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Urease inhibitor on performance of corn hybrids in second crop in Sinop-MT

G. Wiest[1], C. S. Pereira[1], I. V. A. Fiorini[1], M. E. Schoffen[1], V. H. Zanetti[1], A. A. Silva[2]

[1]Universidade Federal de Mato Grosso - Campus Sinop MT
[2]UNIFOR- Centro Universitário de Formiga MG

Author for correspondence: caspaziani@yahoo.com.br

Abstract. Nitrogen is the most demanded element with the most complex management and with the highest responses in productivity in the corn crop, of the principal source of nitrogen supplies, but the urea is inefficient due to its volatilization. The objective of this work was to evaluate the agronomic performance and the efficiency of the urease inhibitor in formulations containing urea, applied in five different commercial corn hybrids in Sinop - MT. The experimental design was in randomized blocks, in a 3 x 5 factorial scheme with three replications. The first factor consisted of three cover fertilizations: control (without application of fertilizer); fertilization with 250 kg ha-1 of urea and fertilization with 250 kg ha-1 of urea with the presence of the urease inhibitor (UREMAX®) NBPT. The second factor was five corn hybrids: 2B433, DKB255, DKB335, NS45 and SYN522. It was found that all hybrids had greater growth and productivity when they received the urease inhibitor, in relation to the treatment without coverage. The hybrids DKB 255, 2B433 and SYN 522, the treatment with UREMAX® reached the highest productivity. The most prominent hybrid in productivity was DKB 255, which reached 9600 kg ha-1, with UREMAX® in cover fertilization, about 31% more than the treatment without urea coverage, and with gains of 18% in relation to urea.
Keywords: Zea mays, no-till, urea, nitrate, ammonium. Demand of nitrogen in maize. Grain yield.

Introduction

Second crop corn in the state of Mato Grosso is of paramount importance for grain production throughout the country. In the 2017/18 crop, production reached 26,201,200 tons of corn in the state, representing around 50% of Brazil's second crop corn production. In the 2019/20 harvest, the participation of Mato Grosso in corn production had a great increase, something estimated at 31,144.50 thousand tons, an increase of 8% in the cultivated area and 18.2% in productivity, favored by the regular rainy season, which allowed a bigger window in the sowing and a full development of the plant (CONAB, 2019).

The sowing time of corn in the second crop occurs between the months of January and March, depending on the planning of the previous crop. Because it is a C4 species, corn is more efficient in the production of carbohydrates that will be used in the production of grain. However, some factors influence productivity, such as hybrid, fertilization, soil type, climatic factors, pest incidence and adopted management (Bergamaschi and Matzenauer, 2014).

Soil fertility is a limiting factor in maize productivity, with a linear relationship between productivity and extraction of elements. The nutrients most required by corn are nitrogen (N) and potassium (K), followed by calcium (Ca), magnesium (Mg) and phosphorus (P) (Coelho and Resende, 2008).

In the initial phase of corn development, about 20 to 30% of the total extraction of nutrients takes place, with a gradual evolution to the weighting stage, which limits the end of absorption for N, P, K and Mg. In order to have a response in productivity, it is necessary to fertilize the corn in the first 30 days after germination, in addition to being the correct time for the plant, there is ease in the operation of the machinery between the corn lines (Resende et al., 2018).

The main nutrient in the composition of corn is nitrogen, whose main source of fertilizer is urea. Of all N absorbed by corn, about 75% is translocated to the grain, therefore directly wrapped with grain weight. The lack of the nutrient affects the number of grains and the size of the ear (IFA, 2016).

The stable forms of N in the soil and absorbed by plants are ammonium (NH4 +) and nitrate (NO3-). Urea, upon contact with the urease enzyme, undergoes the breakdown of molecules, transforming N into ammonia, a volatile compound, allowing the occurrence of loss through ammonia volatilization, causing losses of up to 22% of all nitrogen applied to the soil in rice culture (Scivittaro et al., 2010).

