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Cientific Paper

Agronomics characteritcs of wheat cultivars in response to urea treaded with urease inhibitor in coverage

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Abstract

Reductions of nitrogen losses applied in coverage on the wheat crop is a necessity in the national wheat production, this advanced can increase grains yield, and for this, the use of nitrogen sources enriched with urease inhibitors can be a alternative for producers. In this context the objective of this study was to verify the different nitrogen fertilizers efficiency, with and without urease inhibitors, in coverage on the wheat crop and its effects on the expression of agronomics traits. The experiment was conducted in Guarapuava on the season of 2012, in the Experimental Camp of the Agronomy Department of the Universidade Estadual do Centro-Oeste of Paraná – UNICENTRO. The used design was of randomized blocks with five replications, in 3x2 factorial, being 3 traits of nitrogen coverage (control treatment, conventional urea and urea with urease inhibitor – NBPT), and 2 wheat cultivars (Mirante® e BRS Pardela®). There was significant difference between traits with nitrogen fertilizer for the assessed characteristics: Tillers number (NP), grains number for ears (GE), weight of a thousand grains (P1000) and grains yield (PROD). The results of this study allow to conclude that there was increase in the wheat grains yield when associated to the used coverage fertilizer with uerase inhibitor NBPT (200 kg ha^{-1} - 90 kg N), in face of the other evaluated treatments. The urea with urease inhibitor NBPT provided higher weight of a thousand grains when compared with conventional urea, being the result dependent of the evaluated cultivar.

Keywords: *Triticum aestivum* L.; nitrogen fertilizer; N-(n-butil tiofofórico triamida) – NBPT.

Características agronômicas de cultivares de trigo em resposta à ureia tratada com inibidor de urease em cobertura

Resumo

Reduções de perdas de nitrogênio aplicado em cobertura na cultura do trigo é uma necessidade na triticultura nacional, avanço este que permitirá aumentar a produtividade de grãos e para isto, o uso de fontes nitrogenadas enriquecidas com inibidores da uréase pode ser uma alternativa para os produtores. Neste contexto o objetivo deste trabalho foi estudar a eficiência de diferentes fertilizantes nitrogenados, com e sem inibidor de uréase, em cobertura na cultura do trigo e seus efeitos na manifestação de caracteres agronômicos. O experimento foi conduzido em Guarapuava na safra de 2012, no Campo Experimental do Departamento de Agronomia, da Universidade Estadual do Centro-Oeste do Paraná – UNICENTRO. O delineamento utilizado foi de blocos ao acaso com cinco repetições, em esquema fatorial 3x2, sendo 3 tratamentos de cobertura com nitrogênio (testemunha; ureia convencional e ureia com inibidor da urease - NBPT) e 2 cultivares de trigo (Mirante® e BRS Pardela®). Houve diferença significativa entre os tratamentos com adubação nitrogenada para as características: Números de perfilhos (NP), número de grãos por espigas (GE), peso de mil grãos (P1000) e produtividade de grãos (PROD). Os resultados deste trabalho permitem concluir que houve aumento na produtividade de grãos de trigo quando associado o uso do fertilizante em cobertura com inibidor de uréase NBPT (200 kg ha^{-1} - 90 kg N), frente aos demais tratamentos de cobertura avaliados. A ureia com inibidor de uréase NBPT propiciou maior peso de mil grãos quando comparado com a ureia convencional, sendo este resultado dependente da cultivar avaliada.

Palavras-chave: *Triticum aestivum* L.; adubação nitrogenada; N-(n-butil tiofosfórico triamida) – NBPT.

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Características agronómicas de variedades de trigo en respuesta a la urea tratada con inhibidor de la ureasa en cobertura

