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PERFORMANCE OF A CONTINUOUS FLOW SEEDER AT DIFFERENT TIRE INFLATION PRESSURES

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ABSTRACT: The performance of the seeder is entirely attributable to the interaction of the tires with the ground. Thus, the aim of this study was to evaluate the grain weight (g/m), seed population (nº/ha), tire performance (%) and displacement efficiency (%), at different loads in the continuous seeder-fertilizer flow and tire inflation pressures, in conventional system and no tillage system. This experiment was carried out in 2015; it was performed using randomized blocks with four replications in a 3 × 3 factorial. There were three loads in the continuous flow seeder (100, 50, and 10%), and three inflations of the tires (20, 40, and 60 psi), totaling 36 plots. In both planting systems, when the tire of the seeder is at 60 psi and loads below 100% of fertilizer and seeds, the deposited seed population is less than ideal. In conventional tillage, the tire inflation pressure is less harmful to their performance on the ground.

Keywords: plantability, maintenance of machinery, *Sorghum bicolor*

DESEMPENHO DE UMA SEMEADORA DE FLUXO CONTÍNUO EM DIFERENTES PRESSÕES DOS PNEUS

RESUMO: O desempenho das semeadoras está totalmente ligado à interação dos pneus com o solo. Assim o objetivo do trabalho foi avaliar a massa de grãos (g m-1), população de sementes (nº ha-1), desempenho dos pneus (%) eficiência de deslocamento (%), em diferentes cargas na semeadora adubadora de fluxo contínuo e pressões de inflagem dos pneus, em sistema de plantio convencional e plantio direto. O experimento foi conduzido em 2015, com delineamento em blocos ao acaso, em fatorial 3 × 3, com quatro repetições. Foram três cargas na semeadora-adubadora de fluxo contínuo (100, 50 e 10%) e três inflagens nos pneus (20, 40 e 60 psi), totalizando 36 parcelas. Em ambos os sistemas de plantio, quando os pneus da semeadora estavam preenchidos com 60 psi e cargas abaixo de 100%, a deposição da população de sementes é menor do que a ideal. Em sistema de plantio convencional, a inflagem dos pneus é menos prejudicial ao desempenho da semeadora.

Palavras-chave: plantabilidade, manutenção de máquinas, *Sorghum bicolor*

1 INTRODUCTION

The longitudinal distribution of seeds is one of the most important tasks in the sowing process of any culture, as different cultures require different spacing between the seeds (OKOPNIK; FALATE, 2014).

One reason quality stands are in demand is that they play a role in plant development reaching its full potential. The seeder is the primary tool used for correct seed distribution (PORTELLA, 1999; ANANTACHARA; KUMARB; GURUSWAMYA, 2010; ZHAN et al., 2010;

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NAVID et al., 2011).

According to Correia et al. (2014), a large number of these sowings are performed with continuous seeder-fertilizer flow, characterized by the continuous distribution of small seeds in the furrow along with the fertilizer.

Garcia et al. (2011) observed that common errors occur because of increased displacement speed. Lack of periodic seeder inspection can cause damage affecting improper displacement speed, a seeder that is not inspected can lead to a lack or excess of seed and/or fertilizer in the ground.

The contact of the tires of the seeder with the ground is essential for the activation of the seed and fertilizer metering mechanism (FURLANI et al., 2008), and the deposition efficiency is directly related to factors such as soil conditions, tire characteristics (including inflation pressure), and displacement speed (SILVA & GAMERO, 2010; SANTOS et al., 2011; SILVEIRA et al., 2012; BOTTEGA et al., 2014).

Thus, the aim of this study was to evaluate the grain weight (g/m), seed population (nº/ha), tire performance (%) and displacement efficiency (%), at different loads in the continuous seeder-fertilizer flow and tire inflation pressures, in conventional system and no tillage system.

2 MATERIAL AND METHODS

This experiment was carried out in 2015 at São Paulo State University's College of Agronomy located in Botucatu, São Paulo (22° 51' S and 48° 26' W, average altitude of 770 m).

