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Scientific Article
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Performance of a planter-fertiliser under reduced soil preparation: furrowers, speeds and depths when sowing maize[1]

Desempenho de semeadora-adubadora em preparo reduzido de solo: sulcadores, velocidades e profundidades de semeadura do milho

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ABSTRACT - The search to optimise agricultural systems by adapting mechanised sets for sowing maize, is essential for improving operational performance, energy efficiency and initial crop establishment. The aim of this study was to evaluate the performance and sowing quality of a planter-fertiliser for maize, in a dystroferric Red Latosol managed under reduced tillage, as a function of the type of furrower, depth of seed deposition and operating speed of the planter. The experimental design was completely randomised, in a split-plot scheme with three replications, where the plots represented the type of furrowing mechanism (shank or double-disk) and the subplots represented three displacement speeds (3.20, 5.15 and 7.32 km h^{-1}) and two sowing depths (35 and 40 mm). The best sowing quality for second-crop maize, the lowest power requirement at the tractor drawbar, the lowest specific and hourly fuel and consumption time, and the lowest travel reduction ratio are achieved when the tractor-planter-fertiliser set is configured to use a double-disk at a sowing depth of 35 mm. The adoption of higher displacement speeds results in increased operational and effective field capacity, as well as a lower energy demand when the tractor-planter-fertiliser set develops speeds close to or greater than 7.32 km h^{-1}, irrespective of furrower type or soil depth.

Key words: Sowing quality. Plant production. Soil management. Energy demand.

RESUMO - A busca pela otimização dos sistemas agrícolas, por meio da adequação dos conjuntos mecanizados na semeadura do milho, é essencial visando a melhoria do desempenho operacional, da eficiência energética e do estabelecimento inicial da cultura. Neste contexto, objetivou-se avaliar o desempenho de uma semeadora-adubadora e a qualidade da semeadura do milho, em Latossolo Vermelho Distroférrico manejado sob preparo reduzido, em função do tipo de sulcador, da profundidade de deposição da semente e da velocidade da operação de semeadura. O delineamento experimental foi inteiramente casualizado, em esquema de parcelas subdivididas com três repetições, sendo as parcelas o tipo de mecanismo sulcador (haste sulcadora ou disco-duplo) e as subparcelas três velocidades de deslocamento (3,20; 5,15; 7,32 km h^{-1}) e duas profundidades de semeadura (35 e 40 mm). A melhor qualidade de semeadura do milho segunda safra, a menor exigência de força na barra de tração do trator, os menores consumos específico e horário de combustível e a menor taxa de redução de percurso são obtidos quando o disco-duplo e a profundidade de deposição de sementes de 35 mm são usados na configuração do conjunto trator-semeadora-adubadora. A adoção de velocidades de deslocamento maiores resulta em aumento das capacidades de campo operacional e efetiva, bem como menor demanda energética na semeadura do milho quando o conjunto trator-semeadora-adubadora desenvolve velocidade próximo ou superior a 7,32 km h^{-1}, independentemente do sulcador e da profundidade do solo.

Palavras-chave: Qualidade de semeadura. Produção vegetal. Manejo do solo. Demanda energética.

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INTRODUCTION

Optimised planning for cultivating second-crop maize starts with the first crop, choosing early-cycle soybean cultivars for clearing the area, followed by rapid planting of the maize crop (CORTEZ; ANGHINONI; ARCOVERDE, 2020). To do this, conservationist soil-management systems are adopted, such as no-till, reduced tillage or minimal cultivation, which consists in the minimum of soil turning and maintaining plant residue, with light scarification and harrowing. This allows the maize to be rapidly planted in succession to the soya, with an increase in production potential and less risk of loss from frost and/or drought, especially due to a reduction in soil water availability and air temperature during the winter (CORTEZ; ANGHINONI; ARCOVERDE, 2020; VIAN *et al*., 2016).