Resumen

La reducción de las pérdidas de nitrógeno aportado en cobertura en el cultivo de trigo es una necesidad en la producción nacional de trigo, este avance podrá aumentar el rendimiento y para ello, el uso de fertilizantes nitrogenados fortificados con inhibidores de la ureasa puede ser una alternativa para los productores. En este contexto, el objetivo fue estudiar la eficiencia de los diferentes fertilizantes nitrogenados, con y sin inhibidor de la ureasa en cobertura en el trigo y sus efectos en la expresión de los caracteres agronómicos. El experimento se realizó en Guarapuava en la zafra de 2012 en el campo experimental de la Facultad de Agronomía de la Universidad Estadual do Centro-Oeste do Paraná - UNICENTRO. El diseño experimental fue bloques al azar con cinco repeticiones, en un factorial 3x2, con tres tratamientos de cobertura con nitrógeno (control, urea convencional y urea con el inhibidor de la ureasa - NBPT) y 2 cultivares de trigo (Mirante® y BRS Pardela®). Hubo una diferencia significativa entre los tratamientos con fertilizantes nitrogenados para las características: número de macollos (NP), número de granos por mazorca (GE), peso de mil granos (P1000) y el rendimiento de grano (PROD). Los resultados de este estudio permiten concluir que hubo un aumento en el rendimiento del trigo cuando se asocia el uso de fertilizantes en cobertura con el inhibidor de la ureasa NBPT (200 kg ha^{-1} - 90 kg N), en comparación con los otros tratamientos evaluados. La urea con inhibidor de la ureasa NBPT produjo mayor peso de mil granos en comparación con la urea convencional, siendo este resultado dependiente del cultivar probado.

Palabras clave: *Triticum aestivum* L.; nitrógeno; N - N-(n-butil tiofosfórico triamida) – NBPT).

Introduction

The wheat crop in Brazil is basically cultivated in the southern region and has more than 90% of the national production. The Brazilian production during the season of 2012 was of 5.5 millions of tons and the average yield of 2.6 t ha^{-1} (CONAB, 2012). This production supplies only 50% of the national demand in wheat, being this factor the most prejudiced, because of this low yield.

The optimization of agricultural practices of management in the wheat crop can assist the increase of yield of Brazilian wheat crops (SANGOI et al., 2007). There are many studies that aim to elevate the wheat crop yield, especially on the fertility area of the soil with emphasis in the nitrogen fertilization (TEIXEIRA FILHO et al., 2010).

The nitrogen fertilization expressively influences the growth and development of wheat plants as well as the productive potential and quality of grains (GUTKOSKI et al., 2011; SANGOI et al., 2007). As a result, it is considered one of the most important agricultural practices to be studied and managed for the wheat crop (SANGOI et al., 2007). For the wheat crop, studies demonstrate that doses close to 100 kg ha^{-1} of N in cover result in good yields and economical efficiency (TEIXEIRA FILHO et al., 2010).

Having undeniable importance between the nutrients, the nitrogen is also the nutrient of harder management, because of the great number of reactions that can take place on the soil (ERNANI, 2003). The most important source of nitrogen for the agriculture is the urea, for having low cost, good solubility and absorption by the plants. However, it has presented elevated losses of N by volatilization of ammonia (NH_3), resulting from urease activity, mainly when applied on the surface in conditions of low humidity (BARTH et al., 2006). These losses in the modern agriculture can be aggravated by climate conditions during the moment of application added to large areas to be fertilized, making difficult the obtainment of ideal conditions to the practice.

As alternative for reduction of these losses exist fertilizers that have urease inhibitors which reduce the transformation speed of urea in NH_3, resulting in better percolation of urea on the soil, reducing losses by volatilization of ammonia on the soil surface (MALHI et al., 2001). Reduction of nitrogen losses in the wheat crop can be a tool to elevate the production and yield, strengthening the national wheat culture. Results of research containing urease inhibitors constantly present differences in the product efficiency. However, the literature is unanimous, affirming that are necessary regionalized studies for certain weather conditions, in order to produce information for the correct recommendation of urease inhibitors (MALHI et al., 2001; ESPINDULA,

2010). In this context, the objective of this work was to study the efficiency of different nitrogen fertilizers, with or without urease, in cover on the wheat crop and its effects in the expression of agronomic traits.

Material and Methods

The experiment was conducted in Guarapuava, in the Experimental field of the Agronomy Department of the Universidade Estadual do Centro-Oeste do Paraná – UNICENTRO, with altitude of 25º 23' 36''S, longitude of 51º 27' 19''W and altitude of 1,120 m, in soil classified as Latossolo bruno distroférrico typical[1], very clayey texture (EMBRAPA, 2006), whose results of soil analysis of the experimental areas are presented in Table 1.

The results of soil analysis revealed that the nitrogen contents were considered high (0 - 20 cm), this fact is due to the management performed in the experimental area and for being a consolidated no tillage.

The experimental area was cultivated during the summer, with maize in system of no tillage, and in the previous winter season with oat.

