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Evaluation of the development of sorghum (sorghum bicolor l. Moench) due to different fertilizers and plant densities at 60 and 90 days of emergence

https://doi.org/10.56238/alookdevelopv1-057

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ABSTRACT
The culture of sorghum (Sorghum bicolor L. Moench) disseminated throughout the country, has a relevant importance for northeastern agriculture. An alternative to providing an increase in the productive parameters of this forage is the use of organic compounds. Therefore, the objective of this work was to evaluate sorghum production as a function of different plant spacing and fertilization with organic sources. The experimental design was in randomized blocks (DBC) in a 4x2 factorial scheme, four treatments, of these, three are sources of fertilizers (cattle manure, sheep manure, and commercial NPK1010) plus the control, and two sowing densities 10 and 15 plants per linear meter, with four replications. The preparation of the area for implantation was mechanized, and the planting of the black tip sorghum was carried out manually with a spacing of 0.70 m between rows and 1.5 m of length in each plot. After 60 days of sowing, an evaluation of forage development was performed by evaluating the variables: plant height (AP), stem diameter (DC), and number of leaves (NF). And 90 days after emergence, a second growth assessment was performed. The data were submitted for analysis using Tukey's test (P≤0.05) with the aid of SISVAR software. Given the data, we can conclude that, of the variables studied in this study, at 60 days the treatment using sheep manure was denoted to have negatively influenced the number of leaves, however, at 90 days it obtained higher averages, than the other treatments, in plant height and number of leaves in both densities.

Keywords: Fertilization, Density, Forage, Northeast.

1 INTRODUCTION

Sorghum culture (*Sorghum bicolor L.* Moench) disseminated throughout the country, originating in Asia and Africa, has a relevant importance for northeastern agriculture predominating, as a forage support in the semi-arid zone, due to its greater tolerance to water deficiency in the soil, and can be exploited in regions where rainfall varies from 300 – 700 mm annually (FARIAS et al., 1986).

The average productivity of sorghum in Brazil is still considered low, with around 3,128 kg ha^{-1} of grains, according to the IBGE survey in 2010. (RABELO et al., 2012). Among the main factors responsible for this context, we highlight irregular rainfall, soil fertility, low fertilizer applications, and inadequate plant density in sowing (HAMMER and BROAD, 2003).

The application of organic fertilizers to soils provides improvement of their physical, chemical, and biological properties, obtaining good responses from plants. To keep the soil fertile and enable crops to achieve maximum productivity, some practices are necessary, such as the use of organic waste (FINATTO et al., 2013). The use of organic waste from animal husbandry is an alternative for the fertilization of agricultural areas (KOMIYAMA et al., 2013).

According to Holanda (2003), organic fertilization brings benefits such as improvement of the physical conditions of the soil; increased water retention in the soil; reduction of soil losses due to erosion in addition to providing nutrients to plants.

In addition to fertilization, sowing density, and row spacing are paramount to maximize productivity (HAMMER and BROAD, 2003). Dourado-Neto (1999) states that the sowing density used should be based on the support capacity of the medium, the production system adopted, the index and duration of the photosynthetically active leaf area, at the time of sowing, and the adequate spatial distribution of plants in the area, by their genotypic characteristics.

Therefore, the objective of this study was to evaluate sorghum production as a function of different plant spacing and fertilization with organic sources at 60 and 90 days after emergence.

2 MATERIAL AND METHODS

The experiment was conducted in 2018, in the plant production sector belonging to the Instituto Centro de Ensino Tecnológico CENTEC, campus FATEC - Sertão Central, located in Quixeramobim-CE. The climate of the region is characterized as tropical semi-arid, with an average annual rainfall of 750 mm.

The experimental design was in randomized blocks (DBC) in a 4x2 factorial scheme, four treatments, of these, three are sources of fertilizers (cattle manure, sheep manure, and commercial NPK1010) plus the control, and two sowing densities (10 and 15 plants per linear meter), with four replications. The plots had dimensions of 1.5 m2, with 3 kg of fertilizer, where the fertilization was in function of the treatments, being incorporated in the soil, later, the sowing was carried out in the spacing of 0.70 m between rows with density between plants varying according to the proposed spacing.

Initially, the soil was prepared for planting through plowing, soon after the division of the blocks and application of fertilization according to the treatments and sowing with the Ponta Negra sorghum seed. The fertilization dose of the cattle and sheep manure treatments was 40 t/ha, for the NPK1010 treatment the dosage of 430 kg/ha was used, being applied in foundation in the grooves spaced in 0.70 m at a depth of 3 cm, then the sowing was done manually, and the seeds were distributed

in the furrow abundantly. The population adjustment was performed 3 and 25 days after sowing, according to the treatments evaluated by thinning the plants.

