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CORN GRAIN YIELD COMPONENTS ACCORDING TO THE SOIL MANAGEMENT SYSTEM

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ABSTRACT: Management systems and sowing speed can impact the establishment, development, and Grain yield of crops of economic interest. Thus, this study aimed to assess second crop corn grain yield components according to the soil management system. The experiment was carried out in a randomized block design in a split-plot scheme in one of the years due to the introduction of the sowing speed factor, with four replications. Six management systems were distributed in the plots (one moldboard plow by two off-set disk harrow operations (T1), one offset disk harrow (T2), no mobilization (T3), one subsoiler (T4), one cross-subsoiler by one offset disk harrow (T5) and one subsoiler by one offset disk harrow (T6) and four speeds in the subplot (3.0, 4.7, 6.1, and 6.7 km h^{-1}) during corn sowing operation. The analyzed variables: plant stand, longitudinal distribution of seedlings, stem diameter, plant height, first-ear insertion height, and grain yield. The data were submitted to analysis of variance, and when significant, the Tukey test was applied. The studied management systems showed no effect on plant stand, longitudinal distribution, and grain yield components (stem diameter, plant height, first-ear insertion height and grain yield). Travel speed also interfered with the longitudinal distribution and plant stand.

Keywords: no-tillage, conventional tillage, grain yield.

COMPONENTES DE PRODUÇÃO DO MILHO EM FUNÇÃO DO SISTEMA DE MANEJO DO SOLO

RESUMO: Sistemas de manejo adotados e velocidade de semeadura podem causar impactos no estabelecimento, desenvolvimento e produtividade de cultivos de interesse econômico. Assim, objetivou-se avaliar os componentes de produção do milho em segunda safra, em função do sistema de manejo do solo. O experimento foi desenvolvido em delineamento de blocos ao acaso e no esquema de parcelas subdivididas, devido a introdução do fator velocidade de semeadura, com quatro repetições. Foram alocados seis sistemas de manejo nas parcelas (aração mais duas gradagens, gradagem, sem mobilização, escarificado, escarificado cruzado e escarificação mais uma gradagem) e quatro velocidades na subparcela (3,0, 4,7, 6,1 e 6,7 km h^{-1}) durante a operação de semeadura da cultura do milho. As variáveis analisadas foram: estande de plantas, distribuição longitudinal de plântulas, diâmetro do colmo, altura de planta, altura de inserção da primeira espiga e a produtividade. Os dados foram submetidos à análise de variância e quando significativo aplicado teste de Tukey a 5% de probabilidade para a comparação das médias. Os sistemas de manejo estudados não afetaram o estande de plantas, a distribuição longitudinal, e os componentes

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de produção (diâmetro do caule, altura de planta, altura de inserção da primeira espiga e produtividade de grãos). Velocidade de deslocamento interferiu na distribuição longitudinal e no estande de plantas.

Palavras-chaves: plantio direto, preparo convencional, produtividade.

1 INTRODUCTION

Soil preparation systems can alter soil physical properties (DADALTO et al., 2015), restricting or maximizing grain yield (CORTEZ et al., 2011), which may cause over time undesirable changes in the arable layer structure. Thus, management systems can affect the establishment, development, and grain yield of crops of economic interest (DRESCHER et al., 2012; CORTEZ et al., 2017).

Corn productive potential can be determined by plant stand, sowing density, number of ears per plant, number of grains per ear, mean grain weight, morphophysiological characteristics of genotypes, sowing time, and management (BALBINOT Jr. et al., 2005). Seed distribution carried out by the seed drill, directly associated with seed deposition and sowing depth, could also affect the initial stand and plant establishment (VIAN et al., 2016). Ormond et al. (2018) assessed the travel speed of a pneumatic seed-cum-fertilizer drill to test two seed measuring mechanisms and found that sowing performed at low speed had the best percentage of ideal spacing, but increases in speed led to high percentages of flawed and double spacing, compromising sowing quality.

Agricultural mechanization has been intensifying with the increase in the cultivation of the second crop corn, resulting in high demand for operating capacity and requiring high speed in the execution of agricultural activities in order to reduce operating costs and improve the quality of the sowing process (SANTOS et al., 2016). However, the corn crop requires careful sowing due to the low number of seeds sown per meter to allow plants to express its productive potential.

