Eixo Temático: Inovação e Sustentabilidade

ASSESSMENT OF WHEAT YIELD COMPONENTS WHEN SUBJECTED TO DIFFERENT NITROGEN SOURCES

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ABSTRACT

This study aimed at evaluating the influence of different nitrogen sources on the yield components of wheat when applied at the booting and heading stages of cultivar Quartz - OR seeds. This work was conducted in the city of Frederico Westphalen-RS. The experiment was set in a Randomized Complete Block Design with eight trials and four replications. The trials consisted of combinations of different sources and forms of N application as follows: T1 - Control, T2 – Base fertilization + urea, T3 - Base fertilization + ammonium nitrate, T4 - Base fertilization + urea + foliar nitrogen, T5 - Base fertilization + ammonium nitrate + foliar nitrogen, T6 - Base fertilization + foliar nitrogen, T7 - Base fertilization + urea + ammonium nitrate and T8 - Base fertilization + ammonium nitrate + urea. In conclusion, the application of N via ammonium nitrate along with foliar supplementation resulted in a yield increase of 51.5% compared to the control. Other yield components also obtained means with significant magnitudes verified by Duncan test at 5% probability.

Keywords: trials, nitrogen, yield, increase, replications.

1 INTRODUCTION

Wheat (Triticum aestivum L.) is an annual grass widely grown around the world, with great significance on the global economy. Currently, wheat ranks second in the world cereal cultivation, behind corn and in the third place occupied by rice. In Brazil, it is grown in the South, Southeast and Midwest, highlighting the South Region as responsible for 94% of national production (Conab, 2012).

The arrival of wheat in Brazil dates back to the colonial period. Even in the 16th century, the Portuguese who came to Brazil tried to cultivate this cereal grass, in the middle of the country, as an initiative to plant wheat in the Hereditary Captaincy of São Vicente, which today corresponds to the state of São Paulo. Afterwards, wheat migrated south, finding the environment, climate and soil best suited to its requirements.

The settlement of the crop just happened many decades later, around 1960, with the support policy for wheat cultivation and wheat milling. Research from Embrapa Wheat, located in Passo Fundo, in October 1974, played a key role in the development of the crop. Earlier, Embrapa Wheat, sought to create varieties adapted to the climate and soil of Southern Brazil. Later, it focused efforts on increasing productivity. The advances, based on the use of best technologies, enabled productivity to increase from 700 kilograms per hectare (kg ha^{-1}) up to more than 1,700 kg ha^{-1}. This increase, in a period of time short enough considered by experts, is one of the most significant in the world. The potential yield exceeded 5000 kg ha^{-1} and in experimental fields it has already reached 8000 kg ha^{-1} (ROZA, 2009).

According to Biudes and Camargo (2009), this increase is mainly due to genetic improvement, which combined with modern cultural practices has provided major advances to the wheat crop in Brazil. The achievement of cultivars with agronomic traits of interest that result in greater stability and adaptability to different growing conditions, provided significant increase outcomes in grain production.

On the other hand, with the genetic improvement of the species, emerged needs for a more careful management to the crop, among other mentionable practices, the reformulation in the management of nitrogen topdressing as a major contributor, along with genetics, for the increased production of Wheat in Brazil.

Currently, the per capita consumption of wheat in Brazil is around 60 Kg which gives us an idea of how important this cereal is, not only for the country's economy, but also as an important source of food for the population (EMBRAPA, 2011).

As for the crop fertilization management, according to Rosa Filho, (1977-2007), the availability of nitrogen in the plant during the grain filling period is directly related to the percentage of protein in the grain. Nitrogen is one of the nutrients most required by the wheat and, in most cases, is not supplied in sufficient amounts, nor at the ideal time to ensure yield and quality of the final product. Preliminary results of research in the area indicate that there are many ways to manage the quality of this material in the field, one of them is nitrogen fractional topdressing, combined to the practice of foliar fertilization. According to Rose Filho (1977-2007), a large proportion of nitrogen used by the plant in protein synthesis is absorbed before flowering, and the amount of this nutrient stored in tissues will define the protein content in the grains.

This study aimed at evaluating the influence of nitrogen in different sources on yield components of the wheat crop when applied at stages of booting and heading of the cultivar Quartz - OR seeds.