In June of 2012, twenty days before the experiment installation was done a desiccation with the original herbicide Roundup® in the dose of 3 l ha^{-1}. The experiment was installed in system of no tillage in June, 10th of 2012.

The used design was of randomized blocks, in factorial scheme 3x2, being 3 treatments of cover with nitrogen (control, urea and urea with inhibitor) and 2 cultivars of wheat, these with five repetitions, totalizing 30 plots. The plots were constituted of nine rows (5.0 m length x 0.20 m between lines), with a total area of 9 m^2 and useful area constituted by the central rows (4, 5 and 6).

It was used two wheat cultivars, being one the Mirante®, originated from the OR Melhoramento de Sementes Ltda/Biotrigo Genética Ltda company, this cultivar has intermediate vegetative habit to semi-erect, median tillering, average height of 70 cm, presents average cycle, with average silking of 64 days. The other cultivar is the BRS Pardela®, originated from the Embrapa Trigo, average height of 67 cm, being of early cycle, with average silking of 67 days, and being both cultivars moderately resistant to frost, using 150 kg of seeds per hectare.

For the sowing was used the SEMINA® plots seeder, leaving after the thinning a final population of plants of 350 plants m^{-2}.

The used dosages of fertilizers of base in the experiment conduction were calculated in a way to provide the quantity of 20 kg ha^{-1} of nitrogen, for this was used the formulated fertilizer 08-30-20 with a dosage of 250 kg ha^{-1}, for all treatments.

The cover was done when the plots were at the stage of tillering, according the following treatments: 200 kg ha^{-1} of conventional urea (90 kg N) and 200 kg ha^{-1} of urea inhibitor of urease (N-(n-butyl thiophosphoric triamide – NBPT – 90 kg N) and control treatment (0 kg N). The application was done with use of measures, for control of the fertilizers dosage, being performed in all rows of the plot.

It is worth remembering that for the assessed treatments there was no variation in the points of applied nutrient, since the products provide the same nitrogen points, which is not a factor of study, but a fact of the fertilizer containing the NBPT inhibitor, which enables the slowly liberation of nitrogen, may acting as an inhibitor of urease.

The weed plants control was performed with the metsulfuron-methyl -2.4 g i.a ha^{-1} + iodosulfuron-methyl - 5 g i.a ha^{-1} herbicides, 30 days after the sowing in the phenological stage 2.4, according to the scale of ZADOKS et al. (1974). It was done two applications of fungicide, being the first during the flowering start and the second 25 days after the first, using the commercial product containing Trifloxystrobin + tebuconazole in the dose of 0.6 L ha^{-1}.

All other used cultural traits were the commonly used in the wheat cultivation in the Central-South region of the Paraná state.

It was assessed the following characteristics:

1 Brazilian soil classification.

Table 1. Results of soil analysis performed before of implantation of the experiment.

pH $CaCl_2$	N	P	K	Ca	Mg	Al	H+Al	(T)	V (%)	MO (g dm^{-3})
4.9	2.75	2.1	0.45	4.8	1.9	0.00	5.3	12.26	58.1	44.3

** Levels N this is expressed in mg dm^{-3}, other macronutrients in cmolc dm^{-3}*

*** Analysis performed on the Tecsolo Laboratory.*

Plants height (AP) – average value obtained through measurement of 10 plants in the central rows of the plot, measuring the soil until the point of insertion of the flag leaf;

Number of tillers (NP) – average value obtained through counting of the number of tillers, in a sample of 10 plants collected in the useful area of the plot.

Number of ears (NE) - average value obtained through counting of the number of ears in a sample of 10 plants collected in the useful area of the plot.

Number of grains per ear (GE) - average value obtained through counting of the number of grains in a sample of 5 plants collected in the useful area of the plot.

Hectoliter weight (PH) – the PH was determined in the zero time of the wheat maturation in a device of the Dalle Molle brand, performed according to the methodology described by the Rules of Seed Analysis, BRASIL (2000), in triplicate, and the results were expressed in kg hL^{-1}.

Weight of 1000 grains (P1000) - average value obtained through weighing of three samples of 1000 grains retrieved from the plot useful area.

Grains yield (PROD) – It was collected the plants from the plot useful area (three central rows). The ears were threshed and the grains weighed, then was determined its water content. The data referent to the grains weight was transformed to kg/ha and corrected for standard moisture of 13%.