In addition, correctly regulating the components of the planter-fertiliser is of fundamental importance to maximise operational performance, improve the quality and initial establishment of the crop, and reduce production costs (FRANCETTO *et al*., 2015).

Sowing quality is related to such operational factors as the furrowing mechanism of the planter-fertiliser, displacement speed, and sowing depth (SOUZA *et al*., 2019). When sowing maize, these settings are even more important due to productivity being strongly dependent on seed distribution by the planter (VIAN *et al*., 2016).

The type of furrowing mechanism together with furrowing depth can affect the speed of emergence index and the population of maize plants per hectare (SOUZA *et al*., 2019). Due to its role in turning the soil, the type of furrower influences the tractive force (TRICAI *et al*., 2016), with shanks possibly requiring greater tractive effort than discs (FRANCETTO *et al*., 2015; MILAGRES *et al*., 2016).

An increase in sowing speed can lead to a reduction in the quality of the longitudinal distribution of the maize seeds (CARPES *et al*., 2018; SOUZA *et al*., 2019) and seedlings (ALONÇO *et al*., 2015; CORTEZ; ANGHINONI; ARCOVERDE, 2020). This is due to the greater demand of the dispensing mechanisms, which can lead to filling errors, a fault or lack of seeds in the well of the mechanism, with less regular distribution and more gaps (CARPES *et al*., 2018; CORTEZ; ANGHINONI; ARCOVERDE, 2020).

The energy demand can also increase when increasing the speed of the sowing operation (SILVEIRA *et al*., 2013). The association between furrower type and planter speed is related to furrow depth and area of turned soil (MODOLO *et al*., 2012), factors that establish a relationship with energy demand (TRICAI *et al*., 2016). Therefore, factors such as the suitability and condition of the tractor-equipment set, depth of operation, type and condition of the soil, type and number of operations for preparing the soil, and the soil water content (FURLANI *et al*., 2013), show a relationship with fuel consumption in agricultural tractors, which represents one of the highest costs in agricultural operations.

Therefore, the aim of this study was to evaluate the performance and sowing quality of a planter-fertiliser for maize, in a dystroferric Red Latosol under reduced tillage, as a function of the type of furrower, depth of seed deposition and sowing speed.

MATERIAL AND METHODS

The experimental area is in Dourados, Mato Grosso do Sul, Brazil (22º14’S, 54º59’W, at an altitude of 434 m). The climate in the region is of type Am, tropical monsoon (ALVARES *et al*., 2013). The B2620 PWU hybrid maize cultivar was grown in a dystroferric Red Latosol, with a mean slope of 2%, comprising 60% clay, 15% silt and 25% sand in the 0 to 0.20 m layer. The area had been managed for ten years under a no-till system of soya and maize, and was now under spontaneous vegetation with a large infestation of annual weeds, especially Guinea grass (*Panicum maximum* Jacq.) and sourgrass (Digitaria insularis).

To incorporate the spontaneous vegetation, mechanical soil management was carried out five days before starting the experiment (17/02/2017), using reduced soil preparation by means of heavy harrowing followed by levelling, using a harrow plough with ten discs, each 30” in diameter, a weight of 1,688 kg and working width of 1,530 mm, and a levelling harrow with 28 discs, 22” in diameter, with a weight of 786 kg and working width of 2,350 mm. The 0-0.20 m layer of prepared soil showed a density of 1.38 Mg m^{-3}, penetration resistance of 1.87 MPa, and water content of 0.24 g g^{-1}.

To carry out the field trials, a New Holland model TL85E, 4x2 AFT tractor, with autopilot, a telemetry data collection system (Field Logger), 4.2 Mg total loaded weight including operator, 3,908 cm³ cylinder capacity, 64.8 kW rated engine power at 2,400 rpm, 56.7 kW maximum PTO power, drawbar height of 0.47 m, wheelbase of 2.35 m, 18.4-34 rear tires and 14.9-24 front tires. Coupled to the tractor was a PPSOLO speed box 4500 five-row planter-fertiliser with a working width of 4,480 mm and approximate weight of 4.1 Mg equipped with a smooth disc-type straw-cutting mechanism, horizontal perforated-disc seed-distribution mechanism, channelled-rotor fertiliser-distribution mechanism, and adjustable compactor wheels.

