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WHEAT RESPONSE TO THE APPLICATION OF ZINC AND BORON

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ABSTRACT

The objective of the present work was to evaluate the response of wheat (*Triticumaestivum*) to the application of zinc and boron. The test was carried out in the experimental field of IPTA, Yjhovy, Paraguay. We used the complete random blocks design with 6 treatments and 4 blocks. The treatments were the application of Zinc (Zn) and Boron (B) in sowing and foliar route; being T1- control without fertilization, T2- basic fertilization with NPS without Zn and B, T3-application of Zn in sowing 5kg ha^{-1}, T4- Zn leaf application 5kg ha^{-1}, T5- B leaf application 0.4kg ha^{-1} and T6- Zn + B leaf application 5kg ha^{-1} + 0,4kg ha^{-1}. The variables evaluated were plant height (PH), spike numbersper plant (SNP), ear length (EL), weight of thousand grain (WTG), yield (Y), hectolitric weight (HW) and Falling number (FN).No statistical differences were observed for the variables plant height, number of spikes per plant, hectolitric weight and falling number.Significant differences were observed for the variables ear length where the T6 obtained the highest average with 7.58 cm. The highest weight of thousand seeds was observed with the T2 that obtained 35,16 g. The best productivity was observed with the T3 which obtained 2496 kg ha^{-1}.

Key words: Wheat, Boron, Zinc, Micronutrients, Leaf Fertilizer.

INTRODUCTION

Wheat (*Triticumaestivum* L.) is one of the most widespread cereals in the world and in Paraguay ranks third among the crops most sown after soybean and maize. Is basically used in the production of flour for bread, biscuits and confectionery (Kohli, Viedma, & Cubilla, 2010). Like most of the crops exploited by the man, the wheat needs fertile soil containing the macro and micronutrients necessary for its growth and development and to obtain good quality grains accompanied by satisfactory yields. Between micronutrients stand out the Boron (B) and Zinc (Zn) which are essential for the growth and reproduction of plants (Melgar *et al*., 2001). The Zn is involved in several enzymatic activities, plays a fundamental role in physiological processes such as photosynthesis, sugar metabolism and hormone biosynthesis. Also acts as a protector of the cell membrane structure against oxidative and abiotic stress (Arrom, Lara y Fernández; 2014). Boron (B) is a nutrient that fulfills several roles such as; with the calcium intervenes in the cellular wall, giving greater rigidity to the tissues; together with potassium and magnesium completes the trio of the sugar route, is fundamental for the potting, since it favors the pollen tube, especially in those grains that are at the ends of the spikes (Pich *et al.* 2015).

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Wheat plants show greater absorption of B in the application of the stalk stage or flag leaf, comparing basal or planting fertilization (Pich *et al*, 2015). Considering all the above, the objetive of this study was to evaluated the response of wheat to the aplication of B and Zn in different stages of development.

MATERIAL AND METHODS

The experiment was conducted in the experimental field of Agricultural Research Center, in the 2016 cropping year, dependent on the Instituto Paraguayo de Tecnologia Agropecuarialocated in Yjhovy, Canindeyú department, whose geographical coordinates are: 24 ° 16'20.80 "S and 55 ° 1 '4.17' O. The soil type corresponds to the order Oxisol, subgroup Rhodic and large group Kandiudox. The climate is subtropical humid, with average annual rainfall of 1800 mm, the average annual temperature is of 21.5 ºC(Achan, 1999).The soil was characterized by chemical and physical analysis, the layer of 0 to 10 and 11 to 20 cm of depth being vertically sampled, physically 6% sand, 4% silt and 89% clay by the Boyoucos decimeter method. The experimental area was under the no-tillage system since 2011, under the succession oats/corn/oats/soybean. The soil acidity was corrected with application of 1.5 $tonne^{-1}$ of dolomitic limestone 30 days before sowing. The experimental design used was the complete randomized block with 6 treatments and 4 blocks.

The treatments wereT1 control without fertilization, T2 basic fertilization with NPS without Zn and B, T3 application of Zn in sowing 5kg ha^{-1}, T4 Zn leaf application 5kg ha^{-1}, T5 B leaf application 0.4kg ha^{-1} and T6 Zn + B leaf application 5kg ha^{-1} + 0,4kg ha^{-1}.The wheat variety used was the COODETEC-150. Sowing was done manually, after marking the groove with a motorized seeder for the rows separated from each other at 20 cm, at a distance of 5 cm between plants, totaling 6 rows of 5 meters in each experimental unit. The variables evaluated were plant height (PH), spike numbers / plant (SP), ear length / plant (EP), 1000 grain weight (TGW), yield (Y), hectolitric weight (HW) and Falling number (FN).Plant height was evaluated at the time of harvest, where it was measured from the soil surface to the apex of the plant using a graduated ruler and averaging ten plants of the useful area. The corresponding count was performed manually to determine the number of spike of 10 plants randomly from each experimental unit, which were averaged to obtain a result of the total.

The length of the spike was determined by measuring 10 spikes of the useful plot and then averaged to obtain the length per plant of each treatment. The weight analyzes of the hectoliter, was measured by the Dalle Molle apparatus, according to the method described by manufacturer, the results being standardized for13% moisture, by calculating loss / gain of humidity described by PUZZI. The falling number was obtained by measuring the ability of the alpha-amylase enzyme to liquefy a starch gel, the time (in seconds) required of the mixture being made to allow the agitator to drop to a distance ¯ x, (a) at a constant temperature of 100 ° C (AACC, 1995).To obtain the yield, grains of the useful area of each experimental unit were harvested and then weighed with a precision balance and the result was converted to kg ha^{-1}.The determination of the weight of 1000 grains was performed according to methodology described in Rules for Seed Analysis (Brasil, 2009) where eight samples containing 100 seeds of each repetition were weighed with analytical balance precision and then calculate the average weight of thousand grains. The effects of treatments were compared by the F test and then analyzed through the comparison of means by the Tukey test at a nominal value of 5%. The analysis of variance and test of means were performed according to the usual techniques of SISVAR 5.3 software (Ferreira, 2011).

