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BIOMETRY OF THE CULTURE OF WHITE OATS (AVENA SATIVA L.) UNDER DIFFERENT NITROGEN FERTILIZER DOSES

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Abstract: White oats are one of the main winter cereals produced in Brazil due to its multiplicity of purposes (soil cover, animal feed, green manure, human health). Its productivity is related to management technologies, among which nitrogen fertilization stands out. Therefore, the objective was to evaluate the biometric parameters of white oats under different doses of nitrogen. The experiment was carried out in soil classified as Red Latosol in the municipality of Palmeira das Missões, RS. The treatments consisted of five doses of nitrogen (0, 50, 100, 150, 200 Kg/ha-1) in the form of urea applied in coverage at the beginning of tillering distributed in experimental plots of 3.0 m x 4.0 m, in a Latin square design (DQL) with five replications (25 treatments). The biometric parameters of the plant were analyzed: height, number of tillers, growth rate (TC), leaf width, fresh mass production (MFPA) and dry mass of shoots (MSPA). Oats had their performance favored with nitrogen fertilization doses between 100 and 150 Kg/ha-1.
Keywords: Avena sativa L, nitrogen fertilization, nitrogen, biometrics

INTRODUCTION

White oats (Avena sativa L.) are of great importance as a winter crop (MANTAI et al., 2015), being one of the main cereals produced in Brazil (IBGE, 2021). In the 2019 harvest, of the total area cultivated with white oats, Rio Grande do Sul (RS) contributed with 664.7 thousand tons in an area of 271.1 thousand hectares (CONAB, 2020). This fact is due to its multiplicity of purposes.

Oats are used in animal feed in the form of pasture (MAROLLI et al., 2018), hay and silage (MANTAI et al., 2016), it produces an excellent quality of straw for soil cover in a no-tillage system (SCREMIN et al., 2017; MAROLLI et al., 2018; MALANCHEN at al., 2019), in green manuring in succession to the implementation of summer crops (SCREMIN et al., 2017; MALANCHEN at al., 2019) in addition to promoting soil improvements due to the large root densities, as well as contributing to the biological control of invasive species and helping to break the cycle of pests and diseases (MANTAI et al., 2016) and benefit human health, being considered a functional food, due to the presence of β-glucan dietary fiber, with an effect on reducing LDL cholesterol (MANTAI et al., 2016; MALANCHEN at al., 2019).

Oat productivity, in addition to cultivar performance, climatic factors and soil characteristics, is also related to management technologies (SILVA et al., 2011). Among the management technologies, nitrogen fertilization promotes the growth of shoots and roots of the plant, resulting in better productivity (MANTAI et al., 2015; MAROLLI et al., 2018).

Nitrogen fertilization has a direct influence on grain yield (MANTAI et al., 2016; SCREMIN et al., 2017). Research carried out with white oats indicated that nitrogen results in plants with greater height and number of tillers (MANTAI et al., 2016).

Nitrogen is the fundamental nutrient for plant development, exerting a positive influence on grain quality and production (SCREMIN et al., 2017). On the other hand, very high doses provide lodging (MAROLLI et al., 2018), which makes harvesting difficult, increasing losses and resulting in lower productivity (MANTAI et al., 2015; MANTAI et al., 2016). Therefore, handling nitrogen fertilization is extremely important for crops to express their productive potential. Therefore, its use should be well evaluated, aiming at reducing production costs, increasing crop yields and environmental protection (SCREMIN et al., 2017).

Thus, the objective of the present study was to evaluate the biometric parameters of

Avena sativa L cultivated with different doses of nitrogen fertilization.

METHODOLOGY

The experiment was carried out under field conditions, in the city of Palmeira das Missões, RS. The soil is classified as dystrophic Red Latosol (EMBRAPA, 2018) and the climate described by Köppen as Cfa, humid subtropical with abundant and well distributed precipitation throughout the year (ALVARES et al., 2013).

The broadcast sowing system was carried out distributing an amount of around 110 kg of seeds per ha[1]. Basic fertilizer was used for all treatments: 200 kg ha-1 of simple class A organic fertilizer (3% N, 12% P and 12% K) triple superphosphate applied at planting. The coverage of seeds and fertilizer was carried out by a leveling harrow. Forage oat seeds were treated before sowing.