The machine was adjusted for a distribution of 55,000 maize seeds per hectare, at a spacing of 90 cm between rows. The tractor engine was initially regulated to maintain a rotation of 2,000 rpm during the tests.

The experimental design was completely randomised in a split-plot scheme, where the plots comprised the type of furrowing mechanism (shank or double-disk) and the subplots comprised the three mean displacement speeds (3.20, 5.15 and 7.32 km h^{-1}) and two mean sowing depths (35 and 40 mm), with three replications. Each experimental unit occupied an area of 90 m^2.

After sowing, the depth of seed deposition in the planting row was measured along one linear metre with 4 replications, using a rule with a resolution of 1 mm, as described by Souza *et al*. (2019).

The percentage and speed of emergence index of the seedlings were evaluated in a 20-m length of planting row, with four replications (SOUZA *et al*., 2019). The emerged seedlings were counted daily over 17 days. The percentage of seedling emergence was determined by the total number of emerged seedlings at the last count divided by the number of seeds distributed during sowing (SOUZA *et al*., 2019).

The longitudinal distribution uniformity of the seeds was determined using the methodology described by Arcoverde *et al*. (2017) and Cortez, Anghinoni and Arcoverde (2020), considering the following spacing percentages: 'double' (DBL): ≤ 0.5 times the Xref; 'normal or acceptable' (NOR) (A): 0.5 < Xref ≤ 1.5; and 'gap' (GAP): > 1.5 times the Xref, where Xref is the value of the reference spacing calculated based on the setting of the planter-fertiliser for each operation. As the Xref was 0.20 m, values of less than 0.10 m were considered 'double', values greater 0.10 m and less than or equal to 0.30 m were considered 'normal" and, finally, spacing values greater than 0.30 m were considered 'gaps'.

The force and power required at the drawbar, and the fuel consumption of the tractor with the planter configured for transport were determined as a function of the displacement speed of the set.

The effective field capacity was determined from the quotient of the sown area of each experimental unit and the time actually spent on each test (SOUZA; FERNANDES, 2020). Operational field capacity was calculated using Equation 1, obtained as per the methodology of the American Society of Agricultural and Biological Engineers (2006).

$$FC_O = FCe\frac{5.2V + 25.04}{100} \quad (1)$$

where, FCe – effective field capacity, ha h^{-1}; FC_O – operational field capacity, ha h^{-1}; V – displacement speed, km h^{-1}.

The tractive force was determined using a Z-shaped load cell with a maximum capacity of 49.1 kN. The power required by the planter-fertiliser at the tractor drawbar was determined from the product of force and speed. The equivalent power of the tractor engine was determined using an efficiency of 72% between the boom and the PTO (AMERICAN SOCIETY OF AGRICULTURAL AND BIOLOGICAL ENGINEERS, 2006), and a nominal engine efficiency for a PTO of 87.5%. The energy consumed per hectare of sown maize was determined using Equation 2.

$$E_{ha} = \frac{W}{FCo} \quad (2)$$

where, E_{ha} – energy consumed per hectare of sown maize, kWh ha^{-1}; W – power demanded by the set, kW.

Fuel consumption was determined using two model M-IIILSF41L0-M2 flow meters (injection pump and return), with a pulse-type output signal and resolution of 1 mL per pulse. The hourly consumption was calculated from the fuel consumption data and the time of each test (Equation 3). Specific fuel consumption was determined using Equation 4. Fuel density was 781.5 ± 2.5 g L^{-1}.

$$C_h = 3.6\frac{C}{t} \quad (3)$$

$$C_s = D\frac{C_h}{W} \quad (4)$$

where, Ch – hourly fuel consumption, L h^{-1}; C – fuel consumption of the experimental unit, mL; t – time spent on the experimental unit, s; Cs – specific fuel consumption, g kWh^{-1}; D – fuel density, g L^{-1}.