Therefore, this study aimed to assess second crop corn grain yield components according to the soil management system and also the influence of the sowing speed.

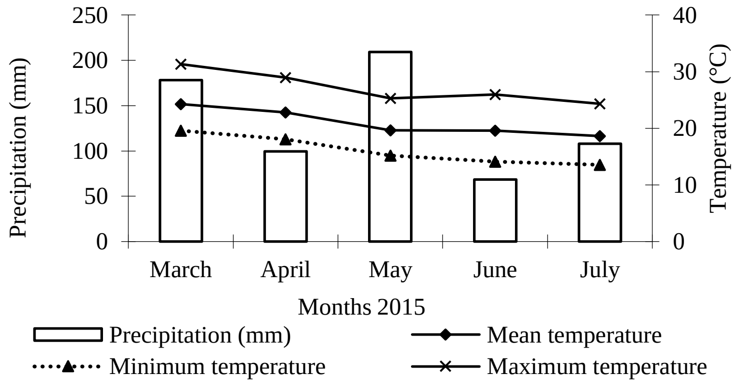
2 MATERIAL AND METHODS

Description of the experimental area

This study was carried out at the Experimental Farm of Agricultural Sciences of the Federal University of Grande Dourados (UFGD), located in Dourados, MS, Brazil, with geographic coordinates of 22°14′ S and 54°59′ W and an average altitude of 434 m.

The climate is CWa, according to the Köppen classification, and the soil is classified as a dystroferric Red Latosol (SANTOS et al., 2018). The meteorological data obtained from the Embrapa Western Agriculture experimental station is shown in Figure 1.

Figure 1. Monthly meteorological data (precipitation and temperature) in 2015



Source: Embrapa Western Agriculture (2015).

2.1 Experimental design

The experimental design used was a randomized block, with treatments arranged in a split-plot and four replications. Treatments consisted of six management systems applied to the plots before sowing the summer crop (soybean), namely: one moldboard plow by two off-set disk harrow operations (T1), one offset disk harrow (T2), no mobilization (T3), one subsoiler (T4), one cross- subsoiler by one offset disk harrow (T5) and one subsoiler by one offset disk harrow (T6).

Speeds applied in the subplots during corn sowing were related to the staggering of the tractor gears, which resulted in average speeds of 3.0, 4.7, 6.1, and 6.7 km h^{-1}. Subplots were considered only the passes of the seed drill during corn sowing.

Each experimental plot occupied an area of 15 × 19 m (285 m^2). A space of 12 m was reserved in the longitudinal direction between plots for maneuvers, machine traffic, and set stabilization.

2.2 Equipment and supplies

Plots of the soil management systems were tilled using a five-shank subsoiler, with 0.08-m width narrow tines at a depth of 0.35 m, cutting disc, and cutting roller; notched moldboard plow with at a depth of 0.40 m; and off-set disk harrow, with 20 discs of 0.51 m in diameter (20″) in each section, notched discs in the front of the chassis, plain discs at the rear, and working depth of 0.15 m.

A tractor model 4 × 2 FWD, with 67.71 kW (92 hp) of nominal engine power at 2400 rpm, front tires 7.50-18 and rear tires 18.4-34, and a mass of 3,400 kg was used for tillage operations, while a tractor model 4 × 2 FWD, with 89.79 kW (122 hp) of nominal engine power at 2200 rpm, with front tires 14.9-58 and rear tires 23.1-30, and mass of 4,510 kg was used for the subsoiler operation.

A seeder-fertilizer with a pneumatic seed distribution system was used. This machine had cutting discs for straw, furrow ridger in the fertilizer row, and helical metering, being set for the spacing of 0.90 m and sowing at a depth of 0.05 m. The seed-fertilizer was set to distribute 6.0 seeds of the hybrid DKB 285 PRO per meter. Topdressing fertilization was performed with 80 kg ha^{-1} of urea. The other management practices were carried out based on the agronomic aspects of the crop.

2.3 Grain yield components

Plant stand was determined by counting the number of seedlings that emerged within two meters, using a measuring tape.

The longitudinal distribution or uniformity of spacing between seedlings was assessed using a measuring tape, with readings taken in the central row of each subplot by measuring the distance between seedlings within two meters. The percentage of normal, flawed, and double spacings was obtained according to ABNT (1984) standards, considering the percentage of spacings: double (D): < 0.5 times the referential X; normal (A): 0.5 < referential X < 1.5; and flawed (F): > 1.5 times the referential X.