2 MATERIAL AND METHODS

2.1 CHARACTERIZATION OF EXPERIMENTAL AREA

The work was conducted in the experimental area of the Federal University of Santa Maria, Campus Frederico Westphalen-RS located in the geographical coordinates 27º37'87 "(S) and 53º21'07" (W) with an approximate altitude of 464m. The county of Frederick Westphalen, belongs to Wheat growing Region 2, characterized by being moderately hot, humid and low (EMBRAPA, 2009). By KÖEPPEN classification, the regional climate is Cfa – rainy temperate, with high annual rainfall and well distributed throughout the year, whose annual average is around 1800mm, and subtropical in terms of temperature (MORENO , 1961). In the region, predominate clay, well drained and deep to very deep soils, classified as Oxisold Dystrophic tipic. The area used in the experiment was in fallow. Thus, there was total weed desiccation, 10 days before the onset of crop, with the *Glyphosate* herbicide at a dosage of 715 g ai ha^{-1}, one more application of wheat-selective *Metsulfuron- methyl* herbicide at a dosage of 3.6 g ai ha^{-1}.

For the implantation of the crop, soil sampling of the experimental area was performed and subjected to chemical analysis, procedure performed a month before the sowing of the wheat, by using a square point shovel, following a specific methodology (Commission, 2004).

The sample was directed to basic analysis at the Soil Laboratory of Integrated Regional University of High Uruguay and Missions, campus Frederico Westphalen/RS and the results are expressed in chart 1.

Chart 1- Soil analysis results carried out in the experimental area on occasion of the trial 1 setup[1]. Frederick Westphalen - RS 2011.

Layer	Clay	O.M.	pH	SMP	P	K	Ca	Mg	H+Al	CEC	Al	V	SatAl
(cm)	-----(%)-----		(H_2O)		-(mg/l)-		------------(Cmolc/l)------------					-----(%)----	
0-20	85	3,2	5,7	6,0	6,3	172	6,4	3,2	5,5	12,1	0,0	70,3	3,6

Source: The authors.

2.2 CROP IMPLANTATION

The preparation of the area was conducted in a conventional sowing system, consisting of deep plowing, followed by two disk harrowing procedures. It was chosen to work with the Wheat cultivar Quartzo, from OR seeds which have the following agronomical and industrial characteristics (Chart 2).

Chart 2 – Agronomic characteristics and industrial quality of the wheat cultivar Quartzo[1]. Passo Fundo – RS, 2012.

AGRONOMICAL TRAITS					**INDUSTRIAL QUALITY**	
Vegetative Habit	**Tillering**	**Plant Height (cm)**	**MSW (mean in g)**	**Cycle (days)**	**Classification**	**Natural Germination on ear**

Intermediate to semi-erect	Medium	85	35	Medium (120)	Bread type (W average of 272), hard red grain	Resistant to mod. resistant

Source: Data obtained from the OR seeds company site. Available at <http// www.orsementes.com.br.>.

Seed treatment was carried out using the insecticide *Imidacloprid*, at a dosage of 0.60 g a.i. kg^{-1} seed, and the fungicide *Triadimenol*, at a dosage of 0.45 g a.i. kg^{-1} seed.

A sowing density of 350 plants per m^2 was utilized, with row spacing of 17 cm and depth of about 3 cm. Sowing was held on June 20th, 2011 by hand with the aid of hoes and a rake developed to demarcate the inter-rows.

The base fertilization recommendation was conducted following specific criteria taking into account the chemical analysis of soil, resulting in 400 kg ha^{-1} NPK in the 05-20-20 formulation (COMMISSION, 2004). Pest monitoring was performed, intervening when necessary, within this context, there were three fungicide applications, at the stages of elongation, booting and grain filling, respectively.

2.3 NITROGEN SOURSES UTILIZED

The following nitrogen sources with their fertilizers were utilized for topdressing fertilization: Amidic - Urea (45% N), nitric - ammonium nitrate (33.5% N) and nitric, amidic and ammoniacal - N32 (32% N), the latter being in liquid formulation and manufactured by Ubyfol® company.