In the no-tillage system, the loss of urea is greater, as in this system there is a greater amount of the urease enzyme and the contact of the fertilizer directly with the soil is less, reducing the absorption of ammonium. In order to avoid losses due to volatilization, alternatives have been sought, among them the application of urea protected with polymers, other sources of nitrogen such as ammonium sulfate and urea with urease inhibitor (NBPT). These fertilizers can be used in the mixture of formulates, establishing at the end of the formulation process the composition of "urea + ammonium sulfate + protected urea", forming an adequate amount of N, with different periods of nutrient release, mitigating losses (Tasca et al., 2011).

Given the above, the objective of the work was to evaluate whether the presence of urease inhibitors in formulations containing urea and ammonium sulfate, influences the response of different commercial corn hybrids, in the Sinop - MT region.

Methods

The experiment was carried out from February to June 2019, in a commercial area of coordinates (11 ° 37´38 "S and 55 ° 26´38" W) on the edge of BR - 163, in the "Mercedes" land area, in the municipality of Sinop-MT. The altitude of the place is 380 m and the climate of the region, according to the Koppen classification, is of the type Am, with an average annual rainfall of 2000 mm and an average annual temperature of 25ºC, with two well-defined seasons, rainy from October to April and dry from May to September. (Souza et al., 2013).

Before preparing the area and sowing, soil sampling was performed at a depth of 0-20 cm, collecting five simple samples, which constituted a composite sample. After collection, the sample was sent to an accredited soil analysis laboratory for chemical and physical analysis of the soil and the following results were obtained: pH (H2O): 5.8; pH (CaCl2): 5.1; P: 32.82 mg / dm3; K: 68 mg / dm3; K: 0.07 cmol / dm3; Ca: 4.10 cmol / dm3; Mg: 0.6 cmol / dm3; Al: 0 cmol / dm3; H: 4.13 cmol / dm3; H + Al: 4.13 cmol / dm3; M.O .: 21.74 g / dm3; Sum of Bases: 4.77 cmol / dm3; CTC at pH 7.0: 8.9 cmol / dm3; V%: 53.63; Ca / Mg: 6.87; Ca / K: 58.63; Mg / K: 8.53; Ca + Mg / K: 67.16; Sand: 729 g / dm3; Silt: 32 gm / dm3; Clay: 239 gm / dm3. Therefore, according to Sousa and Lobato (2004) the soil as medium texture, P content in the high soil, K content in the appropriate soil, adequate Ca content, adequate Mg content. The soil is classified as a dystrophic Yellow Latosol (Santos et al., 2013).

The experimental design was in randomized blocks, in a 3 x 5 factorial scheme, with three replications, totaling 15 treatments and 45 experimental units. The first factor, with three levels of different cover fertilizations in the V4 stage of corn (4 fully expanded leaves): control (without the application of fertilizer); fertilization with 250 kg ha-1 of the formulated 25-00-18, without the presence of a urease inhibitor; cover fertilization with 250 kg ha-1 of the formulated 25-00-18, using the urea inhibitor: N- (nbutil) thiophosphoric triamide - NBPT, trade name UREMAX®. Potassium fertilization was standardized in all plots. The second factor with five corn hybrids, namely: 2B433, DKB255, DKB335, NS45 and SYN522.

The plots consisted of five sowing lines, five meters long, totaling 12.5 m2 and the useful plot was made up of four central meters of the lines, excluding 0.5 m from the ends of three central lines except the two lateral lines that were considered border, totaling 8 m2 of useful plot.