Leaf analysis (AF) – analyzed in the flag leaf when the plants presented full flowering, according methodology described in RAIJ et al. (1997).

All data of the assessed characteristics were submitted to variance analysis and the averages were compared by the Scott Knott test, at 5% of probability, being the used program the SISVAR (FERREIRA, 2008).

Results and Discussion

There was significant difference between the treatments with nitrogen fertilization for the characteristics: Number of tillers (NP), number of grains per ear (GE), weight of a thousand grains (P1000) and grains yield (PROD). There was no interaction cultivar x nitrogen fertilizer for none of the assessed characteristics. The experiment precision, assessed by the variation coefficient (CV) was considered excellent with values of CV inferior to 17% (Table 2).

It is important to emphasize that the other assessed parameters, the AP and PH did not statistically differ. A fact that can explain the obtained data for these characteristics, and may have influenced the other assessed characteristics is mainly linked to the periods of drought, around 40 days, comprehending the tillering to booting stage and low temperatures, during the period after the flowering, occurred during the experiment conduction in the agricultural season of 2012 in the southern region of the Paraná state (Figure 1).

However, the data obtained in the condition of this agricultural season allow inferring important observations in the assessment of fertilizer use in cover with inhibitor of urease. In this sense is possible to present tendencies for the assessed treatments in cover, mainly on the nitrogen fertilizers use containing inhibitors of urease, when applied in the soil without incorporation.

There was no significant difference for the characteristic plants height obtained in different treatments with nitrogen fertilization (Table 2). However, there was significant difference in the average between cultivars, being the BRS Pardela superior in height to the Mirante cultivar (Table 2). In other researches, which studied the urea effect and urea with urease inhibitor (NBPT), was no verified significant difference between treatments for plants height, when the nitrogen was provided in cover in absence of irrigation, evidencing that the sources did not affect the plants structure (ESPINDULA et al., 2010).

For the characteristic number of tillers per plant (NP) there was difference between the cultivars and treatments with nitrogen in cover (Table 2), standing out the BRS Pardela cultivar, superior to the Mirante in average of treatments. As for the nitrogen sources in cover, the control treatments and with conventional urea did not differ, being inferior to the treatment Urea + NBPT, which presented the best average for the studied characteristic (Table 2). The values obtained for NP, when using Urea + NBPT is justified by the smallest losses by volatilization of NH_3 resulting from the urease inhibitor effect and consequently better supplying of nitrogen for the plants, implying lower abortion rate of tillers (CANTARELLA et al., 2008).

The variable grains per ear (GE), was positively affected when submitted to the treatments with nitrogen in cover (Table 2). For the cultivar BRS Pardela, the treatment Urea + NBPT significantly

Table 2. Results of the agronomics traits of two wheat cultivars (BRS Pardela e Mirante) submitted at different nitrogen fertilizers in coverage, with and without presence of urease inhibitor NBPT. UNICENTRO, Guarapuava - PR, 2013.

Plants height (AP)			
Coverage fertilizer1	**Pardela**	**Mirante**	**Average**
Control Treatment	49.1 a	40.8 a	45.0 a
Conventional Urea	49.4 a	41.4 a	45.4 a
Urea + NBPT	49.9 a	41.7 a	45.8 a
Mean	49.5 A	41.3 B	CV – 3.12%
Number of tillers (NP)			
Coverage fertilizer1	**Pardela**	**Mirante**	**Mean**
Control Treatment	2.0 b	1.6 a	1.8 b
Conventional Urea	2.1 b	1.7 a	1.9 b
Urea + NBPT	2.5 a	1.8 a	2.2 a
Mean	2.2 A	1.7 B	CV – 16.2%
Number of grains per ear (GE)			
Coverage fertilizer1	**Pardela**	**Mirante**	**Mean**
Control Treatment	27.3 b	30.4 a	28.9 b
Conventional Urea	31.1 b	30.4 a	30.7 b
Urea + NBPT	34.3 a	33.5 a	33.9 a
Mean	30.9 A	31.4 A	CV – 8.57%
Weight hectoliter (PH)			
Coverage fertilizer1	**Pardela**	**Mirante**	**Mean**
Control Treatment	74.8 a	75.1 a	75.0 a
Conventional Urea	74.9 a	75.2 a	75.0 a
Urea + NBPT	75.0 a	76.5 a	75.7 a
Média	74.9 A	75.6 A	CV – 2.2%
Weight of 1000 grains (P1000)			
Coverage fertilizer1	**Pardela**	**Mirante**	**Mean**
Control Treatment	35.5 b	40.5 a	38.1 b
Conventional Urea	36.9 b	40.1 a	38.5 b
Urea + NBPT	39.3 a	40.7 a	40.0 a
Mean	37.2 B	40.4 A	CV – 5.4%
Grains yield (kg ha^{-1})			
Coverage fertilizer1	**Pardela**	**Mirante**	**Mean**
Control Treatment	2695 b	2903 a	2799 b
Conventional Urea	2847 b	2933 a	2890 b
Urea + NBPT	3150 a	3224 a	3187 a
Average	2897 A	3020 A	CV – 8.0%