A tractor-seeder combination was select for the experiment. The tractor (Valmet) had 4 × 2 front wheel assistance and rated engine power of 94.1 kW (128 hp), with a displacement speed of 4.2 km/h.

A continuous flow seeder (Semeato SHM1517) was used, with diagonal tires measuring 6.00-16, tire circumference of 2,410 mm, recommended air internal pressure of 44 psi (Lb/Pol2), a fertilizer hopper with 580 kg capacity and a seed hopper with 332 kg capacity.

Without periodic inspection of the seeder's tires establishment of the culture is at risk. To test this hypothesis, two experiments were conducted.

The ground was prepared for conventional tillage through one subsoiling at a depth of 0.35 m and two light harrowings. The other system no tillage is characterized by the desiccation of the Braquiária (*Urochloa decumbens*), carried out after three weeks, with the aid of a chaff spreader, shredding and homogenizing the dry matter (estimated at 14 t/ha).

The experiments were performed using randomized blocks with four replications in a 3 × 3 factorial. There were three loads in the continuous flow seeder (100, 50, and 10%), and three inflations of the tires (20, 40, and 60 psi), totaling 36 plots. The seeder fertilizer was checked with three loads (weight), 100% (912 kg), 50% (456 kg), and 10% (91.2 kg), and three inflation pressures into the tires: 20, 40, and 60 psi.

The seeder was checked with fertilizer given predetermined loads and grain weight (g/m) evaluations, and the population (seeds/ha) were seeds of the grain sorghum (Sorghum bicolor) with a predetermined population of 140,000 seeds per hectare.

The seed population was collected in plastic bags fastened to the ends of the seed delivery tubes. The collected seeds were subsequently weighed on a digital balance; 100 seeds were counted manually and weight relative to number of seeds was obtained.

The performance of the wheelsets and displacement efficiency were measured by pulse generators (GIDP-60-U12V), which were fixed in the center axle of the seeder wheelset and converted rotary movements into electrical pulses, sending 60 pulses per turn of the tire.

Performance is measured by the relationship between number of the tire turns, obtained from the pulse generator in each plot, and the number of theoretical turns (length of the plot in relation to the circumference of the tire). The displacement efficiency is determined by the relationship between the real average speed achieved in each plot and the theoretical speed.

The data obtained from each experimental plot were evaluated using variance analysis methods. Treatment effects were assessed using the t-student test to determine the significance of the difference between the means at a 5% probability level. When interaction was verified, post analysis was performed to investigate whether the effect occurred owing to the loads of the seeder, the inflation pressure into the tires, or both.

3 RESULTS AND DISCUSSION

As described above, two separate experiments were conducted one in conventional tillage and the other in no tillage system.

3.1 Conventional tillage

Results of the statistical analysis show that the variance factors were affected by grain weight (g/m), seed population (nº/ha), and tires performance (%), as described in Table 1.

Table 1. Statistical analysis to grain weight (GW), seed population (SP), tire performance (TP), and displacement efficiency (DE), in relationship between the loads (L) and inflation pressures (IP)

Source of variation	**GW**	**SP**	**TP**	**DE**
L	(g/m)	(nº/ha)	----------%------------	
100%	8,45 a	127.062 a	13,11 a	99,95 b
50%	8,20 b	123.295 b	12,16 a	102,7 a
10%	7,70 c	115.782 c	5,85 b	103,8 a
IP				
60 psi	7,89 c	118.663 c	6,85 c	100,5 a
40 psi	8,33 a	125.188 a	9,60 b	102,7 ab
20 psi	8,14 b	122.317 b	14,67 a	103,2 a
C.V. (%)	1,87	1,87	24,74	2,76
L	75,59**	75,59**	28,36 **	6,11*
IP	24,75**	24,75**	28,70 **	3,07 n.s.
L x IP	22,64**	22,64**	3,58*	0,94 n.s.