The experimental design used was a Latin square (DQL) with five replications. The treatments consisted of different doses of nitrogen fertilization, as follows: treatment 1 – without nitrogen application, treatment 2 – 50 kg/ha^{-1} of N; treatment 3 – 100 kg/ha^{-1} of N; treatment 4 – 150 kg ha^{-1} of N and treatment 5 – 200 kg/ha^{-1} of N. The N source used was urea (45-00-00). Nitrogen fertilization was carried out at the beginning of tillering (23 days) and the evaluations, from this moment on, were carried out fortnightly. The experimental plots were constituted with the dimensions of 3 m x 4 m. Treatment control was carried out using horizontal blocks (rows) and vertical blocks (columns) with the aim of eliminating influences due to differences in soil fertility in two directions.

The evaluations were carried out in the useful area with dimensions of 1 m x 1 m (1 m2) in the center of the plot. Plant height was measured from the soil surface to the end of the flag leaf of the largest tiller of the plant. With the height data and evaluation time, through the relationship between these variables, the growth rate in cm day-1 was determined.

The number of leaves, leaf width, shoot fresh mass (MFPA) and shoot dry mass (MSPA) were obtained from the average values measured in 10 tillers at random in each plot. The number of leaves was obtained by manual counting, the width of the leaves was measured with a graduated ruler in centimeters. For analysis of the masses, the roots were separated, obtaining the fresh mass, which was then dried in a forced air oven at 65oC for 24 hours and weighed again to obtain the dry mass.

The results obtained were submitted to analysis of variance (ANOVA) and significant ($p < 0.05$), the means were compared by the Tukey Test at 5% probability of error. The statistical program used was StatPlus®.

RESULTS AND DISCUSSION

Plant height, evaluated at the beginning of tillering (23 days) and after 15 days, showed a significant effect ($p=0.0038$). The analysis at 15 days after treatment showed that the groups that received 100kg/ha^{-1} and 200 kg/ha^{-1} of nitrogen fertilization produced significantly larger plants, with an average height of, respectively, 22.4cm (±2.25) and 20.88cm (±3.72) (Table 1).

The seedling growth and tillering phase, between 10 and 29 days after sowing, is paramount in the establishment of the crop, as good management at this stage will ensure an adequate plant stand and good tillering. For this reason, the management of nitrogen fertilization during this period is very important, since nitrogen stimulates the formation of new tillers (LÂNGARO & CARVALHO, 2014). Nitrogen application promotes changes in several morphological characteristics of oats, from leaf size,

Dose (Kg ha⁻¹)	Days after fertilization	
	0	15
0	7,31(±2,02)	9,27 (±2,02) a
50	8,04(±2,02)	15,75 (±2,87) b
100	7,98(±2,02)	22,4 (±2,25) c
150	7,48(±2,02)	18,63 (±3,01) b
200	8,49(±2,02)	20,88 (±3,72) c

Table 1. Mean height values (cm) of the white oat plant (Avena sativa L.) treated with different doses of nitrogen

p= 0,0038, Means followed by different letters, in the column, differ by Tukey's test at 5% significance.

