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Seeder-fertilizer performance with two furrowing mechanisms and sowing speed

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Abstract

The displacement velocity of the tractor-seeder set, associated with the furrowing mechanism, influences the plant distribution and the establishment of a correct plant stand in the field. The objective of this study was to evaluate the operational performance of a seeder-fertilizer in the non-tillage sunflower crop, according to sowing speeds and furrow mechanisms. The experimental design used was the randomized blocks, with treatments arranged in a split-plot scheme, where the plots were the furrowing mechanisms (chisel openers and double disk) and the subplots were the sowing speeds (3.2; 4.6; 6.2 and 7.0km h^{-1}), with three replicates. The following were determined in this study: the emergence speed index, the emergence in the field, the average distance between the plants, plant height, plant population and the longitudinal distribution of plants. Sunflower sowing using a chisel openers provides greater emergence in the field, emergence speed index and, consequently, greater plant population. Sowing speed ranging from 3.2 to 7.0km h^{-1} do not influence field emergence, emergence speed index, height and population of sunflower plants.
Keywords: *Heliantus annus* L. Longitudinal distribution. No-tillage system. Plant emergence.

Introduction

Several factors affect the performance of sunflower with high productive potential, such as the sowing time, the cultivar, the adequate management of soil fertility and environmental conditions, such as the uniform water distribution over the crop cycle (BEZERRA et al., 2014).

Sowing is a fundamental operation for the crop establishment in the field as it is associated with the uniformity of longitudinal distribution of plants and the final stand (ARCOVERDE et al., 2017). Operational factors related to sowing, such as error in the distribution, deposition and depth of seeds made by the sower may be influenced by the sowing speed (VIAN et al., 2016).

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The use of seeders at speed greater than 7.0km h^{-1} open larger furrows, revolve wider strips and hinder soil compression with the seed by the compacting wheel (NASCIMENTO et al., 2014), damaging germination, seedling emergence and plant population (SANTOS et al., 2016).

In the non-tillage system, the seeder-breaking mechanisms start to perform, in addition to furrow opening for the deposition of seeds, but the localized preparation of the soil. Thus, the action of the furrowing mechanisms, in addition to minimizing the demand for traction power and promotion of an adequate soil mobilization improve seed germination, seedling emergence and crop productivity (FURLANI et al., 2013). Therefore, the furrowing mechanisms must be studied in different edaphoclimatic and operational conditions, as the efficiency of such mechanisms depends on factors such as type of soil, depth of sowing and fertilization, sowing speed, soil water content and soil tillage (FURLANI et al., 2013).

Considering the little information related to the performance of seeder-fertilizer machines in the sunflower crop under different operating conditions, the objective of this study was to evaluate the operational performance of a seeder-fertilizer machine in sunflower growing in non-tillage system as a function of four sowing velocities and two furrowing mechanisms.

Material and methods

The experiment was carried out on the Experimental Farm of the Federal University of Grande Dourados, municipality of Dourados, state of Mato Grosso do Sul (MS). The climate in the region is classified by the international system of Köppen as Am-type, monsoon, with dry winter and average annual rainfall of 1,500 mm and average annual temperature of 22°C (ALVARES et al., 2013).

The soil in the area was classified as Distroferic Red Latosol, with a very clayey texture (65.3% clay, 17.4% silt and 17.3% sand), a representative class of most of the soils in the south-central region of the state of Mato Grosso do Sul, with an average slope of 2% (EMBRAPA, 2013). Sunflower was grown in the experimental area, where there were residues of soybean crops grown as a summer crop (earlier crop).

The tests were carried out using a trailed seeder-fertilizer spreader, model Solografic DIRECTA 4000, with nine sowing lines spaced by 0.45m, equipped with a horizontal perforated-disc type seed dispenser. The machine allows the use of two furrow-opening mechanisms: furrowing-rod and double-disc. The compactor wheel used was a V-shaped smooth metal wheel. The seeder-fertilizer machine was pulled by a 4x2 TDA tractor, with nominal power of 125hp (91.9kW) at 2,300rpm.

In relation to the sunflower sowing, cv. Embrapa 122-V2000 (Striated Grain) was used, with an oil content between 40% to 44% (GIRASSÓIS, 2007), 90-day cycle, population of 45,000 plants ha^{-1} (DALCHIAVON et al, 2016). The seeder was regulated to distribute 230kg ha^{-1} of the formulated 8-20-20 + micro. The weed was controlled in pre-emergence, with the herbicide glyphosate, at the dose of 3L ha^{-1} of commercial product, not needing further applications. Pest control was carried out according to the occurrence.

