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Seeder Performance under Different Speeds and its Relation to Soybean Cultivars Yield

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ABSTRACT

Search for greater operating efficiency of seeders via increased speed in sowing operation has caused many problems in soybean plantability which may affect its yield components and final yield. Due to it, this study was carried out with the objective to evaluate a seeder performance under different operating speeds and its relation to soybean cultivars yield components and final yield in a no-till system. Experiment was laid out as a random block design, in a 2×4 factorial scheme, composed of two soybean cultivars and four seeder operating speeds. It was noticed that the seeder operating speed of 9.2 km h⁻¹ caused a reduction of 1.5 cm in the seed sowing depth resulting in an increase of 14% of exposed seeds. Moreover, soil disturbed area at the center of crop row showed an increase of 23.7% reducing so the seed emergence rate at 9.6% day⁻¹, affecting soybean final plant population what resulted in an yield decrease of 20%. The evaluated parameters showed similar results for the 7.7 and 3.4 km h⁻¹ seeder operating speeds, although, the best seeder performance was noticed at the lower operating speeds.

Key words: No-till system, seed depth deposition, soil mobilization, emergence speed rate, longitudinal distribution of plants, yield components

INTRODUCTION

Sowing is one of the key factors that influence the success of any crop establishment and productivity. No-till sowing requires a seeder that will effectively penetrate untilled soil and place the seed at the optimum depth for rapid plant emergence (Ozmerzi *et al.*, 2002). Precision seeders place fertilizer and seeds at the required spacing and provide a better growing area per seed (Ozmerzi *et al.*, 2002). Although, these parameters can be influenced by the sowing speed.

Brazilian climate associated with actual short crops cycle has allowed farmers to harvest two crops at summer and one at winter. In this productive system, time is very important and due to it, usually, farmers sowing speed is higher than it should be, directly affecting the distribution of seeds, depth of seed deposition and plowing on soils (Staggenborg *et al.*, 2004). However, there are results showing

that the variation on sowing speed does not interfere in the longitudinal distribution of plants, initial stand and soybean yield (Furlani *et al.*, 2010).

These differences between soybean yields in relation to sowing speed may be related to other variables that are occurring and are not being considered, such as: seed distributor mechanisms efficiency at different speeds; the distance from the seed tank deposit to the soil line once the vibration of the seeder may affect seed travel and displacement (Casao *et al.*, 2000); the type of seed feeder can affect seed distribution and sowing quality (Liu *et al.*, 2004a); factors inherent to the evaluated plant species such as the phenotypic plasticity of soybean genotypes expressing the components of production and grain yield and factors linked to population density (Mellendorf, 2011).

This study aimed to evaluate the performance of a seeder under different sowing speeds and its Relation to Soybean Cultivars Yield.

MATERIALS AND METHODS

The study was carried out at the experimental site of the Technologic Federal University of Parana-UTFPR, Campus of Dois Vizinhos. Soil at the experimental site is classified as a Distroferric Alfisol and has been managed with no-till system for over a decade with crop rotation among corn, bean and soybean at summer and wheat and oat at winter. At the sowing day, soil had an average gravimetric water content of 31.4% and bulk density of 1.34 g dm^{-3} .

As a prior crop, Sudan grass was grown in the area. Two months before soybean sowing, grass residue (4.6 Mg ha^{-1}) was desiccated with 1.200 g ha^{-1} of glyphosate.

Soil chemical fertilization was performed and according to the values found in soil analyses (0-15 cm depth), which were: $\text{pH-CaCl}_2 = 5.0$; $\text{P} = 6.92 \text{ mg dm}^{-3}$; $\text{K} = 0.18 \text{ cmol}_c \text{ dm}^{-3}$; 52.3 g kg^{-1} of organic matter; $\text{Ca} = 5.71 \text{ cmol}_c \text{ dm}^{-3}$; $\text{Mg} = 2.72 \text{ cmol dm}^{-3}$; $0.00 \text{ cmol dm}^{-3}$ of Al and Base saturation = 74.5%. Physical soil analyses showed values of 77.4, 1.1 and 21.5%, respectively for Clay, Sand and Silt. A total of 250 kg ha^{-1} of the chemical formula N-P-K (09-20-20) was applied at soybean sowing.