The experiment area was opened more than ten years ago and has been going through the soybean / corn succession since then, in the minimum cultivation system, since the producer does not carry out any type of soil movement. The experiment was sown on February 8, 2019, sowing a final population in order to obtain 60,000 plants ha-1 with a spacing of 0.5 meters between rows. At sowing, fertilization was carried out with 200 kg ha-1 of the formulated 20-00-20, corresponding to 40 kg of N and 40 kg of K2O. The application of cover fertilization was according to the treatments, using the formulated 25-00-18 composed of 282 kg of ammonium sulfate, plus 418 kg of urea and 300 kg of potassium, in 1000 kg of formulated; and the formulated 25-00-18 MAIZ® composed of 278 kg of ammonium sulfate, 420 kg of urea, 300 kg of potassium and 2 kg of UREMAX®. Potassium fertilization was corrected in all treatments with KCl. All cover fertilization was applied at vegetative stage V4 (Ritchie et al., 2003).

On the day of sowing, an application of glyphosate herbicide was carried out with the product Roundup WG® using the dose of 1.5 kg ha-1 and an application of fungicide based on epoxiconazole 160 g L-1 and pyraclostrobin 260 g L-1 at a dose of 0.250 L ha-1.

The meteorological data referring to precipitation, average temperature, maximum temperature and minimum temperature were obtained through the INMET Station in Sinop, from February 8 to June 7, 2019, during which the hybrids remained in the field (Figure 1).

The harvest was performed manually, on June 7, 2019, when the grains were approximately 130 g kg-1 of moisture and the ears were in R6, as a morphological character for the harvest, the formation of the black layer was observed . After harvesting, using five ears per plot to determine the characteristics of ear diameter, cob diameter, ear mass, cob weight, ear length, number of rows of grains and number of grains per row. The threshing of the grains took place in a manual corn threshing machine Bottini®. After threshing, to standardize grain yield determinations, the corn kernels had their moisture corrected to 130 g kg-1 of water and the initial water content of the kernels determined by the direct method, in an oven with forced air circulation, at a temperature of 105 ° C for 24 hours, the mass of a thousand grains and the grain yield were calculated in the useful portion of the experiment.

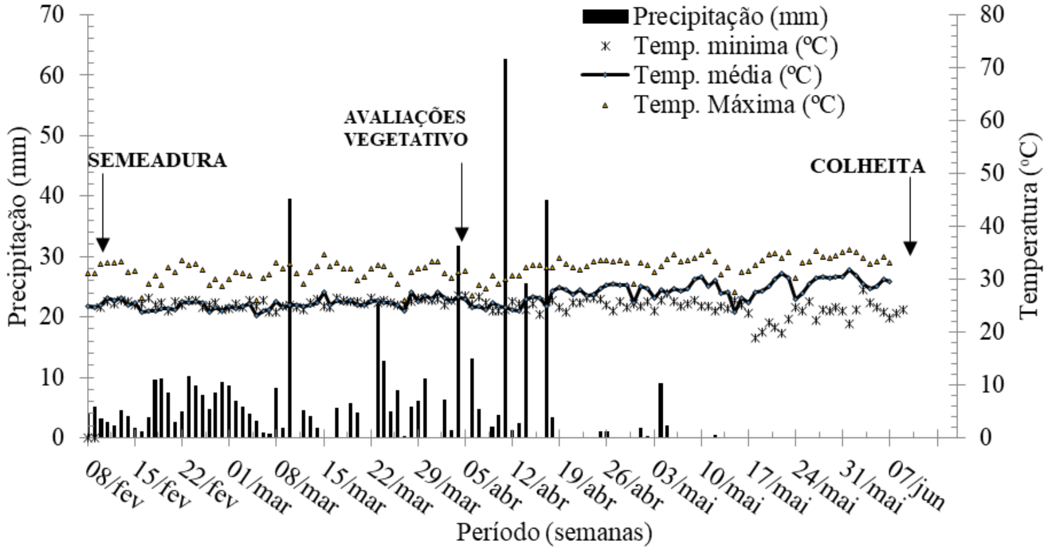


Figure 1. Temperature and precipitation data during the experiment period from February 8 to June 7, 2019.

The data obtained were subjected to analysis of variance at the level of 5% probability by the F test, with the aid of the SISVAR® software (Ferreira, 2011). After the F test (p> 0.05) of the analysis of variance, the means were compared using the Scott Knott test.