The averages followed by the same letter in the column do not differ. The T Student test was applied at 5% probability. * and ** significant at 5 and 1% probability, respectively. n.s. not significant. C.V. (%) coefficient of variation

The displacement efficiency was not affected by the factors. The displacement speed used was satisfactory in regards to the operating performance and lower specific consumption (Macedo et al., 2016; Santos et al., 2016).

Table 2 provides a statistical detailing the interaction results. It can be seen that the smaller the load, the less fewer are the seeds deposited; this effect is amplified when the tire is filled more than recommended (44 psi).

Table 2. Statistical detailing to the grain weight (GW) and seed population (SP) in relationship between the loads (L) and inflation pressures (IP)

L %	IP					
	60 psi		40 psi		20 psi	
	GW (g/m)	SP (nº/ha)	GW (g/m)	SP (nº/ha)	GW (g/m)	SP (nº/ha)
100	8,38 aA	126.025 aA	8,53 aA	128.223 aA	8,45 aA	126.937 aA
50	7,51 cC	112.904 cC	8,73 aA	131.242 aA	8,37 aB	125.738 aB
10	7,78 bA	116.970 bA	7,72 bA	116.101 bA	7,60 bA	114.276 bA

The averages followed by the same do not differ. The uppercase for lines and the lowercase for columns

The efficiency of the seeder is directly related to soil conditions, as well as displacement speed (FURLANI et al., 2008; SILVA & GAMERO, 2010; VALE et al., 2010; SANTOS et al., 2011). In this study, it was observed that soil with conventional tillage is less damaging to the deposition of seeds when the tires are filed with approximately less than 50% of the recommended pressure.

The higher the tire inflation pressure the lower is the seeder performance, as seen in Table 3.

Table 3. Statistical detailing to the tire performance (TP) in relationship between the loads (L) and inflation pressures (IP)

L %	IP		
	60 psi	40 psi	20 psi
100	8,55 aC	12,31 aB	18,48 aA
50	6,54 aC	12,61 aB	17,31 aA
10	5,44 aAB	3,87 bB	8,23 bA

The averages followed by the same do not differ. The uppercase for lines and the lowercase for columns

The performance of the seeder is entirely attributable to the interaction of the tires with the ground. Every time wheel slip occurs, the seeder systems is not triggered, thus seeds and fertilizers are not deposited and failures result in the sowing and plant's stand (OLIVEIRA et al., 2000).

Taghavifar and Mardani (2012) verified the increase of soil contact area by increasing the load on the tires. Moreover, tire inflation was low at the prescribed increase in contact area.

3.2 No tillage

The results of the statistical analysis for the system no tillage show that the variance factors were influenced by the grain weight (g/m), and consequently the seed population (nº/ha), as described in Table 4.

Table 4. Statistical analysis to grain weight (GW), seed population (SP), tire performance (TP), and displacement efficiency (DE), in relationship between the loads (L) and inflation pressures (IP)

Source of variation	GW	SP	TP	DE
L	(g/m)	(nº/ha)	-----------%------------	
100%	9,17 a	137.882 a	3,44 b	99,51 b
50%	8,80 b	132.303 b	5,08 a	102,3 a
10%	8,67 b	130340 b	5,04 a	103,3 a
IP				
60 psi	8,76 b	131.623 b	1,55 c	100,8 a
40 psi	9,12 a	137.009 a	4,98 b	101,6 a
20 psi	8,77 b	131.893 b	7,03 a	102,6 a
C.V. (%)	2,17	2,17	30,33	2,64
L	21,87**	21,87**	5,55*	6,45**
IP	13,16**	13,16**	48,89**	1,31 n.s.
L x IP	13,92**	13,92**	1,72 n.s.	2,17 n.s.

The averages followed by the same letter in the column do not differ. The T Student test was applied at 5% probability. * and ** significant at 5 and 1% probability, respectively. n.s. not significant. C.V. (%) coefficient of variation

The performance of the tires and the displacement efficiency showed no effect on the seeder loads or inflation pressures. Furlani et al. (2008) researching tire pressures also detected no statistical difference in performance in system no tillage.