The travel reduction ratio resulting from drive-wheel slippage was determined based on the relationship between the number of turns of the tyres, as per Equation 5. A wheel with 32 teeth and an infrared sensor were installed at the tip of the rear axle of the tractor to measure the number of turns of the drive wheels.

$$S = 100\left(\frac{n_0}{n_1} - 1\right) \quad (5)$$

where, n_0 – number of turns of the tractor drive wheels configured for the tractive regime of the planter-fertiliser; n_1 – number of turns of the tractor driving wheels operating to transport the planter-fertiliser; s – travel reduction ratio, %.

The data were submitted to analysis of variance with the mean values compared by Tukey's test at 5% probability. Regression analysis was carried out considering the significance of the coefficients, the coefficient of determination and a study of the phenomenon, at 5% probability. The SAEG 9.1 software was used for the analysis.

RESULTS AND DISCUSSION

Using the double-disk, the seedling speed of emergence index (SEI), emergence in the field, acceptable spacing and number of gaps were greater, however using the shank resulted in fewer gaps (Table 1). Normal spacing occurs at a depth of 35 mm. When the soil is submitted to reduced tillage, the sowing speed does not affect the SEI, emergence in the field or seed distribution.

Souza *et al*. (2019) found that only from 7.2 km h^{-1} was there any effect on seed deposition, germination, SEI or seedling population. These authors found no effect from the furrower or depth. Bottega *et al*. (2014), also found a reduction in the acceptable spacing from 7.0 km h^{-1}.

It should be noted that the values for acceptable spacing (Table 1) were not considered satisfactory, as they were less than 60%, which is the minimum required for a quality mechanical planter (MIALHE, 1996). This contributed to the increase in faulty spacing, which may have been due to mechanical damage to the seeds from the action of the horizontal dispensing mechanism (BOTTEGA *et al*., 2018). Furthermore, as there was no effect from the sowing speed, the existence of any gaps when filling the holes with seeds may not have been noticeable due to a reduction in the time available at higher speeds (CORTEZ; ANGHINONI; ARCOVERDE, 2020).

The speed of emergence index, emergence in the field and normal spacing demonstrate the better action of the double-disc furrower at smaller depths (Table 1), agreeing with Modolo *et al*. (2013) and Trogello *et al*. (2012). For Souza *et al*. (2019), in no-tillage maize, the furrowing mechanisms exert different behaviour over germination depending on the cutting depth of the soil and seed deposition.

There was an increase in effective and operational capacity, as well as in power, with the increase in speed, while force was not affected (Table 2). These results corroborate those of Cortez *et al*. (2018). However, Milagres *et al*. (2015) found that each increment of 1.0 km h^{-1} increased the planting row by 1.19 kN. Queiroz *et al*. (2017) point out that because power is a product of strength and speed, it is expected that the higher the speed, the greater the tractive power, to maintain constant strength.

The force required at the tractor drawbar was influenced by the interaction of depth of seed deposition and furrower type of the planter-fertiliser (Table 2), agreeing with the results obtained by Francetto *et al*. (2015), Milagres *et al*. (2015) and Tricai *et al*. (2016).