Results and discussions

Table 1 shows the averages for ear diameter, cob diameter, ear mass, cob weight and ear length, which differed between hybrids. For the diameter of the ear and the diameter of the cob, the hybrid 2B433 surpassed all others, reaching 5.03 cm and 2.98 cm, respectively. However, DKB255 and SYN522 were intermediate with 2.75 and 2.81 cm, and the smallest were DKB335 and NS45 with 2.55 and 2.64 cm for the diameter of the cob. The hybrid NS45 had an emphasis on the ear mass and cob mass with 218.23g and 29.37g, respectively, with the others having lower values. The NS45 also reached the second largest ear length at 17.81g, being below only the SYN522 hybrid with 18.49 cm, which meant a greater amount of grains, as can be seen in the variable of the number of grains per row.

For the different sources of N applied in coverage, the ear mass, ear length, number of grain rows and grain yield were significantly influenced (Table 2). The ear mass and ear length had similar results, in which UREMAX® and urea were superior to the control without nitrogen application. Okumura et al., (2013), also observed a significant influence on the application of urea treated with urea inhibitor, where the ear length had quadratic behavior and its peak point on the curve was observed at a dose of 120.83 kg ha 1 of N reaching 17.45 cm. This result is similar to that observed for the UREMAX treatment with 17.21 cm.

Table 1. Average of the variables for ear diameter (DE), sabugo diameter (DS), ear mass (EM), sabugo mass (SM) and ear length (EL) of corn hybrids in Sinop - MT (2019).

Híbrids:	Traits				
	DE (cm)	DS (cm)	EM (g)	SM (g)	EL (cm)
2B433	5,0 a	2,9 a	204,4 b	24,9 c	16,0 c
DKB255	4,7 b	2,7 b	205,4 b	24,8 c	15,5 c
DKB335	4,7 b	2,5 c	201,8 b	21,5 d	15,9 c
NS45	4,6 b	2,6 c	218,2 a	29,3 a	17,8 b
SYN522	4,6 b	2,8 b	207,3 b	26,5 b	18,4 a

*Means with equal letters in the columns do not differ at the 5% probability level by the Scott-Knott test.

Table 2. Means of the variables ear mass (EM), ear length (EL), number of rows (NR) and grain yield (GY) for N sources in coverage. Sinop - MT (2019).

Sources of N in coverage:	Traits			
	EM(g)	CE (cm)	NR	GY (kg ha^{-1})
UREMAX	209,7 a	17,2 a	16,0 a	8424,3 a
Uréia	209,4 a	16,8 a	15,3 b	7703,5 b
Without N	203,1 b	16,2 b	15,5 b	6991,0 c

*Means with equal letters in the columns do not differ at the 5% probability level by the Scott-Knott test.

The number of rows and grain yield also obtained superiority for the source of N in UREMAX® covering in relation to urea and the control without N in the covering fertilization. According to Sousa et al, (2017) the application of coated urea provides an increase in the number of rows per ear of 1.9% in relation to the use of conventional urea, data that corroborates with the present study. This characteristic is defined in the V8 stage, showing a possible decrease in nitrogen loss and making this element available, resulting in an increase in the number of rows (Carmo et al., 2012). The number of rows is defined at the phenological stage V8, needing at this time an adequate supply of N, as in the experiment the fertilization of cover occurred at this stage, some hybrids need higher levels of N to respond to the fertilization justifying the difference between the hybrids (Fornasiere Filho, 2007).

The averages of the productivity component variables such as the number of grains per row, number of rows of grains, mass of a thousand grains and grain productivity differed between the corn hybrids (Table 4). The number of grains per row ranged from 32.83 to 36.51 where the NS45 hybrid presented the highest value in relation to the other hybrids and this result is closely related to the greater amount of grains in the ear. It appears that the hybrids DKB 255 and 2B433 reached the highest values of number of grain rows, leading to understand that the use of N in these hybrids was more efficient compared to the others. When insufficient supply of N occurs during the stage of floral differentiation, there may be a reduction in the number of eggs at the beginning of the ear and a decrease in the amount of grains formed, in addition, a deficiency in the nutrients boron and calcium can cause losses in pollination, as they are the fundamental elements in the composition of the stigma style (Ernani et al., 2005).