The experimental design was the randomized blocks, with treatments arranged in a split-plot scheme, in which the plots were the types of furrow (chisel openers and double disc) and the subplots were the sowing speeds (3.2; 4.6; 6.2 and 7.0km h^{-1}), with three replicates. The experimental unit consisted of five sowing rows spaced by 0.9m apart, by 50.0m in length. Each experimental unit occupied an area of 225.0m^2.

Sowing was carried out at soil water content of 0.28 kg kg^{-1}. The water content was determined through the gravimetric method (standard greenhouse method), according to the relationship between the water mass and the soil dry mass at 105ºC. The soil density was 1.28 ± 0.11Mg m^{-3}. Seed germination was evaluated before sowing for experimental control by taking a sample from the seed lot used. The test evaluation was performed according to the recommendations of the Rules for Seed Analysis (BRASIL, 2009). The seeds used in the experiment had a germinating power of 80%.

After sowing, the seed depth was measured in the sowing line in one meter for all treatments, using a 1-mm graduated ruler with four replicates. To measure the depth of the seed, the soil was carefully removed from the sowing line until they were found, considering the distance between the surface of the soil and the deposited seed as the depth.

The emergency speed index was determined by counting the sunflower seedlings in 3-m of seeded line, in two central lines of each experimental unit, with seven field measurements, from the 5th to the 21st day after the emergency. The determination of the seedling emergence speed index was performed using the Maguire equation (TROGELLO et al., 2013), while the total number of seedlings emerged in the last count was used for field emergence.

The average distance between the plants was made by measuring the distance between all sunflower plants found in 4.0m of seeded line, in the two central lines of each experimental unit. A 1-mm resolution measuring tape was used in the measurement. At the end of the sunflower crop cycle, plant height assessments were carried out up to the point of insertion of the head with the aid of a 0.01-m precision measuring tape.

The longitudinal distribution of plants was evaluated by determining the percentages of the multiple, normal and defective spacing, which were analyzed using the adapted classification of Kurachi et al. (1989), at which the following percentage of spacing corresponding to the classes: acceptable or normal ($Xref < Xi < 1.5\ Xref$), multiple ($Xi < 0.5\ Xref$) and defective ($Xi > 1.5\ Xref$), based on the reference spacing (Xref) according to the seeder-fertilizer regulation for a population of 45,000 plants ha^{-1}. Thus, the spacing between plants (X) was classified as normal ($0.098m < X \leq 0.296m$), multiple ($X \leq 0.098m$) and defective ($X > 0.296m$).

The data were subjected to analysis of variance, and when significant at the 5% probability level by the F test, regression analysis was performed for the quantitative factors.

Results and discussion

A significant effect was observed in the furrowing mechanism for emergence in the field, emergence speed index, average distance between plants, sowing depth and plant population, and no influence on plant height. The sowing speeds did not influence the evaluated factors and an interaction was found between the furrowing mechanisms and the sowing speeds only for the sowing depth (TABLE 1).

Table 1 – Summary of analysis of variances of the data on emergency on the field (EF), emergence speed index (ESI), average distance between plants (PD), plant height (PH), sowing depth (DEPTH) and plant population (PP) according to the furrowing mechanism and the sowing speed. Dourados/MS, 2016.

	EF	ESI	PD	PH	DEPTH	PP
Furrower						
Furrowing-rod	86.4 A	1.79 A	38.9 A	112.9^{ns}	7.5 A	47,993.80 A
Double disc	59.4 B	1.42 B	35.7 B	108.3	5.6 B	33,024.70 B
Speed (km h^{-1})						
3.2	75.0^{ns}	1.49^{ns}	36.8^{ns}	109.7^{ns}	6.3^{ns}	41,666.60^{ns}
4.6	66.1	1.58	39.4	114.4	6.5	36,728.4
6.2	75.5	1.82	35.1	109.8	6.5	41,975.3
7.0	75.0	1.54	37.9	108.5	6.9	41,666.6
Furrower x Speed	72.91^{ns}	1.61^{ns}	37.3^{ns}	110.6^{ns}	6.5*	40,509.2^{ns}
C.V. (%)	20.3	12.3	18.1	3.8	8.8	20.2

*Significant at 5% probability, ^{ns} not significant by the F test.