Plant height, stem diameter, and first-ear insertion height (FEIH) were performed by measuring five consecutive plants in the subplot, with values expressed as a mean. Plant height was measured from soil level to the flag leaf insertion, stem diameter was determined by measuring the plant collar (± 5 cm in height), and FEIH was measured from soil level to the first productive ear.

After collecting the plants from an area of 5 m in length and two central rows of each subplot, ears were threshed, grain moisture corrected to 13%, and Grain yield obtained in kg ha^{-1}.

2.4 Data analysis

The data were subjected to analysis of variance and, when significant, the Tukey test was applied at 5% probability for comparison of means.

3 RESULTS AND DISCUSSION

Plant stand and longitudinal

distribution were not affected by management systems (Table 1).The highest travel speed at sowing led to a low plant stand (Table 1). Trogelo et al. (2014) assessed the development of corn sown at different speeds and found that the lowest speed resulted in better crop performance.

Table 1. Analysis of variance and test of means for the variables stand and longitudinal distribution of corn seedlings.

Factor	Plant stand (plants m^{-1})	Longitudinal distribution		
		Normal (%)	Flawed (%)	Double (%)
Management (M)	2015	2015	2015	2015
T1	7.46	60.27	19.95	19.76
T2	7.56	66.75	14.54	18.69
T3	6.96	68.25	17.52	14.21
T4	6.68	68.86	18.92	12.20
T5	7.12	69.64	14.73	15.61
T6	7.15	67.66	17.51	14.81
Speed (S)				
3.0 km h^{-1}	7.62 a	68.00 ab	12.84 b	19.15 a
4.7 km h^{-1}	7.43 a	60.37 b	18.21 ab	21.40 a
6.1 km h^{-1}	7.02 ab	71.41 a	16.57 ab	12.01 b
6.7 km h^{-1}	6.56 b	67.84 ab	21.18 a	10.96 b
F-test				
M	1.36 ns	0.82 ns	0.65 ns	0.87 ns
S	5.85 **	3.44 **	3.04 **	8.08 **
M × S	0.69 ns	0.48 ns	0.55 ns	0.83 ns
CV M (%)	15.38	22.36	62.93	76.64
CV S (%)	13.36	18.38	56.70	56.14

ns: not significant (p>0.05); *: significant (p<0.05); **: significant (p<0.01); CV: coefficient of variation. Means followed by the same lowercase letter in the column do not differ from each other by the Tukey test at 5% probability. Management: One moldboard plow by two off-set disk harrow operations (T1), one offset disk harrow (T2), no mobilization (T3), one subsoiler (T4), one cross-subsoiler by one offset disk harrow (T5) and one subsoiler by one offset disk harrow (T6). **Source:** Author (2015).

Uniform spacing between seeds allows delimitating the maximum space for each plant, reducing intraspecific competition (ZHAO et al., 2010). It is a key factor for corn development because the crop has no plasticity, i.e., it cannot compensate for flaws, which may affect its performance (SILVA et al., 2016).

The obtained data was below the minimum necessary for a normal distribution using a pneumatic seed drill, i.e., 90% of normal regularity (MIALHE, 1996) either due to the high number of plants of the second crop corn or the lack of regulation and/or adequacy of the disc to the seed. The treatment most similar to this regularity was plowing and harrowing, which provided a loose and completely disturbed soil. Sowing speed at 6.1 km h^{-1} had the highest percentage of longitudinal distribution (Table 1) for the normal spacing (71.41%). The speed of 6.7 km h^{-1} showed the highest value of flawed spacing for the longitudinal distribution, while the lowest speeds (3.0 and 4.7 km h^{-1}) had the highest percentages of double spacing for the distribution.