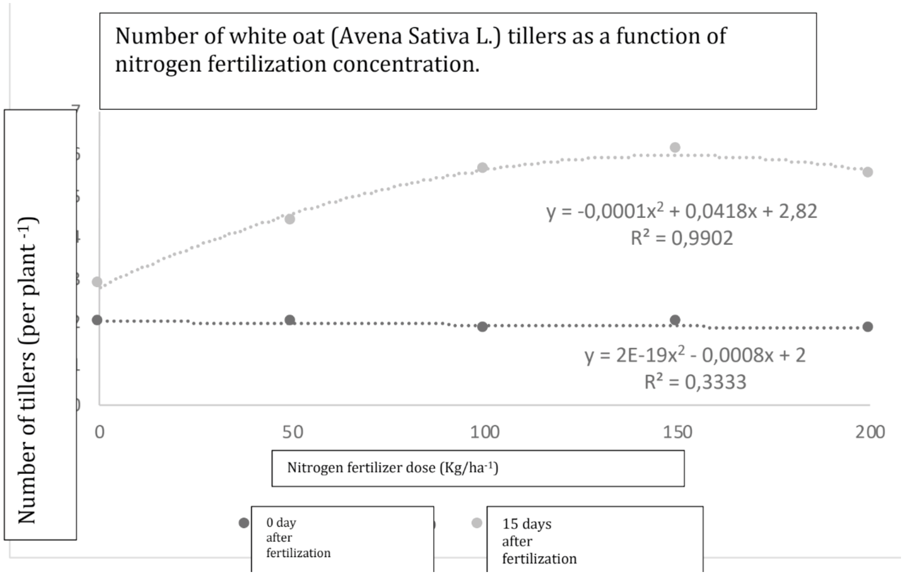

Figure 1. Number of white oat (Avena sativa L.) tillers (per plant-1) as a function of nitrogen fertilization concentration (Kg/ha^{-1}).

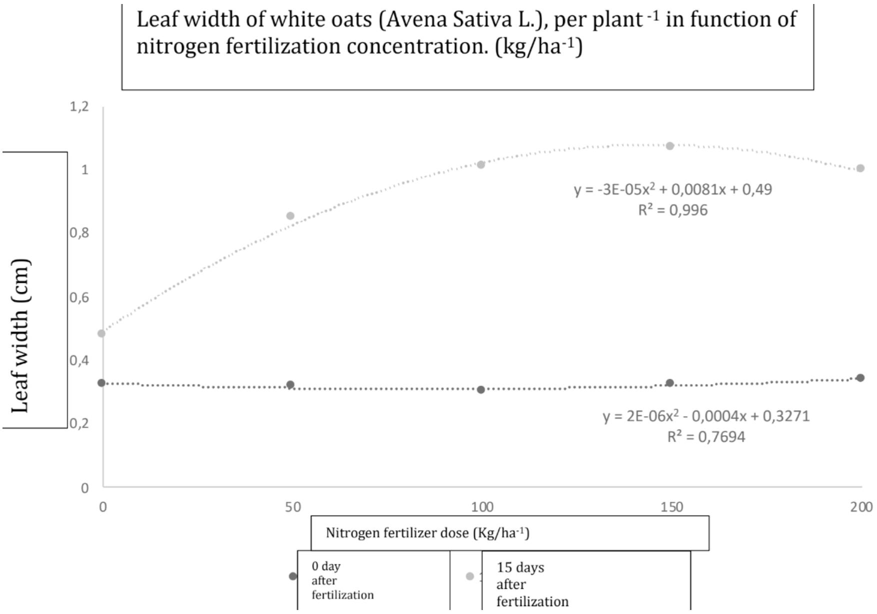

Figure 2. White oat (Avena sativa L.) flag leaf width (per plant-1) as a function of nitrogen fertilization concentration (Kg/ha^{-1}).

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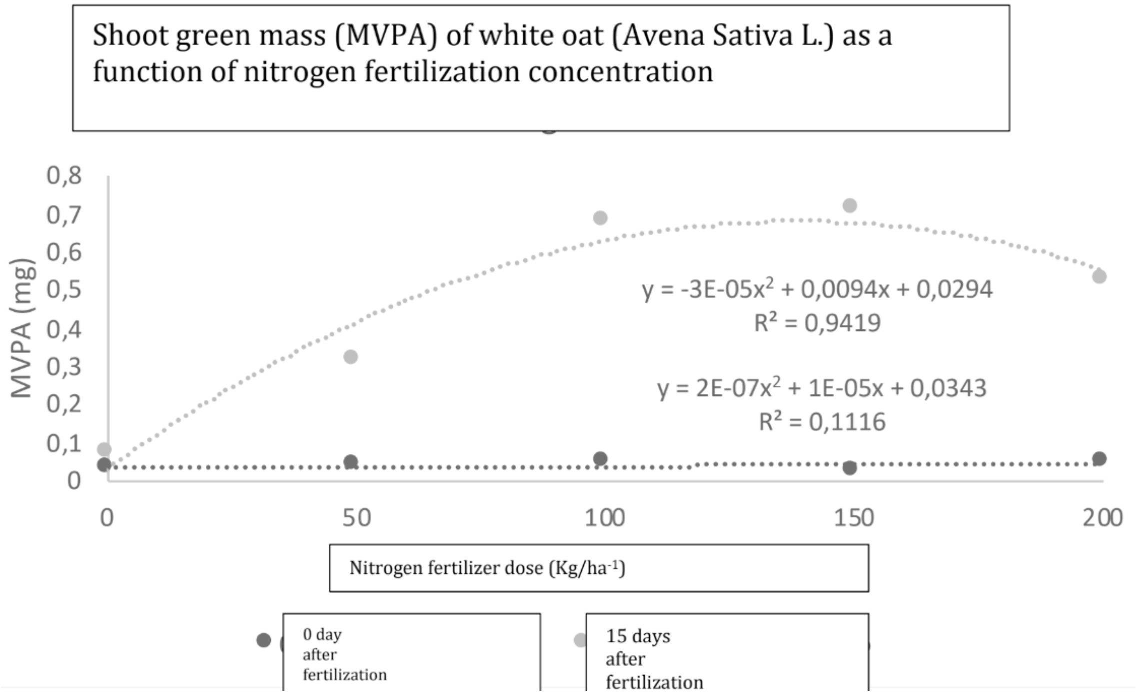