During the entire period of the experiment, irrigation was performed manually. After 60 days of emergence, the first forage development evaluation was performed, evaluating the variables: plant height (AP), stem diameter (DC), and number of leaves (NF). Subsequently, 90 days after emergence, the second forage development evaluation was performed. The data obtained were expressed in centimeters (cm) and submitted to analysis of variance, and the means were compared with each other by Tukey's test at 5% probability.

3 RESULTS AND DISCUSSION

3.1 ASSESSMENT AT 60 DAYS OF EMERGENCY

In the first evaluation of forage development, no significant difference (P>0.05) was observed between the densities of plants that were used (Table 1). A result was also found in the work of Berenguer and Faci (2004), studying the effect of the density of sorghum plants, where the authors did not find significant differences between the densities. However, they point out that the highest productivity was found in the treatment of higher plant density.

Table 1 - Plant height (AP), stem diameter (DC), and number of leaves (NF) as a function of different fertilizers and plant densities at 60 days of emergence.

Treatments	Number of Plants					
	10 Floors			15 Floors		
	AP	DC	NF	AP	DC	NF
Cattle Manure	136,05a	13,4a	6,6from	138,4a	12,1a	6,6from
Esterco Ovino	131,13a	13,5a	7,1a	146,9a	13a	6,3c
NPK	129,4a	13,2a	6.3from	145,7a	13,9a	6.8from
Witness	138,8a	13,1a	6,1c	153a	13,4a	7,3a

For the variables plant height and stem diameter, there was no significant difference between the fertilizers used in the densities of 10 leaves per linear meter. The control treatment obtained the lowest mean value for the number of leaves.

For the variable plant height within the density of 15 planes there was no significant difference, but in the variables stem diameter and number of leaves, there were significant differences, especially in the NPK and control treatments. Denoting that the sheep manure fertilizer was the one that provided the least development of the number of leaves.

Oliveira et al. (1995), point out that although there is no difference between the treatments, organic fertilization is important for the maintenance of soil quality and for the development of the crop.

The use of organic matter in the soil as a source of nutrients for plants has positive aspects on the quality of the harvested product, and of the soil, since its incorporation, especially manure is a viable practice in increasing productivity (NORONHA, 2000).

3.2 ASSESSMENT AT 90 DAYS OF EMERGENCY

In the second evaluation of forage development, there was also no significant difference at the level of (P>0.05) probability in the densities used (Table 2). Similar results were found by Emygdio et al, (2011), evaluating the sowing densities of 120 thousand, 140 thousand, and 160 thousand plants/ha, where the statistical analysis did not reveal significant differences between the cultivars and among the different populations of plants of the same cultivar for the variables plant height and stem diameter.

Table 2 - Plant height (AP), stem diameter (DC), and number of leaves (NF) as a function of different plant densities and fertilization at 90 days of emergence.

Treatments	Number of Plants					
	10 Floors			15 Floors		
	AP	DC	NF	AP	DC	NF
Cattle Manure	135,95c	12,9a	9.2from	145,45c	12,1a	8,6a
Esterco Ovino	154,80a	13,7a	9,5a	162,95a	12,5a	8,3a
NPK	143,15from	13,1a	8,5from	152from	12,5a	9,0a
Witness	147,85from	12,4a	7,8c	150,43from	11,9a	8,5a

The variables plant height and number of leaves in the treatment with sheep manure obtained the best means in both densities. Having as worst average in plant height the treatment with cattle manure. As for the variable stem diameter, no significant results were obtained between densities and fertilization.

The stem diameter found in this study ranged from 11.9 mm to 12.4 mm, where these results corroborate those observed by Mateus et al. (2011), who worked evaluating the cultivation of single and intercropped grain sorghum with pastures submitted to different forms of nitrogen fertilization, where they obtained mean stem diameter ranging from 11.4 mm to 12.9 mm.

The development of the sorghum crop to achieve high yields depends on the realization of the fertilization in an adequate way, to provide the availability of nutrients in periods of development of the plant of greater nutritional demand.

4 CONCLUSIONS

Therefore, it is concluded that, of the variables studied in this study, at 60 days the treatment using sheep manure was denoted to have negatively influenced the number of leaves, however, at 90 days it obtained higher averages, than the other treatments, in plant height and number of leaves in both densities.

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