VETERINÁRIA NOTÍCIAS

Article

Sorghum culture initial establishment based on sowing machines working speed and furrowing mechanisms

Received: sep 2020; Accepted: oct 2020

Flávio Coutinho Longui[1*], *Daniel Mariano Leite*[2], *Amanda Magalhães Lêdo de Oliveira*[1], *Camila Jesus de Moraes*[1], *Leonardo Bastos Santos*[1], *Vitor Hugo Borges Souza*[1]

Abstract: The main goal of this article was to evaluate, at field conditions, the performance of a seeder-fertilizer in the initial establishment and the sorghum culture productivity according to tractor working speed and seed deposition depth. This study was conducted at the Experimental Farm in São Gonçalo dos Campos, located in the municipality of São Gonçalo dos Campos, BA, which belongs to the Veterinarian Medicine and Animal Science School of the Federal University of Bahia - UFBA. It was adopted factorial scheme methodology 3x3 in CDR (Completely Randomized Design) or Dic (Delineamento Inteiramente Casualizado) in Portuguese, with 36 experimental unities with three displacement speed (4, 6, and 8 km h-1), and three sowing deposition depths (0.01, 0.03 and 0.05 m). The real seed deposition, the Plant Height at 30, 60, and 90 days, as well as the productivity per m2 after 90 days, were assessed. The working speed did not influence (P> 0.05) the evaluated parameters. The sowing depth did not change (P> 0.05) the crop productivity; however, it did influence the actual seeds deposition and the plants height on the first two cuts. Sowing at speeds from 4 to 8 km h-1 and planting from 0.01 to 0.05 m depths do not influence the sorghum crop productivity. Thus, it is recommended to carry out planting at a speed of 8 km h-1 with a depth of 0.05 m.
Keywords: pasture formation, plant spacing, agricultural mechanization.

Introduction

Due to its rusticity, sorghum stands out in arid and semi-arid regions, achieving good biomass productivity and showing tolerance to water deficit (TOLENTINO et al., 2016). The Brazilian sorghum production practically doubled in 2017, when compared to 2007. The

[1] Departamento de Zootecnia da Universidade Federal da Bahia.
[2] Universidade Federal do Vale do São Francisco.
* Corresponding author: flavio.longui@ufba.br Av Adhemar de barros, n.500 – – Escola de Medicina Veterinária e Zootecnia – Departamento de Zootecnia, Ondina, Salvador – Bahia, Brasil. Cep: 40170-115. Tel (71) 3283-6722

estimate is 1.9 million tons cultivated in an area of 652.8 thousand hectares for 2018 (CONAB, 2020). Among the various types of sorghum grown in Brazil, forage sorghum is the one which shows the prominent growth in new areas of the country (SILVA et al., 2020).

Sowing quality, alongside several other factors, may impact Sorghum productivity. Thus, this is one of the agricultural operations which requires a lot of attention and control. The performance of the sowing operation must be proper and under suitable quality control (CARPES et al., 2018).

For the process, the sowing machine must be regulated according to type soil, preparation, density, and texture. Incorrect adequacy may lead to problems in the deposition of seed and fertilizer, in the emergence of seedlings, and consequently, the final crop productivity will be affected (MACEDO et al., 2016).

For Garcia et al. (2011), another major factor to be dealt with in mechanized seeding process is the operating speed of tractor/seeder set, which may influence the sliding of the wheels, the operational capacity, the dosage of seeds and fertilizers, the distance between seeds as well as the depth and seed exposure.

Working during sowing at speeds above the recommended can increase the number of failures and double seeds, which will impair the uniformity in seed distribution. Working under low speed, the time for sowing is increased significantly. Such factors may reduce the plant population and increase the number of competing plants (BELLÉ et al., 2018).

Carpes et al. (2016) described a tendency to reduce the level of machine precision by angular speed increase of seed dosing disk. Similarly, Jasper et al. (2011) observed that the reduction of acceptable spacing is associated with angular speed increase of dosing disk pneumatic mechanisms, when analyzing the influence of sowing speed (speeds of 4; 6; 8; 10 and 12 km h-1) on the longitudinal distribution of soybean seeds.