Table 1 - Summary of the analysis of variance and mean values for the speed of emergence index (SEI, seedlings day^{-1}), emergence in the field (SE, %), acceptable spacing (NOR, %), double spacing (DBL, %), gaps (GAP, %), effective field capacity (FCe, ha h^{-1}) and operational field capacity (FCo, ha h^{-1}) for furrower type (Fu), sowing speed (V) and sowing depth (P)

SV	DF	Mean square						
		SEI	SE	NOR	DNL	GAP	FCe	FCo
Fu	1	0.4032*	401.334*	814.151*	42.453	492.100*	0.0584	0.0665
Error(a)	4	0.0448	30.629	130.569	70.301	88.291	0.1841	0.1539
V	2	0.0340	9.366	248.814	52.975	109.345	10.635*	6.9808*
V×Fu	2	0.0474	28.066	29.501	11.675	57.103	0.0605	0.0508
P	1	0.0434	32.111	676.0*	1.913	607.622	0.0111	0.0089
P×V	2	0.27×10^{-5}	2.250	0.711	16.133	19.213	0.0106	0.0089
P×Fu	1	0.0092	5.126	273.463	59.375	119.415	0.0214	0.0130
Fu×V×P	2	0.0075	1.335	0.411	24.585	25.935	0.0025	0.0015
Residuals	20	0.0424	19.889	134.916	36.447	165.171	0.0599	0.0493
Furrowers								
Double-disk		3.27 a	81.18 a	51.74 a	6.35 a	51.42 a	2.39 a	1.35 a
Shank		3.06 b	74.50 b	42.23 b	4.23 a	44.03 b	2.31 a	1.26 a
Sowing speed (km h^{-1})								
3.20		3.18 a	78.18 a	46.01 a	4.34 a	49.63 a	1.44 c	0.60 c
5.15		3.23 a	79.15 a	45.40 a	7.53 a	47.07 a	2.32 b	1.21 b
7.32		3.10 a	76.20 a	49.54 a	4.00 a	46.48 a	3.30 a	2.09 a
Sowing depth (mm)								
35		3.21 a	78.78 a	51.32 a	5.06 a	43.62 a	2.37 a	1.33 a
40		3.14 a	76.90 a	42.65 b	5.52 a	51.83 a	2.33 a	1.28 a

*Significant at 5% probability by F-test. Mean values followed by the same letter do not differ by Tukey's test at 5% probability. SV – source of variation. DF – degrees of freedom

Table 2 - Summary of analysis of variance and mean values for tractive force (Fb, kN), tractor engine power (Pm, kW), energy demand (EPH, kWh ha^{-1}), hourly fuel consumption (Ch, L h^{-1}), specific fuel consumption (Cs, g kWh^{-1}) and travel reduction ratio (s, %) for the variables furrower type (Fu), sowing speed (V) and sowing depth (P)

SV	DF	Mean square					
		Fb	Pm	EPH	Ch	Cs	s
Su	1	0.0487	3.6269	0.9487	3.8993	38265.88*	57.557**
Error(a)	4	1.7947	8.7076	13.975	1.5993	2964.733	13.410
V	2	12.878	957.64*	80.997*	190.298**	26827.77	660.23*
V×Su	2	6.1606	65.208	18.536	17.7231**	30040.67	36.657
P	1	21.814*	180.48*	61.426	1.5260	70198.50*	103.63*
P×V	2	3.0637	24.801	11.488	2.6453	7755.443	271.16**
P×Fu	1	98.937*	360.01*	435.05*	0.00004	897724.7**	1.1306
Fu×V×P	2	3.3918	2.6261	30.805	2.2104	13493.44	19.692
Residuals	20	4.2399	34.155	15.157	2.3974	13629.1	22.322
Furrowers							
Double-disk		7.15 a	17.11 a	13.68 a	10.4 a	530.9 b	15.9 b
Shank		7.23 a	16.48 a	14.00 a	11.1 a	596.1 a	18.4 a
Sowing speed (km h^{-1})							
3.20		7.15 a	10.06 b	16.81 a	7.33 c	597.15 a	12.3 b
5.15		6.84 a	15.48 b	13.02 ab	9.88 b	584.07 a	13.5 b
7.32		7.58 a	24.85 a	11.69 b	15.1 a	509.50 a	25.7 a
Sowing depth(mm)							
35		7.11 b	17.12 a	13.54 a	10.57 a	519.42 b	15.49 b
40		7.27 a	16.48 b	14.13 a	10.98 a	607.73 a	18.88 a

*Significant at 5% probability by F-test. Mean values followed by the same letter do not differ by Tukey's test at 5% probability. SV – source of variation. DF – degrees of freedom

The force at the drawbar seen while transporting the planter-fertiliser was 5.2 kN, equal to the effort required to overcome soil resistance to the rolling of the machine support wheels.