Table 4. Averages of the variables of the number of grains per row (NGR), number of rows (NR), mass of a thousand grains (M1000) and grain yield (GY) in corn hybrids in Sinop - MT (2019).

Híbrids	Traits			
	NGR	NR	M1000 (g)	GY (kg ha^{-1})
2B433	32,8 c	16,2 a	334,6 b	7211 b
DKB 255	29,5 d	16,2 a	363,5 a	8583 a
DKB 335	32,1 c	15,4 b	325,5 b	7881 a
NS45	36,5 a	15,2 b	332,9 b	8011 a
SYN522	34,2 b	15,1 b	322,4 b	6843 b

*Means with equal letters in the columns do not differ at the 5% probability level by the Scott-Knott test.

For the mass of a thousand grains, the hybrid DKB 255 was superior to the others with 363.55g, as well as high averages for grain productivity with 8,583.61 kg ha-1 (139.99 bags ha-1). As a result, it is likely that the DKB 255 has a greater extraction of N and use of it. The mass of a thousand grains is important because it is a direct factor to indicate and explain productivity, demonstrating which treatment was most relevant for grain filling, since about 75% of the absorbed N is translocated to the grain (Ritche et al. , 2003), but this factor is dependent on the extraction and export to the grain, so if the plant is unable to extract the sufficient element there will be losses in the mass of a thousand grains. The grain yields of the corn hybrids were higher for the hybrids DKB255, NS 45 and DKB335 compared to the others with averages of 8583.61; 8011.31 and 7881.79 kg ha-1 respectively.

Regarding the sources of N in coverage, there were significant differences only for the number of rows, the source Uremax® was superior to conventional urea and the control without N in coverage. For the number of grains per row and mass of a thousand grains, there were no significant differences between the sources of N in the cover (Table 5). According to Sousa et al, (2017) the application of coated urea provides an increase in the number of rows per ear of 1.9% in relation to the use of conventional urea, data that the present study corroborates. Characteristic defined in the V8 stage, showing a possible decrease in nitrogen loss and making this element available, resulting in an increase in the number of rows (CARMO et al., 2012).

Table 5. Average of the variables number of grains per row (NGR), number of rows (NR) and mass of one thousand grains (M 1000) of five corn hybrids under application of urea, Uremax and without application of nitrogen. Sinop - MT (2019).

Sources of N in coverage:	Traits:		
	NGR	NR	M1000
Uremax	32,6 a	16,0 a	338,8 a
Ureia	33,5 a	15,3 b	331,5 a
Without N	32,9 a	15,5 b	337,0 a
C.V.(%)	5,60	4,42	4,62

*****Means with equal letters in the columns do not differ at the 5% probability level by the Scott-Knott test.

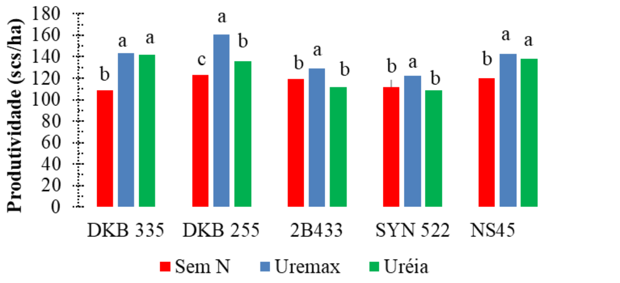
Kappes and Silva (2016) obtained values of average increase of 7.6% in grain productivity with the application of N, in relation to the treatment without application of N in coverage, regardless of the urea used. Kappes et al. (2009), observed a significant increase in corn productivity with application of 70 kg ha-1 of N, regardless of the source used.