Averages followed by same letters uppercase in lines and lowercase on the columns do not differ by Scott Knott test at 5% ($P \leq 0.05$).

provided the greatest number of grains per ear, in face of the control and the treatment with conventional urea which did differ between them (Table 2). For this characteristic there was no significant response of the treatments with nitrogen fertilization in cover for the cultivar Mirante (Table 2). When was analyzed the general average of treatments with nitrogen fertilization, it is observed again, that the source Urea + NBPT provided better performance for the number of grains per ear (Table 2).

According to ESPINDULA (2010), an improved nitrogen supply in the start of the ear development in wheat plants can result in greater number of grains per ear. The better providing of nitrogen can be justified by the results found by BARTH et al. (2006), who studying urea and urea

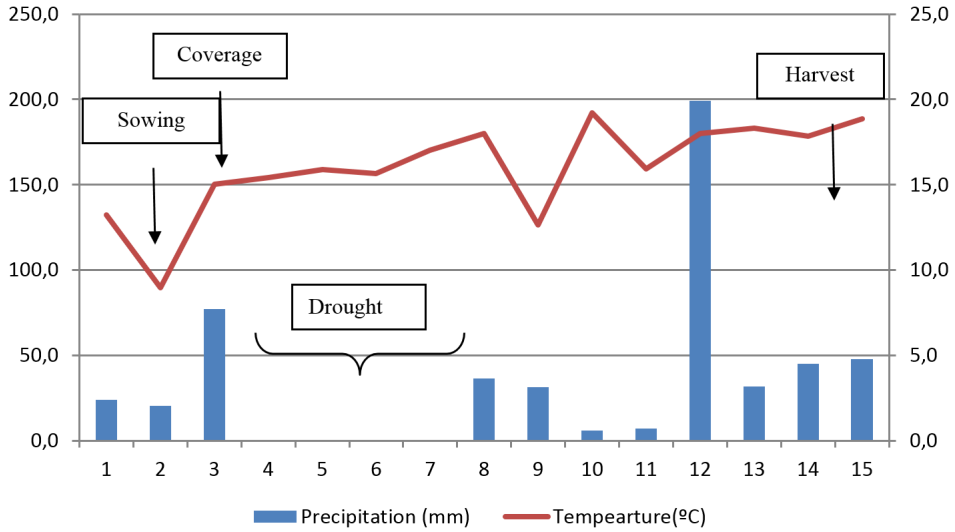

Figure 1. Results of rainfall regime (mm), for decendial, in Guarapuava - PR, during the period of 07/01/12 to 11/31/12.

with inhibitor of urease in sugar cane crop obtained reduction of 15% in losses by NH_3 volatilization when using urea treated with urease inhibitor, in face of conventional urea.

According to ALMEIDA et al. (2002) one of the reasons of low yields in the Brazilian crops is the reduced number of tillers, which is an important component of yield, and in many situations is hindered by the low availability of nitrogen for the plants.

For the variable hectoliter weight there was no significant difference between cultivars and treatments with nitrogen fertilizer in cover (Table 2). The results of this study agree with those found by GUTKOSKI et al. (2011), who assessed different wheat cultivars submitted to nitrogen doses in cover and found that the hectoliter weight of certain genotypes was no altered by the different availabilities of nitrogen.

For the P1000 there was only significant difference for the cultivar BRS Pardela, with better performance for the treatment with Urea + NBPT, in face of the control treatments and conventional urea which did not differ (Table 2). This result is similar to those of number of tillers and number of grains per ear, when used the Urea + NBPT, with the possibility of a greater nitrogen availability for the plant development and grains filling.