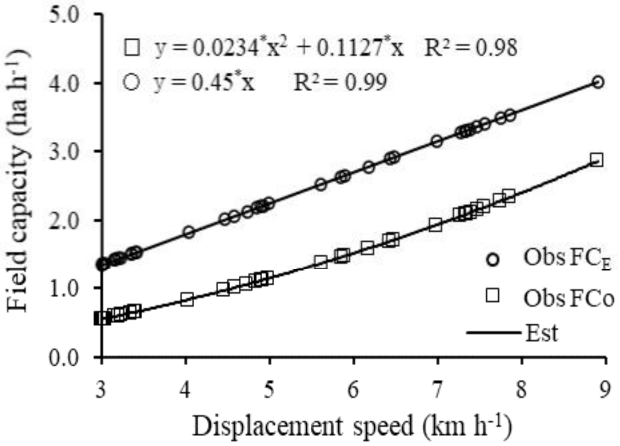
The effective field capacity increased with the increase in the speed of the tractor-planter-fertiliser set (Figure 1). These results were expected, as field capacity is a direct function of speed (FURLANI *et al*., 2008).

The values for operational field capacity showed quadratic behaviour with an increase in speed (Figure 1). This result can be explained by the fact that an increase in speed reduces machine time while maintaining the manoeuvring and interruption times. Field production (AMERICAN SOCIETY OF AGRICULTURAL AND BIOLOGICAL ENGINEERS, 2006) varies with the speed of operation, differing from the results obtained by Amorim *et al*. (2019), who adopted a constant yield value of 75%. Santos *et al*. (2021) adopted a constant value of 75% for yield, working with a speed of 4.5 km h^{-1} when sowing; while for the same speed in this study, a yield of 48.4% was achieved.

The power required at the engine and tractor drawbar to transport and pull the machine increased linearly with the increase in speed (Figure 2). An increase in speed entails greater energy demand to traverse the experimental unit in less time, thereby explaining the behaviour of the power values. Transportation power represents up to 69% of the power required at the drawbar during sowing tests, for this reason the less displacement lost in the field, the better the planting system can be optimised, with a reduction in displacement costs.

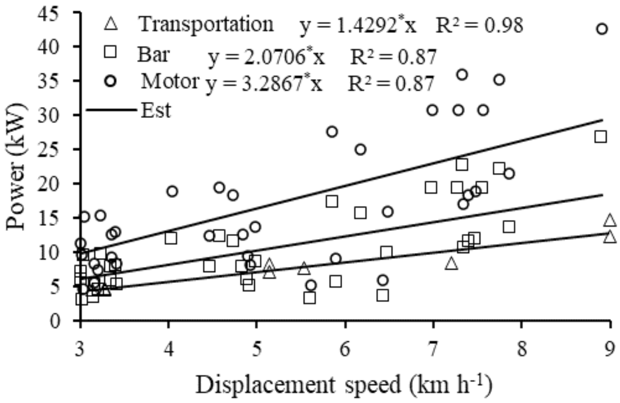
Higher specific fuel consumption and a higher travel reduction ratio were seen when the shank furrower was used. The travel reduction ratio was lower at the lowest speed and at a depth of 35 mm. At higher speeds, less energy was consumed per hectare, despite showing the highest hourly fuel consumption and travel reduction ratio (Table 2). The values for the travel reduction ratio were similar to those found by Furlani *et al.* (2008) while sowing maize in a clayey Oxisol under conventional tillage.