2.4 TRIALS

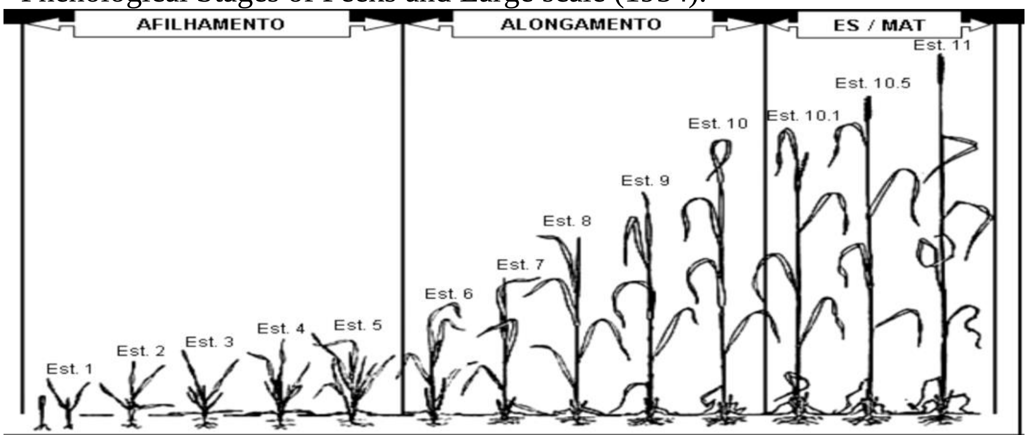
Trials sized to the experiment are as follows: T1 - Control (base fertilization), T2 – base fertilization + topdressing (urea), T3 – base fertilization + topdressing (ammonium nitrate), T4 – base fertilization + topdressing (urea) + coverage (foliar nitrogen), T5 – base fertilization + topdressing (ammonium nitrate) + coverage (foliar nitrogen), T6 - base fertilization + coverage (foliar nitrogen), T7 - base fertilization + coverage (urea) + coverage (ammonium nitrate) and T8 - base fertilization + coverage (ammonium nitrate) + coverage (urea) . The topdressing applications of nitrogen were conducted following the phenological scale of Feeks and Large (Figure 1) at the stage 9 with only one application, and at the stage 10.1 with two applications, this phenological numeration corresponds respectively to the pre-booting stage (ligule of the last leaf is visible), and early heading stage (the first newly visible ears).

These practices were carried out based on the recommendations given to regional wheat growers (COODETC, 2010). Importantly, the amount of total nitrogen used for each trial was calculated so that all trials received the same dosage of this nutrient (100 $Kg.ha^{-1}$), except for the control which received no topdressing application, only at the time of sowing with base fertilization.

2.5 EVALUATIONS

The assessments aimed at quantifying the major yield components of wheat crop. The components evaluated were: yield, number of tillers per plant, number of spikes per square meter and one-thousand-kernel mass. In order to determine the number of tillers 10 plants were used per plot, chosen randomly at the tillering stage, according to the phenological scale of Large and Feeks (1954) (Figure 1).

Figure 1 - Phenological Stages of Feeks and Large scale (1954).



Source: Feeks e Large (1954).

The component number of spikes per square meter was obtained by counting the number of spikes on each of two sampling sites (0.25 m²), and subsequently extrapolated to square meter. The thousand-kernel mass was obtained by weighing eight sub-samples of one hundred grains, and extrapolated to thousand-kernel mass, which was followed by specific methodology (BRAZIL, 2009).

The hectoliter mass was calculated through the mass related to the volume of 100 liters of wheat, obtained by specific scale. For grain yield evaluation, it was collected manually two-0.25 m² sites (0.5 m x 0.5 m), totaling 0.5 m², chosen at random, for each one of the plots. Manual threshing of samples was performed with posteriorly weighing through electronic scale. Moisture content was determined with subsequently correction to 13%.

The plot mean production was determined through the grain yield average obtained from the two sites collected per plot.

2.6 EXPERIMENTAL DESIGN

The plots were scaled so that each totalized eight square meters (4 x 2). For purposes of evaluations, it was discarded two side lines of the plot and initial 30 cm at the ends of each line in order to reduce the effect of border strips so that each plot had an usable area of 5, 64 m².