Rodrigues et al. (2018) found that the application of urea is beneficial for the cultivation of corn even in years of favorable climatic conditions, obtaining gains of 31% in grain productivity in the treatment with urease inhibiting urea, Super N. As well as the climatic conditions , previously mentioned, favored the development of corn in the present experiment. It is also noticeable the high productivity of the control, it should be noted that 40 kg ha-1 of N was applied in the sowing despite not having been covered, and its production is within the average values with application of nitrogen in coverage (RESENDE et al., 2018).

The hybrids responded differently to the application of urease inhibitor, but all of them had productivity gains, in comparison with the treatment without covering fertilization. Urea provided values similar to urea treated in treatments with the NS 45 and DKB 335 hybrids. Mota et al. (2015), reported that the different sources of urea did not interfere statistically in the grain yield, but the two hybrids mentioned obtained a great final productivity, proving to be highly responsive to covering fertilization, regardless of the source.

Frazão et al. (2014) found that the use of urea treated with NBPT additive reached an increase in grain of 13 bags ha-1 when compared to common urea and an increase of 23 bags ha-1 in relation to the control, the authors reporting the occurrence of a possible decrease in the loss of N through volatilization and a consequent increase in the levels of N available to the plants. In the present work, the hybrid DKB 225 reached the highest yield values, in the application of urea treated with NBPT the gain in relation to common urea was 24 bags ha-1 and 37 bags ha-1 compared to the control (Figure 2).

Figure 2. Average of the split of five hybrids of the productivity variable in ha-1 bags according to the application of urea, UREMAX® and without nitrogen application, Sinop - MT (2019).



* The averages followed by the same letters do not differ at the 5% probability level by the Scott-Knott test.

The most prominent hybrid in productivity was DKB 255, which reached 160 bags ha-1 (9600 kg ha-1) with cover fertilization with the presence of UREMAX®, about 31% higher than the treatment without cover urea, and with gains of 18% in relation to urea (Figure 2). This productivity difference occurred due to the probable reduction in urea volatilization rates, as Guelfi (2017) verified that he estimated a 79% reduction in urea volatilization, when treated with the urease inhibitor.

Conclusions

Application in nitrogen cover under the conditions of the study, using urease with urease inhibitor, increases the efficiency of fertilization and increases productivity of corn hybrids.

In the DKB 255, 2B433 and SYN 522 hybrids, treatment with UREMAX® achieves better results than the application of only urea. Highlighting the hybrid DKB 255, which achieved the highest average productivity.

References

ALBUQUERQUE, P.E.P.; RESENDE, M. Cultivo do milho: manejo de irrigação. 2010. Disponível em: <https://goo.gl/ tn2uNQ>. Acesso em: 15 de junho de 2019.

BERGAMASCHI, H.; MATZENAUER, R. O milho e o clima. Porto Alegre: Emater/RS-Ascar, p. 11, 2014.

CARMO, M. S. et al. Doses e fontes de nitrogênio no desenvolvimento e produtividade da cultura de milho doce. Bioscience Journal, v. 28, p. 223-231, 2012.

CIVARDI, E. A. et al. Uréia de liberação lenta aplicada superficialmente e ureia comum incorporada ao solo no rendimento do milho. Pesquisa Agropecuária Tropical, v. 41, n. 1, p. 52–59, 2011.

COELHO, A. M.; RESENDE, Á. V. Exigências nutricionais e adubação do milho safrinha. Sete Lagoas: Embrapa Milho e Sorgo, 2008.

COELHO, A. M. Manejo da adubação nitrogenada na cultura do milho. Cultivar Grandes Culturas, Sete Lagoas-MG. 2011.

COMPANHIA NACIONAL DE ABASTECIMENTO (CONAB). Acompanhamento da safra brasileira de grãos: Oitavo levantamento. n.8 ed. Brasília, 2019. 6 v. maio 2019.