Figure 3. Aerial part green mass production (MVPA) of white oat (Avena sativa L.) (mg) (per plant^{-1}) as a function of nitrogen fertilization concentration (Kg/ha^{-1}).

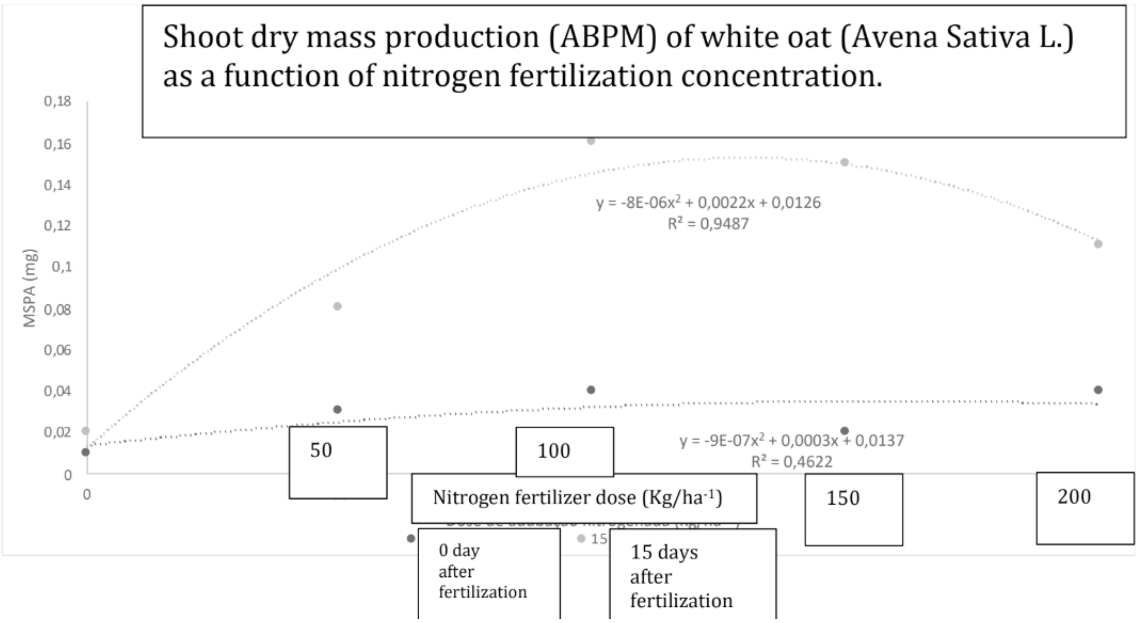

Figure 4. Aerial part dry mass production (MSPA) of white oat (Avena sativa L.) (mg) (per plant^{-1}) as a function of nitrogen fertilization concentration (Kg/ha^{-1}).

appearance of leaves and tillers, and growth rate (MAYER, 2017).