RESULTS AND DISCUSSION

In relation to plant height of wheat, no significant differences were observed ($p > 0,05$) with an average height of 64,63 cm (Table 1). This result can be explained considering that Codetec 150 is considered as determined growth to avoid tumbling. Although Arrom, Lara and Fernández (2014) have mentioned that Zinc (Zn) is one of the essential micronutrients necessary for plant growth, in this test both Zn and Boron did not show positive results regarding this evaluated variable.

With respect to spike numbers per plants (SNP), no significant differences were observed ($p > 0,05$) between treatments (Table 1). In absolute terms, T2 obtained the largest number of spike per plants with 1,72 units. For the variable ear length significant differences were observed between treatments ($p < 0,05$) (Table 1) where the T6(Zn + B leaf application) obtained the longest with 7,58 cm although it was not different with the T2, T3, T4 and T5.

Table 1. Media of plant height (PH), spike numbers per plant (SNP), ear length (EL), weight of thousand grain (WTG) of wheat in Yjhovy, Canindeyú, in the harvest of 2016

Treatments	PH(cm)	SNP	EL(cm)	WTG(g)
T1- Control	63,43	1,40	6,43b	31,81b
T2- Basic fertilization with NPS	64,08	1,72	7,33 a	35,16a
T3- Application of Zn in sowing	65,75	1,57	7,23 a	33,84ab
T4- Zn leaf application	64,72	1,47	7,18 a	34.00ab
T5- B leaf application	66,20	1,40	7,30 a	34,21ab
T6- Zn + B leaf application	63,60	1,50	7,58 a	34,46ab
Average	64,63	1,51	7,19	33,91
F value	0,46 ns	0,81 ns	6,46 *	3,28*
CV (%)	5,20	18,07	4,67	3,26

Means followed by at least one lowercase letter in the column do not differ from each other by theTukey test (p≤0.05).

Table 2.Media of yield, hectolitric weight (HW), falling number (FN) of wheat in Yjhovy, Canindeyú, in the harvest of 2016

Treatments	Yield (kg $há^{-1}$)	HW(g)	FN
T1- Control	1639,84b	76,85	509,00
T2- Basic fertilization with NPS	2315,62 ab	76,13	566,50
T3- Application of Zn in sowing	2496,10 a	76,83	552,50
T4- Zn leaf application	2408,60 a	77,50	538,75
T5- B leaf application	2421,87 a	77,23	584,50
T6- Zn + B leaf application	2053,12ab	76,53	543,00
Average	2222,52	76,85	549,04
F value	4,07	1,05 ns	2,73ns
CV (%)	14,46	1,23	5,7

Means followed by at least one lowercase letter in the column do not differ from each other by the Tukey test (p≤0.05).

For the weight of thousand grain it was observed statistical differences between treatments ($p<0,05$). The treatment T2 in which it was fertilized only with NPK obtained the greater weight (Table 1). Similarly, Moreto & Moraisin a work with fertilizers did not observe differences between treatments in relation to the mass of a thousand grains. However, Fungueto (2006) when using zinc in rice seeds, obtained a increase in grain weight by 101.5% when compared to the control. Lopes (1999) reported that the fact that the plant is well nourished in the reproductive phase may favor the reduction of the fruit glue, that is, the better nutritional balance will be the plant's ability to maintain its potential. production and increase the number of grains, which, consequently, can influence the total weight of grains. The best productivity was observed with the T3 (Application of Zn in sowing) which obtained 2496 kg ha^{-1} (Table 2) although no statistical differences were observed with the treatments T2, T4, T5 and T6.The worst yield was the T1 (control) with 1639,84kg $há^{-1}$. A similar result was reported by Karim *et al*. (2012), who found that foliar application of Zn increased wheat grain yield as well as raising grain Zn concentration under drought. The increasing grain yield and grain Zn concentration was due to the plant obtaining more Zn through the soil or leaf.Dongyun *et al*., (2017) observed that the foliar Zn application significantly increased the wheat yield and Ohse *et al* (2000) state, Zinc is responsible for plant growth and yield. The hectolitric weight presented no significant differences ($p > 0,05$) between the treatments (Table 2). Vasquez (2006) says that the hectoliter weight is the parameter that the agricultural producer knows best. It is defined as the weight in kilograms of a volume of grain of 100 liters. It is a very useful value because it summarizes in a single value how healthy the grain is. The hectoliter weight is a good estimate of both the physical quality of the grain and the mill quality. With regard to falling number no significant differences were observed between treatments (p > 0,05) (Table 2).

The Hagberg-Perten Falling Number test is used to measure damage to starch in flour (Perten 1964). Low falling numbers result from high levels of the enzyme alpha-amylase (Perten 1964; Kruger and Tipples 1980; Yu *et al*. 2015). Alpha amylase catalyzes cleavage of starch chains. This starch damage leads to poor end-use quality of wheat products including bread, noodles, and cakes (Gooding and Davies 1997). For example, Japanese-style sponge cakes show an increasing tendency to fall with increasing levels of alpha-amylase.

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