It is necessary to emphasize that the significant demands for power will occur at the highest operation speeds and seed deposition depth, once the demand for power has a direct relationship between traction force, speed, and worked area. The sowing depth is an important factor relevant to its seed germination (Oliveira & Scivittaro, 2007). It may vary according to the cultures to be worked with. Proper sowing needs to be carried out at a depth enough for the plant to obtain nutrients more easily and to assist the plant's sustainability. Thereby, fast, and uniform germination occurs, spending fewer energy reserves. (Shanmuganathan & Benjamin, 1992).

The usage of inadequate speeds and adjustments in mechanized sowing can provide uneven seed distribution in the row; plants remarkably close to each other will cause competition, inhibiting their development, greater lengths of the hypocotyl, and negative effects on crop productivity. (MONDO et al., 2013).

Correia et al. (2015) stated that the sorghum sowing period is short according to the edaphoclimatic conditions and the economic situation of the crop. Thus, operations must be carried out as quickly as possible, being necessary to increase the speed of the tractor-seeder-fertilizer set. This increase is one of the main factors which negatively affect the sowing quality. The authors comment that the sowing-fertilizers have undergone modifications to improve the efficiency of longitudinal distribution between seeds and, therefore, positively influence the crops productivity.

Hence, the objective of this study was to evaluate, at field conditions, the effects of working speed and seed deposition depth on the initial establishment as well as productivity of the sorghum crop.

Methods and material

The study was carried out at the experimental farm of the Federal University of Bahia, located in the municipality of São Gonçalo dos

Campos - BA. The geographical location of the area is defined by the coordinates 12 ° 23'57" S and 38 ° 52'44" W, at average altitude of 219 meters. The climate, according to the KÖPPEN classification, is called As (tropical climate with dry summer season). The average maximum temperature and the average minimum temperature were 30.3 and 21.2 ° C, respectively. The total precipitation was 34.4, 161.2, and 99.1 mm for the months from April to June.

Germination test occurred to determine the quality of seeds, using an air-conditioned chamber at 12-hour photoperiod; and substrate, the germi-test paper roll, moistened with distilled water in the proportion of 2.5: 1 (mass of water: the mass of paper). Four repetitions of 25 seeds were made, totaling 100 seeds, at average temperature of 25ºC. The germination of seeds, obtaining normal seedlings, was 94%.

At the field, it was used a Baldan seeder-fertilizer spreader, model SPDE 3000, 16 planting lines, approximate weight of 3595 kg when empty. The implement was mounted on the three-point lift of the New Holland tractor, model TL85E, 63 kW (85 hp) engine power at 2400 rpm.

The seeder comes with striated disk type seed metering mechanisms, such as the smooth straw cutting disk. The furrow for seeds deposition is composed of offset double discs.

The experiment was conducted in a 3x3 factorial scheme, under three displacement speeds, being 4, 6, and 8 km h-1 (1.11, 1.67, and 2.22 m s-1) and three sowing depths and fertilizer (0.01, 0.03, and 0.05 m). Moreover, it was a completely randomized design, four replications, totaling 36 experimental units. The experimental units were 4 meters wide by 10 meters long, 40 m2 area. Amid the experimental units, there were 2 meters spacing for maneuvers and the selected speeds stabilization, and 10 meters area was used for tractor movement.

The seeder-fertilizer was adjusted to 0.60 m spacing between lines and stand of 150,000 plants per hectare, sowing six lines. The first and sixth

lines were removed, obtaining data from lines 2, 3, 4, and 5 (central lines), from now on renamed lines 1, 2, 3 and 4. Two meters were disregarded at the beginning and at the end of each sowing line to stabilize the speed of the mechanized set in the data collection.

The parameter analyzed to check the sowing quality was the seed deposition actual depth. Productivity was verified in each treatment using following parameters: (1) productivity per hectare and (2) height of the plants.

A 150 mm Vernier digital caliper was used to verify the seed deposition actual depth. Twenty measurements were taken along each line, removing the plot average. The dry matter productivity (DM) was estimated after cutting the plants 20 cm from the soil after 90 days of sowing, by weighing the existing plants in 1 m2 area, later calculating the estimate per hectare.

For plant height analysis, 20 plants were measured in each of the four experimental lines, totaling 80 plants per plot, removing the plot average. The measurements were performed at 30, 60, and 90 days after germination.