Figure 1 - Effective (FC_E) and operational (FC_O) field capacity of the planter-fertiliser as a function of operating speed



*Significant at 1% by t-test

Figure 2 - Power demand at the drawbar for transport, and at the bar and tractor engine to pull the planter-fertiliser as a function of operating speed



*Significant at 1% by t-test

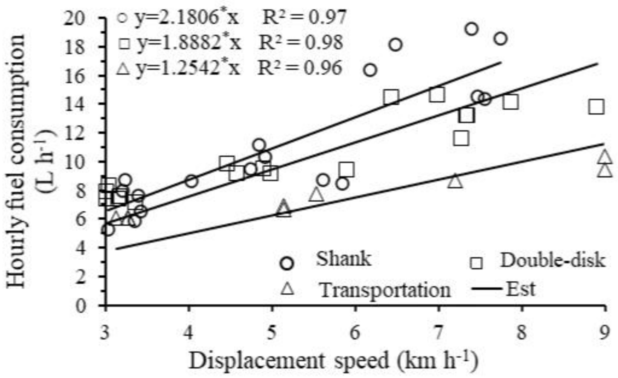
For both furrowing mechanisms, an increase in hourly fuel consumption was seen with the increase in speed (Figure 3), the highest values being found when using the shank furrower. These results are related to the increase in travel reduction ratio with the increase in speed (Figure 4), responsible for raising the equivalent power of the engine, and reflecting in increased fuel consumption. The hourly fuel consumption seen for transportation ranged from 3.7 to 11.2 L h^{-1}, which demonstrates that lower displacement speeds should be chosen, provided that the search for optimal yield allows for higher speeds to be adopted.

There was a linear increase in hourly fuel consumption with the increase in the travel reduction ratio (Figure 5). According to Furlani *et al.* (2008), the increase in hourly consumption is attributed to greater tractive force and power, in this study, to the equivalent power of the engine.

The force required at the drawbar, the power demand on the engine and the energy required to sow one hectare of maize showed higher values when the greatest depth was chosen, regardless of the furrower (Table 3). On the other hand, when the shank furrower was used at the shallowest depth, it showed similar results in terms of strength and power to those obtained using the double disc. At the greatest depth, only energy demand was affected by the type of furrower, with the double disk showing the highest value; the opposite was seen at the greatest sowing depth (Table 3).

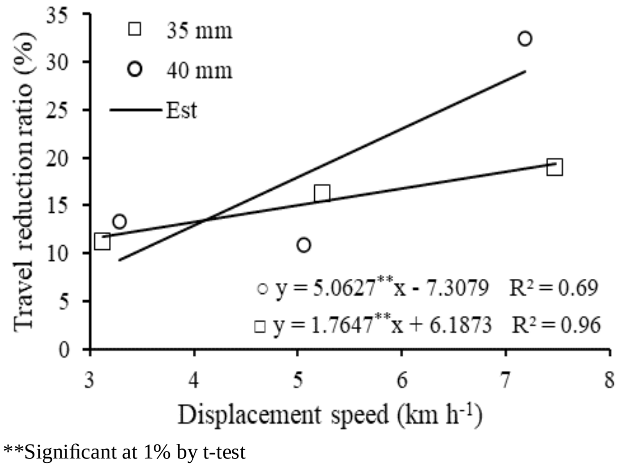
Francetto *et al*. (2015), Levien *et al*. (2011) and Milagres *et al*. (2015), evaluating different furrowers, found that shanks result in a greater demand for tractive force, and that when working at greater depths, there was an increase in the demand for force and power at the bar (GROTTA *et al*., 2009).