The experiment was set in a Randomized Complete Block Design (RCB), with four replications for each trial. The trials were randomized and are presented in annex 1. The results were subjected to analysis of variance by F test. Afterwards, mean comparisons for the factor fertilization source was carried out by Duncan test at the 5% level.

3 RESULTS AND DISCUSSION

The analysis of variance showed a significant effect on the comparison of trials for the variables thousand-kernel mass, productivity (kg ha-1), hectoliter mass, spikes/m² and number of tillers per plant. The results are shown in Tables 1 and 2.

Table 1 – The mean results for the variables 1000-kernel mass (TKM), productivity (PROD) and hectoliter mass (HLM), Frederico Westphalen – RS, 2012.

Trial	TKM(g)	PROD (Kg ha^{-1})	HLM
Control	30,45 c*	3178,80 d	70,55 c
BF + Ur	33,10 bc	64,34 cd	76,05 b
BF + AN	33,78 ab	3860,40 cd	78,30 ab
BF + Ur + FN**	35,37 ab	4738,80 b	78,15 ab
BF + NA + FN**	37,40 a	6172,20 a	74,09 bc
BF + FN	32,34 bc	3620,40 cd	77,98 ab
BF + Ur + AN	36,04 a	5239,80 b	79,09 a
BF + AN + Ur	36,79 a	5758,80 ab	80,69 a
CV (%)	3,32	15,08	3,97

* Means followed by the same letter in the column do not differ statistically by Duncan test at 5% probability. ** BF: base fertilization. Ur: urea. FN: foliar nitrogen. AN: ammonium nitrate. Source: The authors.

There were no significant differences for the variable thousand-kernel mass among trials, where trials (base fertilization + ammonium nitrate + foliar nitrogen), (base fertilization + urea + ammonium nitrate) and base fertilization + ammonium nitrate + urea) showed superiority over the others as for the estimated character. This is one of the yield components which is directly related to the final crop yield (BREDEMEIER et al. 2001).

Nitrogen is the nutrient that most burdens the cost of production of winter cereal crops. However, application management of base and topdressing fertilization are determinant factors for crop yield, so it is interesting to adopt management practices that provide greater N uptake from the soil and, consequently, greater allocation of the nutrient to the grains (SCHUCH et al., 2000).

Regarding productivity in Kgha^{-1}, trials (base fertilization + ammonium nitrate + foliar nitrogen) and (base fertilization + ammonium nitrate + urea) showed themselves superior to others. Since the trials were effective in demonstrating significant differences for the variable. According to Zagonel et al (2002), nitrogen is the main nutrient required by grasses, immediately providing a yield increase. Its deficiency results in small plants, slow development, fewer tillers and lower productivity, this feature is noticed in trials, where the use of ammonium nitrate plus foliar fertilization provided yield increases, possibly the nitrogen required by the plant was being made available in a gradually manner as the plant grew.

Yet, according to Rosa Filho (1977-2007), it was noticed a clear response in the 1000-kernel mass (TKM), from 30,6g to values over 34g, when N was topdressed at the heading stage. Consequently, a higher yield in Kgha^{-1} was deduced due to the increased TKM.

Wheat is an important crop in Southern Brazil and especially in Rio Grande do Su state, and every year finds difficulties, both in the commercial sector and changes in weather conditions. In years with ideal environmental conditions the crop is profitable for most growers. Producers need, beyond productivity that guarantees the crop profitability, to pay attention to the quality of wheat grain. This factor can be observed in part by the hectoliter mass or HLM, as noted by comparing the trials there was no significant magnitudes, occurring superiority for the trials four and eight, however, these values are still below the ideal indexes and more remunerative of the market.

An important feature that may be considered is that the best response in productivity is not bound to the trial with the higher HLM, such circumstance regarding Mallmann et al., (1994), is that grains with smaller size provide better fit in the scale cylinder, avoiding empty spaces and causing greater agglutination at the time of checking the hectoliter mass of grains. Frizzone et al (1996) observed reduction in hectoliter mass with increasing nitrogen fertilization, which may be attributed to the greater competition between grains over photoassimilates, since the increase in nitrogen dosage raised the number of grains per unit area.