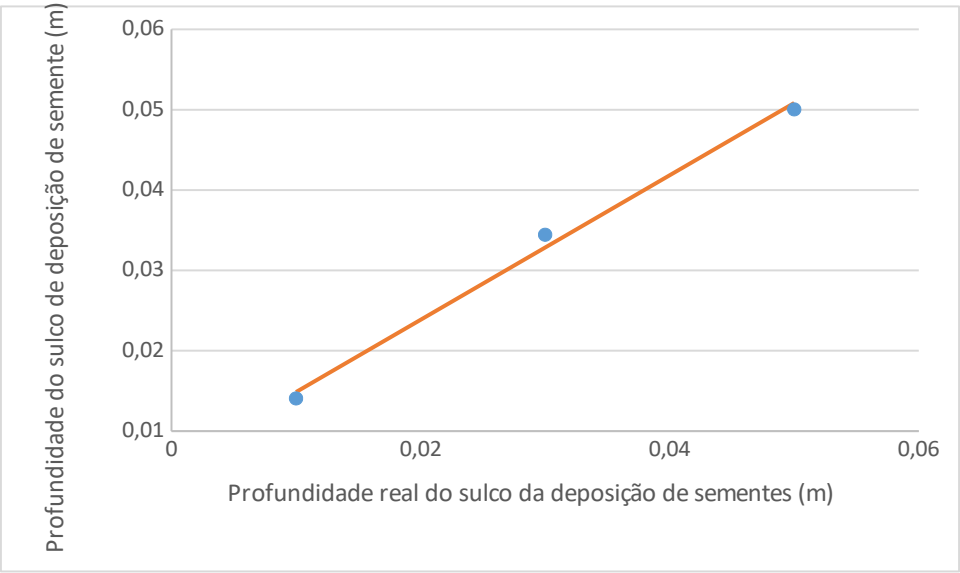
First, the assumptions of data normality were analyzed. The data with normal distribution were performed by variance analysis and, when significant, the data were performed to regression analysis for all parameters. The complete linear and quadratic models were tested. In case of significant interactions for the factors, the respective developments were carried out. All analyses were performed using the statistical software SAS 9.2 Student at 5% significance level.

Discussion and results

The real seed deposition depth was not influenced by the displacement speed. However, there was an effect of sowing depth and interaction of the factors studied under this characteristic. As to produce dry matter, there was no influence of the studied factors or their interactions.

The actual seed deposition depth was influenced by sowing regulation, which shows that the machine system worked as expected (Figure 1). The averages for those treatments demonstrated the numbers are close to regulation.

Figure 1. Relationship between seeder regulation and the actual depth of the seed deposition groove.



** significant at 0.01% probability.

Correia et al. (2015) evaluated the slope influence of land and operation speed in the sowing of forage sorghum via a flow sowing machine and identified that there was a strong mechanical seed damage possibility by increasing the speed of operation. On the other hand, the same authors described the speed of operation did not influence the seed deposition depth.

For Pinto et al. (2017), studying the longitudinal spacing and productivity of cowpea using a manual seeder, stated that the manual seeder at speeds from 2 to 4 km h-1 influences the depth of seed deposition, with effects on the initial and final crop populations.

The sowing speed influence on the seed deposition actual depth is quite favorable to the producer. Thus, the producer may adopt any speeds between 4 to 8 km h-1. However, at higher speeds, the tractor-seeder-

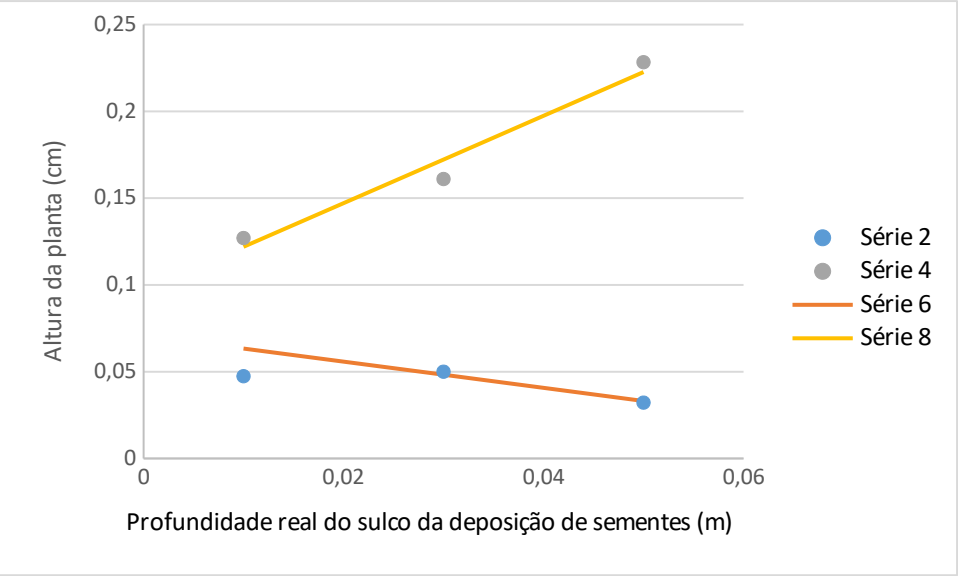
fertilizer set will have a greater operational capacity, reducing the hours worked in the seeding and, consequently, reducing the final costs.