One desirable characteristic in the plant stand is the uniformity in the longitudinal distribution of seeds, as their irregularity influences crop development, contributing to intraspecific competition and favoring the appearance of weeds (ORMOND et al., 2018). Also, an increase in the sowing speed leads to an increase in disc rotation, reducing the time of filling them and, consequently, resulting in an irregular spacing between plants

(CANOVA et al., 2007). On the other hand, a decrease in the travel speed can lead to double filling of seeds in the orifices of discs, also affecting acceptable standards during sowing. Appropriate population and uniformity in the longitudinal distribution of plants are essential factors in searching for high grain yield in corn (STORCK et al., 2015). Coefficients of variation (CV) (Table 1) were classified according to Warrick and Nielsen (1980), being high when CV>62%, medium when 12%<CV<62%, and low when CV<12%. Thus, longitudinal distribution for double spacing was classified as having a high CV and the other variables presented a medium CV.

Regarding grain yield components (Table 2), soil management had no effect on stem diameter, plant height, and first-ear insertion height (FEIH). The average grain grain yield was above that predicted by Milho (2022) (4,056.00 kg ha^{-1}).

Table 2. Analysis of variance and test of means for stem diameter, plant height, first-ear insertion height (FEIH), and grain yield.

Factor	Stem diameter (mm)	Plant height (cm)	FEIH (cm)	Grain yield (kg ha^{-1})
Management (M)				
T1	18.48	185.78	80.37	4530.73
T2	17.97	188.46	78.25	4688.97
T3	17.94	182.90	79.16	4647.30
T4	18.39	185.17	77.16	4641.10
T5	18.20	185.28	76.45	4475.47
T6	17.72	189.82	78.91	4610.50
Speed (S)				
3,0 km h^{-1}	18.22	185.89	77.38	4482.74 b
4,7 km h^{-1}	18.28	185.20	77.72	4515.28 b
6,1 km h^{-1}	17.97	184.00	76.96	4239.73 b
6,7 km h^{-1}	17.99	189.85	81.46	5158.30 a
Teste F				
M	1.20 ns	1.10 ns	0.49 ns	0.20 ns
S	0.39 ns	1.92 ns	2.75 ns	6.86 *
M × S	1.02 ns	1.59 ns	1.59 ns	0.86 ns
CV M (%)	5.88	5.10	10.33	15.32
CV S (%)	6.94	4.81	7.83	15.92

ns: not significant (p>0.05); *: significant (p<0.05); **: significant (p<0.01); CV: coefficient of variation. Means followed by the same lowercase letter in the column do not differ from each other by the Tukey test at 5% probability. Management: One moldboard plow by two off-set disk harrow operations (T1), one offset disk harrow (T2), no mobilization (T3), one subsoiler (T4), one cross- subsoiler by one offset disk harrow (T5) and one subsoiler by one offset disk harrow (T6). **Source:** Author (2015).

The highest grain yield in these treatments may be attributed to the fact that the management used in these treatments favored soil decompaction, and consequently, corn crop development. This interaction stands out when using a plow or chisel with a leveling harrow, the former promoting the turning and breaking of the compacted soil layers, with organic matter incorporation, and the latter promoting the breaking of clods formed in the previous tillage, leveling the soil.

Compacted surface layers have been observed in cultivation systems under a no-tillage system in the Cerrado due to soil mobilization only in the sowing furrow. Added to it is the high soil compression by the traffic of agricultural machinery for sowing, harvesting, and management practices under non-ideal conditions of moisture in clay soils due to the short time available for carrying out operations with adequate soil moisture, which may lead to undesirable changes in the arable layer.

Travel speed showed no significant

interaction for stem diameter, plant height, and FEIH (Table 2). However, a high travel speed provided an increase in Grain yield due to the low number of plants per meter (Table 1). Thus, a low plant stand for corn can favor an increase in Grain yield, since there would be more space between plants in the row, favoring a better spatial condition for the development and performance of its productive potential under the studied conditions. The increased number of plants in the row impaired corn grain yield because the sowing stand at the lowest speeds was slightly above the recommended.

However, according to Fattahi et al. (2015), sowing speed for corn should be usually lower than 8 km h^{-1}, which is dependent on planting conditions. Thus, it is essential to consider factors such as travel speed, seed distribution, plant stand, and grain yield components as indicators of corn cultivation quality, allowing the crop to express its productive potential, thus guaranteeing high Grain yield.

4 CONCLUSIONS

The soil management systems showed no effect on plant stand, longitudinal distribution, grain yield components (stem diameter, plant height, first-ear insertion height and grain yield).

The highest travel speed resulted in the highest corn Grain yield and lowest plant stand. Travel speed interfered with the longitudinal distribution.

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