In relation to the variable number of spikes per square meter there were significant magnitudes in the comparison of means. Trials five, seven and eight showed themselves superior concerning the character assessed. Trials one, two and three obtained the lowest expression for the number of tillers. The low number of spikes in these trials is possibly related to the availability of nitrogen, trial one received only base fertilization, supposing that in the grain filling stage the plant came to suffer from nutrient deficiency. Another important comparison is that regardless of the source urea or ammonium nitrate, the crop response followed the same parameter for variable number of spikes per square meter (RODRIGUES et al., 2002).

Table 2 – Mean results of trials for the variables number of spikes per square meter (SN) and number of tillers per plant (TP), Frederico Westphalen – RS, 2012.

Trials	**SN**	**TP**
Control	350,5 e*	2,04 b
BF + Ur	430,5 de	3,40 ab
BF + AN	490,06 de	3,50 ab
BF + Ur + FN**	541,5 cd	3,55 ab
BF + NA + FN**	690,34 a	4,07 a
BF + FN	570,76 bc	3,90 ab
BF + Ur + AN	668,54 a	4,10 a
BF + AN + Ur	680, 02 a	4,02 a
CV (%)	19,87	15,98 a

* Means followed by the same letter in the column do not differ statistically by Duncan test at 5% probability. ** BF: base fertilization. Ur: urea. FN: foliar nitrogen. AN: ammonium nitrate. Source: The authors.

The number of tillers per plant is an important variable that relates indirectly to the yield, particularly if the majority of tillers remain fertile. An important feature to note is that the splitting of nitrogen is directly related to the number of tillers per plant, because the development of these first vegetative structures and later reproductive, require larger amounts of plant nutrients, and once the availability is adequate the growth and development contributes to the grain yield increase, but under low availability of nutrients the plants only develop the vegetative stages of tillers, drawing the plant's energy, when there is lack of this nutrient for the growth of the spike the plant ends up performing the abortion of these structures and redistributing nutrients mainly for growing and developing the mother plant's spike, this in turn being the main source of energy demand by the plant.

Valerius et al. (2009), by concluding their work argue that the best performance in productivity is achieved in the selection for reduced number of tillers, in the condition of, also considering a high grain mass, however, is common to find differences on the character number of fertile tillers. Dofing and Karlsson (1993 *apud* SILVA, 2010), reported that single-stem lines showed rapid development of leaves and earlier maturation than conventional tillering lines. On the other hand, single-stem lines require high sowing density to express great yield of grains. Nevertheless, Common and Klinck (1981 apud SILVEIRA, 2010), claim that the single-stem phenotype would be limited while the ideal one would be a phenotype with a main stem and two or three tillers.

In this context, it is suggested further study of the identification of effective strategies to know, based on the tillering pattern of each cultivar, the techniques that provide increased grain yield, because the number of grains and the average weight are strongly determined through wheat genetics, the number of fertile tillers is the most strongly influenced character by environmental changes, and therefore the adjustment of management techniques in cultivars of small and high tillering pattern will be crucial to raise the grain yield character.

The results expressed in this paper show that trials with higher tillering, T5 (base fertilizer + ammonium nitrate + foliar nitrogen), T7 (base fertilizer + urea + ammonium nitrate) and T8 (base fertilizer + ammonium nitrate + urea) also express higher significance for yield, which leads to an indirect relationship among these characters, which possibly higher magnitude of yield of these trials can be explained by the greater tillering of these plants, having a positive contribution for the expression of these characters.

According to Sangoi et al (2008), the availability of N at the beginning of the cycle is important so that primary tillers are not omitted, which was observed in wheat. Therefore, the lack of N during the cycle reduces the number of tillers per unit area emitted, which reflects on the reduction of grain yield by the crop.

4 CONCLUSION

The N via ammonium nitrate plus foliar supplementation implies on yield increase of 51.5% compared to the control.

For the factor thousand-kernel mass is expressed superiority when this sources are used: ammonium nitrate + foliar fertilizer; urea + ammonium nitrate and ammonium nitrate + urea, respectively.

The HLM component is observed supremacy in two trials: when it is used urea + ammonium nitrate, and ammonium nitrate + urea.

For the variables number of spikes/m² and tillers per plant there is superiority over others when using: ammonium nitrate + foliar fertilization, urea + ammonium nitrate and ammonium nitrate + urea.

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