DEKALB. DKB 255 PRO3. Disponível em: <https://www.dekalb.com.br/pt-br/nossos-produtos/hibridos-milho/safrinha/dkb-255-lancamento.html> Acesso em: 15 de julho de 2019.

ERNANI, P. R. et al. A forma de aplicação da uréia e dos resíduos vegetais afeta a disponibilidade de nitrogênio. Ciência Rural, v. 35, n. 02, p. 360-365, 2005.

FERREIRA, D. F. Sisvar: A computer statistical analysis system. Ciência e Agrotecnologia, Lavras, v. 35, n. 6, p. 1039-1042, 2011. Disponível em: <http://www.scielo.br/pdf/cagro/v35n6/a01v35n6.pdf >. Acesso em: 18 de julho 2019.

FORNASIERI FILHO, D. Manual da cultura do milho. Jaboticabal: Funep, 2007. 576 p.

FRAZÃO, J. J. et al. Fertilizantes nitrogenados de eficiência aumentada e ureia na cultura do milho. Revista Brasileira de Engenharia Agrícola e Ambiental, v. 18, n. 12, p. 1262–1267, 2014.

GUELFI, D. Fertilizantes nitrogenados estabilizados, de liberação lenta ou controlada. Informações agronômicas IPNI, v. 157, n. 19, p. 1–32, 2017.

IFA - International Fertilizer Industry Association. Nutrient Management Handbook, 2016 <http://www.fertilizer.org/>. 20 mai. 2019.

INSTITUTO NACIONAL DE METEOROLOGIA (INMET). Sistema de suporte á decisão na agropecuária (Sisdagro), 2019. Disponível em:

<http://sisdagro.inmet.gov.br/sisdagro/app/monitoramento/bhc>. Acesso em: 15 jul. 2019.

KAPPES, C. et al. Influência do nitrogênio no desempenho produtivo do milho cultivado na segunda safra em sucessão à soja. Pesquisa Agropecuária Tropical, v. 39, n. 03, p. 251-259, 2009.

KAPPES, C.; SILVA, R. G. Fontes e doses de nitrogênio no cultivo do milho safrinha em sucessão à soja. Enciclopédia Biosfera, v. 13, n. 23, p. 646–659, 2016.

KERBAUY, G. B. Fisiologia vegetal. Rio de Janeiro: Guanabara Koogan, 2004.

MAGALHÃES, P. C. et al. Fisiologia do milho. Sete Lagoas: EMBRAPA-CNPMS, Circular Técnica, 22. 23 p. 2002.

MOTA, M. R. et al. Fontes estabilizadas de nitrogênio como alternativa para aumentar o rendimento de grãos e a eficiência de uso do nitrogênio pelo milho. Revista Brasileira de Ciencia do Solo, v. 39, n. 2, p. 512–522, 2015.

RESENDE, Á. V. et al. Manejo de nutrientes no cultivo de milho segunda safra na região do cerrado. Embrapa Milho e Sorgo-Artigo em periódico indexado (ALICE), 2018.

RITCHIE, S. W.; HANWAY, J. J.; BENSON, G. O. Como a planta de milho se desenvolve. Informações agronômicas, v. 103, p. 1-19, 2003.

RODRIGUES, F. J. et al. Eficiência agronômica da cultura do milho sob diferentes fontes de nitrogênio em cobertura. Uniciências, v. 22, n. 2, p. 66, 2018.

TASCA, F. A. et al. Volatilização de amônia do solo após a aplicação de ureia convencional ou com inibidor de urease. Revista Brasileira de Ciência do Solo, v. 35, n. 2, 2011.

SCIVITTARO, B. W.; GONÇALVES, D. R. N.; VALE, M. L. C do; RICORDI, V. G. Perdas de nitrogênio por volatilização de amônia e resposta do arroz irrigado à aplicação de ureia tratada com o inibidor de urease NBPT. Ciência Rural, Santa Maria, v. 40, n. 6, p. 1283-1289, jun, 2010.