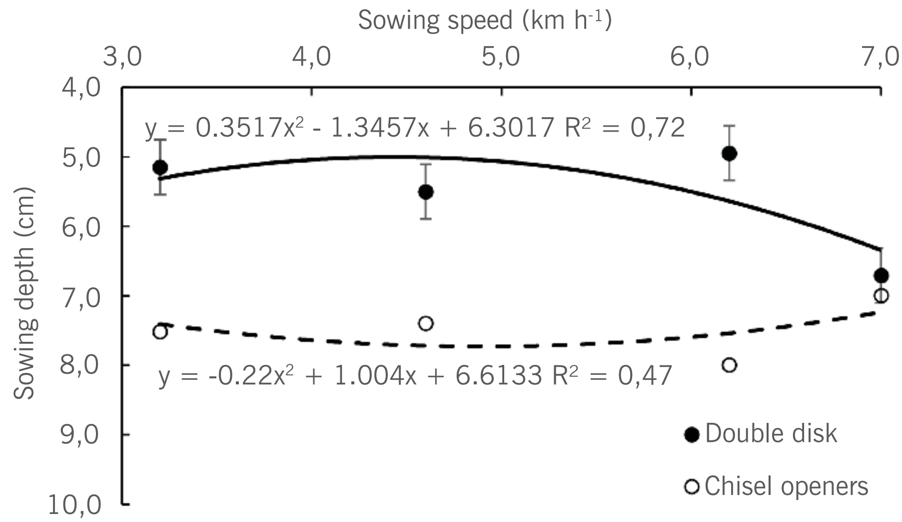
Source: Elaborated by the authors (2019).

The furrowing-rod provided higher values in the emergency in the field, the emergency speed index, and the plant population. The chisel openers provide a better contact between the soil and the seed, promoting better conditions for the germination of the seeds, consequently favoring the ESI and, at the end, final plant population. Similar results were obtained by Trogello et al. (2012), when evaluating the performance of a seeder-fertilizer in clayey soil. The authors found a greater emergence of plants when the chisel openers were used. Santos et al. (2016) observed that the action of the chisel openers can provide better seed distribution at adequate sowing speeds, consequently, favoring the emergence of the plants.

Plant height was not influenced by the evaluated factors, showing a mean of 110.6cm. Nobre et al. (2012), when carrying out tests with different cultivars in the North of Minas Gerais, and Dalchiavon et al. (2016), when carrying out tests with different cultivars in the Chapadão de Parecis region in the state of Mato Grosso, reported means that were higher than those observed in this study, ranging from 170.0 to 200.0cm and from 142.0 to 198.5 cm, respectively. According to Dalchiavon et al. (2016), the smallest plant height in the sunflower facilitates the crop management and reduces the losses in mechanized harvesting. However, they emphasize that the variation of this characteristic depends on the most efficient cultivars in terms of the response to the edaphoclimatic conditions of their cultivation. Also, according to Ivanoff et al. (2010), this is a reflection of nutrition in the stem elongation period.

An interaction was found between the furrowing mechanism and the sowing speed (FIGURE 1). The furrowing rod provided greater sowing depth than the use of the double disc for all speeds from 3.2 to 7.0km h^{-1}. Garcia et al. (2011), when evaluating the sowing of the corn crop at different sowing speeds, observed that the increment in the speed from 2.5 to 4.4km h^{-1} provided an increase in depth of 30.2%. Koakoski et al. (2007), Mion and Benez (2008) and Modolo et al. (2013) also observed higher values of seed deposition depth for the rod-type furrowing mechanism, in comparison to the double-disc type mechanism. These results may be related to the greater penetration capacity of the furrow, which, due to its physical characteristics, provided greater efficiency in the breaking of the superficial layers of the soil, causing a greater penetration of the seeds in the furrow.

Figure 1 – Sowing depth (PS) as a function of the furrowing mechanism and sunflower sowing velocity.



Source: Elaborated by the authors (2019).

A significant effect of the furrow mechanism was found on the longitudinal distribution of plants, therefore, affecting the percentage of multiple and defective spacing. The use of the furrowing-rod provided a lower percentage of multiple spacing, but a higher percentage of defective spacing. There was interaction between the furrowing mechanisms and the sowing speeds for the percentage of normal spacing (TABLE 2).