There was significant interaction between the loads and tire inflation with respect to number of seeds deposited, as described in Table 5.

Table 5. Statistical detailing to the grain weight (GW) and seed population (SP) in relationship between the loads (L) and inflation pressures (IP)

L%	IP					
	60 psi		40 psi		20 psi	
	GW	SP	GW	SP	GW	SP
	(g m^{-1})	(sem ha^{-1})	(g m^{-1})	(sem ha^{-1})	(g m^{-1})	(sem ha^{-1})
100	9,23 aA	138.732 aA	9,12 bA	137.076 bA	9,17 aA	137.837 aA
50	8,45 bB	127.051 bB	9,51 aA	142.900 aA	8,45 bB	126.958 bB
10	8,59 bA	129.085 bA	8,72 cA	131.051 cA	8,71 bA	130.884 bA

The averages followed by the same do not differ. The uppercase for lines and the lowercase for columns

Despite the factors related to the displacement of the seeder not showing a difference in this study, the ideal would be the smallest wheel slip possible, as this directly influences the distribution of seeds (FURLANI et al., 2008). In addition note that the ideal pressure is designated by the manufacturer, regardless of whether the seeder is at maximum or minimum load.

Cortez et al. (2009) studying inflation pressure of the wheel set from 55 to 75 psi, did not find damage in the longitudinal distribution of maize, which differ from the pressures of 20, 40, and 60 psi for sorghum distribution used in this study.

4 CONCLUSIONS

In conventional tillage, the seed population is closer to the deposition ideal when the tire 6.00-16 is filled with 40 psi. In system no tillage, the seed population deposited is more regular for tire inflation pressures of 60 and 20 psi when the seeder is fully loaded.

In both planting systems, when the tire of the seeder is at 60 psi and loads below 100% of fertilizer and seeds, the deposited seed population is less than ideal. In conventional tillage, the tire inflation pressure is less harmful to their performance on the ground.

5 REFERENCES

ANANTACHARA, M.; KUMARB, P. G. V.; GURUSWAMYA, T. Neural network prediction of performance parameters of an inclined plate seed metering device and its reverse mapping for the determination of optimum design and operational parameters. **Computer Electronic Agriculture**, Amsterdam, v. 72, n. 2, p. 87-98, 2010.

BOTTEGA, E. L.; ROSOLEM, D. N.; OLIVEIRA NETO, A. M.; PIAZZETTA, H. V. L.; GUERRA, N. Qualidade da semeadura do milho em função do sistema dosador de sementes e velocidades de operação. **Global Science Technology**, Rio Verde, v. 7, n. 1, p. 107-114, 2014.

CORREIA, T. P. S.; SILVA, P. R. A.; SOUSA, S. F. G.; TAVARES, L. A. F.; PALUDO, V. Deposição e danos mecânicos em sementes de sorgo utilizando um mecanismo dosador de fluxo contínuo em ensaio de bancada. **Energia na Agricultura**, Botucatu, v. 29, n. 1, p. 22-26, 2014.

CORTEZ, J. W.; FURLANI, C. E. A.; VIGNA, G. P.; BORSATTO, E. A.; SILVA, R. P. Desempenho do trator agrícola no manejo da cultura de cobertura e pressão de inflação do pneu da semeadora. **Engenharia Agrícola**, Jaboticabal, v. 29, n. 1, p. 72-80, 2009.

FURLANI, C. E. A.; SILVA, R. P.; CARVALHO FILHO, A.; CORTEZ, J. W.; GROTTA, D. C. C. Semeadora-adubadora: exigências em função do preparo do solo, da pressão de inflagem do pneu e da velocidade. **Revista Brasileira Ciências do Solo**, Viçosa, v. 32, n. 1, p. 345-352, 2008.

GARCIA, R. F.; VALE, W. G.; OLIVEIRA, M. T. R.; PEREIRA, E. M.; AMIM, R. T.; BRAGA, T. C. Influência da velocidade de deslocamento no desempenho de uma semeadora-adubadora de precisão no Norte Fluminense. **Acta Scientiarum Agronomy**, Maringá, v. 33, n. 3, p. 417-422, 2011.