The planting speed and seed deposition regulation did not influence the final crop yield, which showed values between 53 to 56 tons per hectare of DM. These production levels are in accordance with those reported by Rodrigues Filho et al. (2006).

Our results were different from those found by Reynaldo et al. (2016). Evaluating the influence of displacement speed in the soybean culture sowing operation, using a fertilizer sowing machine with a mechanical seed distribution system by horizontal discs, they verified a reduction in productivity from 3550 to 3450 kg ha-1 of grains, when the speed was increased from 2 to 10 km-1. Rinaldi et al. (2013) also observed that speed increase provided higher values of flawed spacing in the bean culture, which can contribute to plants number reduction and, therefore, the culture productivity.

The plant height was influenced by sowing depth at 30 and 60 days, which did not occur at 90 days. The seeds deposited more superficially emerged and developed first. Over time, the deeper seeds matched the growth with those sown more superficially. Figure 2 shows the equations, describing this response pattern. This phenomenon is noticeable at the beginning of growth, due to the smallest soil strip that must break from germination to emergence. However, over time, the height of plants tends to match, as the deeper seeds may explore a larger volume of soil, which allows for greater support and nutrition (SOUZA e FERNANDES, 2006). Studies show that the seeds have an ideal range of sowing depth. If planted too deeply, they do not have enough energy to reach the surface. On the other hand, when they are shallow plants, there is no soil-seed contact, and the action of the sun accelerates their dryness (BIULCHI, 2012).

Figure 2. Relationship between the depth of seed deposition and the height of the sorghum plants at 30 and 60 days after germination.



*significativo a 0,5% de probabilidade.

This result corroborates with the study developed by Teixeira et al. (2018) that studying different sowing depths in the corn crop, described differences in the initial periods of their study. However, they did not obtain this result in the last collection.

Conclusion

- Sowing at speeds from 4 to 8 km h-1 and at depths of 0.01, 0.03, and 0.05 m, does not influence the productivity of forage sorghum culture.
- It is recommended to sow forage sorghum at a speed of 8 km h-1 at sowing depth of 0.05m.

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Estabelecimento inicial e produtividade do sorgo em função da velocidade de trabalho do trator e da profundidade de semeadura

Resumo: Objetivou-se com este trabalho avaliar, em condições de campo, o desempenho de uma semeadora-adubadora no estabelecimento inicial e na produtividade da cultura do sorgo, em função da velocidade de trabalho do trator e da profundidade de deposição de semente. O experimento foi conduzido na fazenda experimental de São Gonçalo dos Campos, localizada no município de São Gonçalo dos Campos, BA, pertencente a Escola de Medicina Veterinária e Zootecnia, da Universidade Federal da Bahia. Adotou-se o esquema fatorial 3x3, em delineamento inteiramente casualizado (DIC), com 36 unidades experimentais, com três velocidades de deslocamento (4, 6 e 8 km h^{-1}) e três profundidades de deposição da semente (0,01, 0,03 e 0,05 m) foram estudadas. Avaliaram-se a altura real de deposição de sementes, a altura da planta em 30, 60 e 90 dias e a produtividade por m^2 após 90 dias. A velocidade de trabalho não influenciou (P>0,05) os parâmetros avaliados. A profundidade da semeadura não modificou (P>,0,05) a produtividade da cultura, porém influenciou a deposição real de sementes e a altura das plantas nos dois primeiros cortes. A semeadura nas velocidades de 4 a 8 km h^{-1}, e o plantio em profundidade de 0,01 a 0,05 m não influenciam a produtividade da cultura do sorgo. Assim, recomenda-se realizar o plantio na velocidade de 8 km h^{-1} com uma profundidade de 0,05m.
Palavras-chave: formação de pastagem, espaçamento entre plantas, mecanização agrícola.

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