Regarding growth rate, fertilization at a nitrogen concentration of 100Kg/ha^{-1} provided the highest daily increment, going from an average of 0.34 cm day1, in the group without nitrogen, to 0.59 cm day-1, that is, an increase of 73.53%. Data similar to this one, demonstrated that the installment of the dose of 120 kg ha^{-1} of nitrogen did not result in a productive difference, being feasible the application in a single dose (HASELBAUER et al., 2019), which reduces an application with the tractor, amortizing machine traffic costs in the area.

For oats, the favorable climate is milder temperatures and radiation quality that favors tillering and grain filling, without a large amount and intensity of rainfall, but in sufficient volume to favor an adequate supply of moisture in the soil (MAROLLI et al, 2018). Weather conditions were unfavorable up to 28 days after sowing, when there was a period of water deficit. The water deficit in the soil is also decisive in hampering the processes involved in plant nutrition, showing that grain productivity due to the greater efficiency of nitrogen use can be considerably increased with adequate soil moisture (MANTAI et al., 2015).

Regarding plant biometry, the highest number of tillers was observed in treatments with fertilization at doses of 150 Kg/ha^{-1}, with Maximum Technical Efficiency (MET) at this dose, as shown below (Figure 1). The analysis of these data is extremely important, since the greater the number of tillers considered mature, the greater the survival capacity and dry matter production, since they can increase the height of the plant, elongating and making them competitive in conditions of shading (MAYER, 2017).

The leaf is an important organ for plants, it contains the organelles related to energy production (chloroplasts), it is where photosynthesis occurs. The application of nitrogen promotes changes in the morphology of the forage, among which are the growth rate, appearance of leaves and tillers and leaf size (MAYER, 2017).

As for the width of the flag leaf, 15 days after treatment, it responded better to a nitrogen fertilizer dose of 150 Kg/ha^{-1} (Figure 2).

Unlike legumes, oats do not have the capacity to add nitrogen to the soil, but it can prevent a lot of soil nitrogen from being lost, absorbing it and immobilizing it in its biomass, adding its productive response (MELGAREJO et al., 2011). By adding nitrogen in high doses and in coverage, this absorption capacity is increased (MELGAREJO et al., 2011), with subsequent productive response (SANDINI et al., 2011).

On the other hand, the efficiency of nitrogen use is inversely proportional to the doses used, that is, at lower doses of nitrogen the effect of its use is greater. However, this may result in the use of the stock of this mineral present in the soil, which may compromise its fertility in the medium term (SHARMA & BALI, 2018) especially if the biomass produced is removed from the cultivation area. This lower efficiency in the use of nitrogen in treatments with a higher volume of N per hectare is related to the capacity of N absorption by the plant, and in general only 50% of the N of nitrogen fertilizers is absorbed by the plants (CANTARELLA and MONTEZANO, 2010).

Regarding the white oat biomass, the doses of nitrogen fertilization between 100 and 150Kg/ha^{-1} showed higher production of green mass of shoots (MVPA) and nitrogen fertilization doses greater than 150Kg/ha^{-1} were accompanied by a decrease in MVPA (Figure 3). These results are positive because with higher doses of nitrogen fertilization comes an increase in production costs (BARRACLOUGH et al., 2010), in addition to environmental damage, due to nitrate leaching or ammonia volatilization and economic losses by farmers (COSTA et al., 2013).

Another important parameter to determine the amount of forage for soil cover is the Dry Mass of Aerial Part (MSPA). In this experiment, the doses that most produced straw were 100Kg/ha^{-1} and 150 kg ha^{-1} (Figure 4) Other research has shown greater DM production at levels of 120 e 180 kg ha^{-1} of nitrogen (HASELBAUER et al., 2019). Corroborating that nitrogen is one of the nutrients that most favors the production of oat dry matter (PRIMAVESI et al., 2002).

CONCLUSIONS

Nitrogen fertilization is efficient to improve biometric parameters of *Avena sativa L.* Plant height showed a significant effect with an intermediate dose of nitrogen fertilization (100kg/ha^{-1}). The dose of 150 Kg/ ha^{-1} was associated with the highest number of tillers per plant. And, the highest MVPA and MSPA production were with 100 and 150Kg/ha^{-1} of N fertilizer. Therefore, aiming at the productivity of oats, whether for coverage or pasture, intermediate doses of nitrogen fertilization are necessary, which, applied in ideal humidity conditions, is economically viable for the farmer and environmentally sustainable.

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