1730.7 kg ha^{-1} resulting in 2.38 t ha^{-1} of culms dry mass of (CDM). The maximum dose for this variable corroborates that for total dry mass (TDM). Aiming at the maximum production of the study, the culms dry mass of (CDM) represents 47.9% of the total dry mass of the pasture.

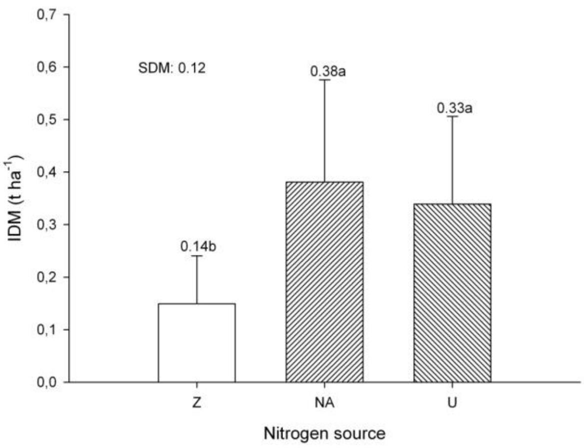
The observed event can be elucidated by the increase in the number of tillers per area and the greater weight of tillers. With the increase in stalk weight, the tillers become more developed, as a way to guarantee the support of the leaves (Santos *et al*, 2009).

Figure 7. The culms dry mass of (CDM) of forage after cultivation with nitrogen sources and doses of agricultural gypsum. Andradina, 2019. NA= Ammonium nitrate; U= Urea; Z= Absence of Nitrogen. Ns p= 0.05; * 0.01=<p<0.05; ** p<0.01.



Source: Authors.

Figure 8. The inflorescence dry mass (IDM) of forage after cultivation with nitrogen sources and doses of agricultural gypsum. Andradina, 2019. NA= Ammonium nitrate; U= Urea; Z= Absence of Nitrogen. Ns p= 0.05; * 0.01=<p<0.05; ** p<0.01.



Source: Authors.

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No statistical difference was found for the variable weed dry mass (WDM), for any factor under study. Possibly, the beneficial effect of the practice of fertilization had a more accentuated effect on the pasture, accelerating the muffling effect in relation to the invaders (Crusciol & Borghi, 2007), which did not show a more developed, hesbistatic or hermetic behavior.

4. Final considerations

The use of urea as a source of N resulted in a higher plant height (PH) when compared to the use of ammonium nitrate, representing a relative increase of approximately 12% in relation to the control.

Dose of 1730.8 kg ha^{-1} of agricultural gypsum resulted in a maximum production of 4.97 t ha^{-1} of dry pasture.

The linear interaction of the use of ammonium nitrate with gypsum doses shows an extremely interesting synergistic potential with this source.

For dry mass of culms (CDM), the use of urea had a PMTE of 1730.8 kg ha^{-1} of agricultural gypsum resulting in 2.38 t ha^{-1}.

The culms dry mass of (CDM) represented 47.9% of the total dry mass of the pasture.

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