The experiment was laid out as a randomized block design in a 2×4 factorial scheme with four replications. Treatments consisted of two soybean cultivars (Nidera 5909 and Nidera 7000) and four sowing speed 0.94 m sec^{-1} (3.4 km h^{-1}), 1.58 m sec^{-1} (5.7 km h^{-1}), 2.14 m sec^{-1} (7.7 km h^{-1}) and 2.56 m sec^{-1} (9.2 km h^{-1}).

Both cultivars are resistant to herbicide glyphosate (RR2), have great branch potential and indeterminate growth habit. Moreover, NS-7000-IPRO Intacta RR2 PRO™ has been genetically modified and express a endotoxin that allows the soybean plant to protect itself against the main caterpillars (PRO™), having also a longer cycle than the Nidera 5909.

Soybean cultivars were sowed on March 6th, 2014 as a second summer crop with a no-till seed-drill manufactured by Semeato, model SHM 11/13 (Fig. 1a and b) with 6 rows, spaced 0.41 m from each other, configured with smooth cuts disk, fertilizer plow rod type, seed furrow double disc type and seed feeder system with seed disc rotating in a vertical plane set at 37 cm from the soil in a pantograph system. A New Holland® tractor, model TT3840, 4×2 with a maximum power of 41 kW (55 hp) at 2,400 rpm with wheel tires was used to pull the seed drill.

In order to obtain the different sowing speeds, tractor transmission gear choice and engine rpm varied, being the second low gear with 1.960 rpm used to reach 3.4 km h^{-1} . Speed of 5.7 km h^{-1} was obtained in third low gear with 2.400 rpm; Speed of 7.7 km h^{-1} was obtained in fourth low gear with 2,600 rpm and the speed of 9.2 km h^{-1} was obtained in the first single gear with 2,500 engine rpm. Measurements were done for all the speeds and plots evaluating the lapsed of time and distance in meters, obtaining meters per second which multiplied by a constant 3.6 resulted in kilometers per hour.

To evaluate the seeder performance some parameters were evaluated: Straw retention rate in the sowing line, percentage of soil removed to the side of the line, depth and exposure of the seeds as well as the longitudinal distribution of plants and the emergence speed index.

Seeder was set up to place the seeds on soil at 3 cm deep. After sowing, seeds depth measurement was obtained by direct measurement of the position of the seeds in the soil by measuring 10 m in the two central rows in each plot. The soil over the seeds was removed manually, maintaining the seeds in their original positions. Then, the distance from the seed to the groove edge was measured.



Fig. 1(a-b): Seed-drill used at the experiment, as follows, (a) Seed-drill semeato brand, model SHM and (b) Pantograph system of lines with their respective regulator pressure on vertical line position

The percentage of exposed seeds was measured by counting the number of seeds that visually appeared on the soil surface of two lines of sowing by 10 m for each plot in relation to the total number of seeds, obtained from the analysis of the soil seeds depth.

The rate of straw-covering permanence on the Seeding Line (SCS) was quantified before and soon after seeding with the use of a 15 m tape having markings equivalent each 0.15 m. Tape measure was placed centrally on top of the seeding line surface with one sample for each plot. The soil coverage percentage was determinate directly by counting the number of points intertwined with vegetative residues underneath the marked out tape measure. The percentages of soil covering before (BS) and after (AS) seeding allowed the determination of straw-covering permanence on the seeding line (SPS), where, $SCS = (AS/BS) \times 100$.

Seeding line soil mobilization was determinate soon after the seeder's action in the same way SCS. Tape measure was positioned at 15 cm on the right and left sides of two seeding lines resulting in average values. Percentage of seeding line soil mobilization was achieved by counting the number of points intertwined with the soil's turf underneath the tape's intertwined point.

Seed Emergence Speed Rate (ESR) was determinate by dividing the seedlings percentage emerging each day by the number of days from seeding up to stabilization of emergence. Each two days, emerged seedlings were counted on 10 m of line in each plot starting from the day that the first seedlings emerged until it ceased as a feature of emergence stability. Percentage of Emergence (PE) was achieved by considering the number of plants which were seen at the Field Count (FC) together with the number of Sprouting-Potential Seeds (SPS), determined at the seed depth evaluation corrected by means of physiologic analysis of the seeds at the UTFPR-DV Laboratory, where $PE = (FC/SPS) \times 100$.