Figure 3 - Hourly fuel consumption as a function of speed, with two furrowers and transportation of the planter-fertiliser



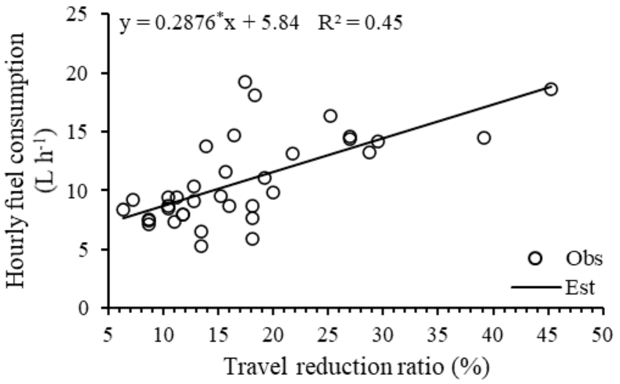
*Significant at 1% by t-test

Figure 4 - Travel reduction ratio as a function of sowing speed and depth



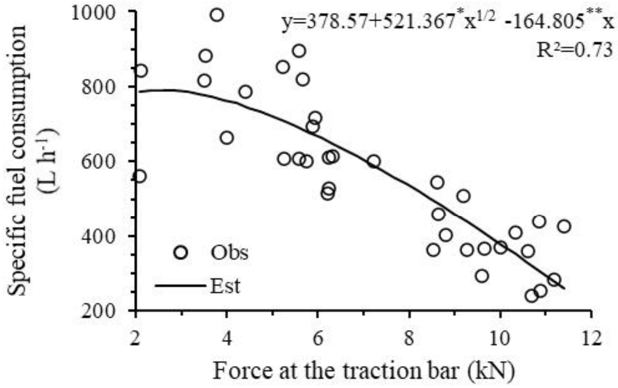
**Significant at 1% by t-test

Figure 5 - Hourly fuel consumption of the tractor engine for pulling the planter-fertiliser as a function of the travel reduction ratio



*Significant at 1% by t-test

Figure 6 - Specific fuel consumption of the tractor engine to pull the planter-fertiliser as a function of the force required at the drawbar



* and ** Significant at 1% and 5% by t-test

Table 3 - Mean values for drawbar force, engine power, energy required per hectare and specific fuel consumption for furrower type and sowing depth

Furrower	Sowing depth	
	35 mm	40 mm
	Drawbar force (kN)	
Double-disk	4.87 aB	9.43 bA
Shank	4.79 aB	9.66 aA
	Engine power	
Double-disk	11.08 aB	23.15 aA
Shank	11.08 aB	21.88 bA
	Energy demand (kWh ha^{-1})	
Double-disk	9.48 aB	17.87 bA
Shank	9.22 bB	18.78 aA
	Specific fuel consumption (g kWh^{-1})	
Double-disk	417.22 bB	798.26 aA
Shank	644.73 aA	394.11 bB

Mean values followed by the same lowercase letters in a column and uppercase letters on a line do not differ by Tukey's test at 5% probability

Specific fuel consumption was reduced as the square root of the force increased (Figure 6). This shows that an increase in force affords better use of fuel within the adopted configurations for tractor engine acceleration during the seeding operation and its effective demand in the field.

According to Levien *et al.* (2011), use of the shank furrower generally results in more soil being turned along the planting row than when using double discs, with less demand for tractive force and fuel consumption, as well as less slippage, thereby affording an increase in operational capacity.

CONCLUSIONS

1. Use of the double-disk instead of the shank furrower, regulated to deposit seeds at a depth of 35 mm, in addition to benefitting the initial establishment of second-crop maize, allows the mechanised sowing system to be optimised in relation to an increase in operational performance and reduction in energy demand, when carried out in a dystroferric Red Latosol managed under reduced tillage;
2. When sowing maize, the adoption of higher displacement speeds results in an increase in operational and effective field capacity, as well as a lower energy demand when the tractor-planter-fertiliser set develops a speed close to or greater than 7 km h^{-1}, irrespective of the type of furrower.

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