Table 2 – Summary of analysis of variances of the percentage data of multiple, normal, and defective spacing for the furrowing mechanisms and seeding speed. Dourados/MS, 2016.

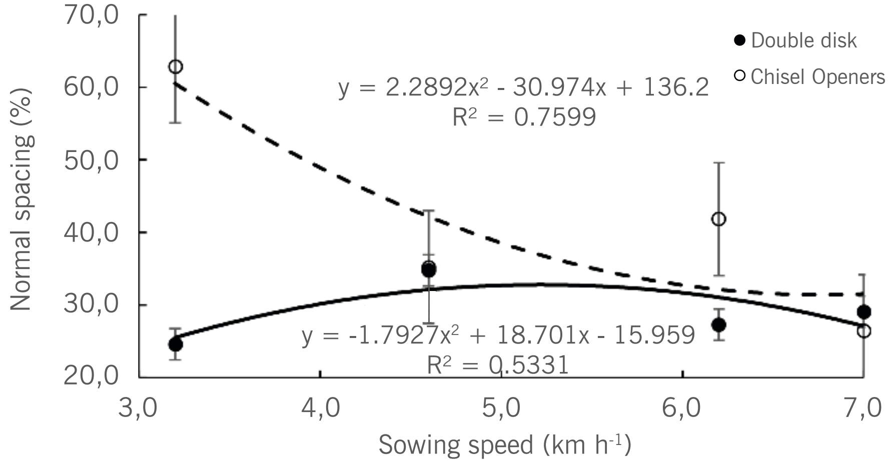
	Multiple	Normal	Defective
Furrower			
Furrowing-rod	8.8 A	41.6	49.6 B
Double disc	3.0 B	29.0^{ns}	67.0 A
Speed (km h^{-1})			
3.2	1.1^{ns}	43.7^{ns}	55.2^{ns}
4.6	2.4	35.0	62.6
6.2	5.5	34.6	59.9
7.0	14.8	27.8	57.4
Furrower x Velocity	5.9^{ns}	35.3*	58.8^{ns}
C.V. (%)	39.5	26.8	19.2

*Significant at 5% probability, ^{ns} not significant by the F test; C.V. coefficient of variation.

Source: Elaborated by the authors (2019).

Figure 2 shows the interaction between the furrowing mechanism and sowing speeds. The use of chisel openers and planting speeds from 3.2 to 5.0km h^{-1} resulted in normal spacing greater than 40.0%. These results are similar to Furlani et al. (2013), at which almost half of the seeds deposited at an adequate spacing was obtained.

Figure 2 – Normal spacing percentage as a function of the furrowing mechanism and sunflower sowing speed.



Source: Elaborated by the authors (2019).

Conclusions

The use of chisel openers in sunflower sowing provides greater emergence in the field, emergence speed index and a larger plant population than the use of the double disk.

Sowing speeds of 3.2 to 5.0km h^{-1} and with the use of the chisel openers provided better plant distribution.

Desempenho de semeadora-adubadora com dois mecanismos sulcadores e velocidades de semeadura

Resumo

A velocidade de deslocamento do conjunto trator-semeadora, associada ao mecanismo sulcador utilizado, influencia a distribuição de plantas e o estabelecimento de um estande correto de plantas em campo. Objetivou-se avaliar o desempenho operacional de uma semeadora-adubadora na semeadura direta do girassol, em função de velocidades de semeadura e mecanismos sulcadores. O delineamento experimental utilizado foi o de blocos ao acaso, com tratamentos arranjados em esquema de parcelas subdivididas, em que as parcelas foram os mecanismos sulcadores (haste sulcadora e disco duplo) e as subparcelas as velocidades de semeadura (3,2; 4,6; 6,2 e 7,0km h^{-1}), com três repetições. Foram determinados: o índice de velocidade de emergência, a emergência a campo, a distância média entre as plantas, a altura de plantas, a população de plantas e a distribuição longitudinal de plantas. A semeadura do girassol utilizando-se de haste sulcadora proporciona maior emergência a campo, índice de velocidade de emergência e consequentemente maior população de plantas. As velocidades de semeadura de 3,2 a 7,0km h^{-1} não influenciam a emergência a campo, o índice de velocidade de emergência, a altura e a população de plantas do girassol.

Palavras-chave: *Heliantus annus* L. Distribuição longitudinal. Emergência de plantas. Plantio direto.

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