The same fact occurred for the grains yield, having only significant difference between the treatments with nitrogen in cover for the cultivar BRS Pardela, where the treatment Urea + NBPT was significantly superior to the other treatments, with increase of 14% in the grains yield, being that the control treatment and with conventional urea did not statistically differ (Table 2). When analyzed the general average of treatments with nitrogen in cover for both cultivars, it is verified that the same performance pattern occurred for the treatments with fertilizer Urea + NBPT, showing to be significantly superior to the other treatments with nitrogen in cover, providing an increase in the grains yield, when compared to the conventional urea in the order of 300 kg per hectare.

These obtained results for grains yield are reinforced by the obtained for GE, NP and P1000 which were superior for the Urea + NBPT, and which constitute in components of production and certainly reflected in this greater grains yield for the treatment. These results are in agreement with other research results with urea, which possess urease inhibitor and are technically justified by the smallest loss of nitrogen by volatilization of ammonia and consequently better nutrient availability for absorption by the plants roots (ESPINDULA, 2010; CANTARELLA et al., 2008; BARTH et al., 2006).

According to CANTARELLA et al. (2008), when the urea has mechanisms that can work as urease inhibitors, the urea transformation in NH_3 is reduced, so, in conditions of drier weather, during

Table 3. Means results of nitrogen macronutrient valuated by levels analysis, considering the different treatments in coverage. Guarapuava, PR, 2013.

Content of leaf nitrogen (N – g/kg)			
Coverage fertilizer1	**Pardela**	**Mirante**	**Mean**
Control Treatment	29.3 a	29.2 a	29.2 a
Urea Conventional	30.2 a	30.2 a	30.2 a
Urea + NBPT	32.6 a	29.1 a	30.8 a
Average	30.7 A	29.5 A	CV – 8.4%

Averages followed by same letters do not differ by Scott Knott test at 5% of probability.

Lowercase letters in lines and uppercase on the columns by valuated macronutrient.

the application of nitrogen in cover, the nitrogen incorporation on the soil is favored, because as it is being transformed into gas, it incorporates into the soil at slow rates.

In the conditions of the Brazilian agriculture of large areas that must be fertilized in a short period of time, it is not always possible to cover a crop within the best conditions, mainly when it is being used nitrogen in cover using urea as source. In this context, the use of fertilizers with mechanisms capable of acting as urease inhibitors constitute in an alternative considered viable, to improve the efficiency of the urea applied in cover, increasing the nitrogen harnessing through the reduction of losses by volatilization of NH_3 and consequently elevating the crop yield (KRAJEWSKA, 2009).

For a better understanding of the N contribution in each assessed cover treatment, was made a leaf analysis whose obtained data are in the following. Remembering that the treatments were standardized to the doses of applied nutrients, since that the products provide equal points of nitrogen, being the urease inhibition the factor of study, following the proper proportions: 200 kg ha^{-1} of conventional urea (90 kg N) and 200 kg ha^{-1} Ureia + NBPT (90 kg N) and control treatment (0 kg N).

In the comparison of 5% of probability, was not found significant differences between the treatments for the assessment of content of the macronutrient nitrogen (N foliar) in the leaves collected in the experimental plot (Table 3). However, when analyzed the obtained numeric values, for the contents of N foliar, there was difference between the treatments of fertilization in cover, where the treatment with Urea + NBPT was superior to the treatments with conventional urea and control (without application), when assessed the cultivar BRS Pardela, being the obtained values: 32.6; 30.2 and 29.3 g/kg. These results corroborate with the ones obtained by GIOACCHINI et al. (2002), which in the wheat crop, the inhibitor was no capable of significantly increase the N content in the plant, however, the author states that the NBPT was capable of significantly reducing the losses by volatilization, both the in clayey soil as in the sandy in 89 and 47%, respectively, this factor can have contributed with the responses obtained for the agronomical characteristics in this research.

Conclusions

There was increase in the wheat grains yield when associated the use of the fertilizer in cover with the urease inhibitor NBPT (200 kg ha^{-1} - 90 kg N), in face to the other assessed treatments of cover, conventional urea (200 kg ha^{-1} - 90 kg N) and control treatment. (0 kg N).

The urea with urease inhibitor NBPT provided greater weight of a thousand grains when compared to the conventional urea, being this dependent of the assessed cultivar.

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