MACEDO, D. X. S.; NICOLAU, F. E. A.; NASCIMENTO, H. C. F.; COSTA, E.; CHIODEROLI, C. A.; Loureiro, D. R. Operational performance of a tractor-seeder according to the velocity and working depth. Revista Brasileira de **Engenharia Agrícola e Ambiental**, Campina Grande, v. 20, n. 3, p. 280-285, 2016.

NAVID, H.; EBRAHIMIAN, S.; GASSEMZADEH, H. R.; MOUSAVINIA, M. J. Laboratory evaluation of seed metering device using image processing method. **Australian Journal of Agricultural Engineering**, Lismore, v. 2, n. 1, p. 1-4, 2011.

OKOPNIK, D. L.; FALATE, R. Usage of the DFRobot RB-DFR-49 Infrared Sensor to detect maize seed passage on a conveyor belt. **Computers and Electronics in Agriculture**, Amsterdam, v. 102, n. 1, p. 106-111, 2014.

OLIVEIRA, M. L.; VIEIRA, L. B.; MANTOVANI, E. C.; SOUZA, C. M.; DIAS, G. P. Desempenho de uma semeadora-adubadora para plantio direto, em dois solos com diferentes tipos de cobertura vegetal. **Pesquisa Agropecuária Brasileira**, Brasília, v. 35, n. 7, p. 1455-1463, 2000.

PORTELLA, J. A. **Plantio de precisão**: o desafio para o século XXI. Passo Fundo: Embrapa Trigo, 1999.

SANTOS, A. J. M.; GAMERO, C. A.; OLIVEIRA, R. B.; VILLEN, A. C. Análise espacial da distribuição longitudinal de sementes de milho em uma semeadora-adubadora de precisão. **Bioscience Journal**, Uberlândia, v. 27, n. 1, p. 16-23, 2011.

SANTOS, V. C.; SANTOS, P. R. A.; LIMA, I. O.; PEREIRA; V. R. F.; GONÇALVES, F. R. F.; CHIODEROLI, C. A. Performance of a seeder according to the displacement velocity and furrowing mechanism for fertilizer deposition. **Revista Brasileira de Engenharia Agrícola e Ambiental**, Campina Grande, v. 20, n. 3, p. 286-291, 2016.

SILVA, M. C.; GAMERO, C. A. Qualidade da operação de semeadura de uma semeadora-adubadora de plantio direto em função do tipo de martelete e velocidade de deslocamento. **Energia na Agricultura**, Botucatu, v. 25, n. 1, p. 85-102, 2010.

SILVEIRA, J. C. M.; FERNANDES, H. C.; LEITE, D. M.; TEIXEIRA, M. M.; FURTADO JUNIOR, M. R. Avaliação da qualidade da semeadura direta do milho em função do aumento da velocidade de deslocamento e do escalonamento de marcha de um conjunto trator-semeadora-adubadora. **Engenharia na Agricultura**, Viçosa, v. 20, n. 2, p. 95-102, 2012.

TAGHAVIFAR, H.; MARDANI, A. Contact area determination of agricultural tractor wheel with soil. **Cercetări Agronomice în Moldova**, Iasi, v. 45, n. 2, p. 15-20, 2012.

VALE, W. G.; GARCIA, R. F.; CORRÊA JUNIOR, D.; GRAVINA, G. A.; KLAVER, P. P. C.; Vasconcelos Junior, J. F. S. Influência da velocidade de deslocamento no desempenho de uma semeadora-adubadora direta. **Global Science Technology**, Rio Verde, v. 3, n. 3, p. 67-74, 2010.

ZHAN, Z.; YAOMING, L.; JIN, C.; LIZHANG, X. Numerical analysis and laboratory testing of seed spacing uniformity performance for vacuum-cylinder precision seeder. **Biosystems Engineering**, London, v. 106, n. 4, p. 344-351, 2010.