Seedlings longitudinal distribution was evaluate 5 m along at the two central lines of the plots soon after emergence stabilization. Seedlings distance (X_i) results were evaluated according to a classification proposed by Tourino and Klingenstein (1983) meant for classify the distance among seeds in acceptable or normal classes ($0.5 \cdot X_{ref} < X_i < 1.5 \cdot X_{ref}$), double ones ($X_i < 0.5 \cdot X_{ref}$) and failed ones ($X_i > 1.5 \cdot X_{ref}$) based on reference spacing (X_{ref}) according to the pre-established seeder regulation. Based on that, seeder was regulated to distribute 17.8 seeds per meter, allowing for reference spacing between seeds equal to 5.62 cm, being values from 2.81-8.43 cm considered acceptable, doubles seeds for the distance <2.81 cm and failed ones distances greater than 8.43 cm.

Regarding to the soybean yield components and grains' yield, were evaluated: plants height, number of branches and legumes pod number by evaluating 10 plants from each plot. Final plant population was evaluated by counting the number of plants 10 m along two lines. Weight of thousand grain and grain yield was evaluating by harvesting 5 m of the three central lines of the plots. Grain moisture was determined according to the Rules for Seed Analysis (MAL.S., 2009) and results were expressed considering standard grain moisture of 13%.

Experimental results were subjected to analysis of variance, compared by the Tukey test, at 1 and 5% probability. Moreover, the relationship between the data sets were evaluated by linear correlation analysis comparing its significance by Test t at 1 and 5% probability.

RESULTS AND DISCUSSION

There was no interaction between soybean cultivars and seeding speed as shown in Table 1. Cultivars differed only on the seed emergence speed rate. In the other hand, all the evaluated parameters were affected by the seeder sowing speed.

Table 1: Synthesis of variance test to evaluate the seeder-fertilizer performance

Factors	SCS (%)	SLM (%)	SD (cm)	ES (%)	ESR % dia ⁻¹	Seedlings distribution		
						Double	Standard (%)	Failing
Cultivars (C)								
Nideira 5909	46.50 ^a	20.30 ^a	3.80 ^a	9.00 ^a	33.20 ^a	40.9 ^a	37.8 ^a	21.3 ^a
Nideira 7000	41.00 ^a	17.90 ^a	3.40 ^a	10.10 ^a	27.60 ^b	38.4 ^a	32.2 ^a	29.4 ^a
Speed (S)								
3.4 km h ⁻¹	50.80 ^a	9.00 ^d	4.60 ^a	3.40 ^c	34.50 ^a	29.6 ^d	51.5 ^a	18.9 ^b
5.7 km h ⁻¹	49.50 ^a	15.50 ^c	3.90 ^b	6.20 ^c	32.40 ^{ab}	35.9 ^c	40.4 ^a	23.7 ^b
7.7 km h ⁻¹	43.50 ^{ab}	19.30 ^b	3.50 ^c	10.70 ^b	29.80 ^b	42.0 ^b	29.1 ^b	28.9 ^a
9.2 km h ⁻¹	31.20 ^b	32.70 ^a	3.10 ^c	17.40 ^a	24.90 ^c	51.1 ^a	18.9 ^c	30.0 ^a
Test F								
C	1.22 ^{ns}	1.15 ^{ns}	1.74 ^{ns}	7.04 ^{ns}	45.10 [*]	4.2 ^{ns}	8.2 ^{ns}	96.9 ^{ns}
S	3.34 [*]	20.00 ^{**}	54.84 ^{**}	145.50 ^{**}	24.80 [*]	179.5 ^{**}	373.5 [*]	156.1 [*]
C×S	1.53 ^{ns}	0.46 ^{ns}	0.29 ^{ns}	2.45 ^{ns}	0.78 ^{ns}	1.6 ^{ns}	6.5 ^{ns}	26.4 ^{ns}
CV (%)	31.70	32.90	22.30	21.70	19.60	18.9	27.4	28.5

In each column, to each factor, averages followed by different lowercase letter differ by the Tukey Test in 5 (*) and 1% (**) of probability, CV: Coefficient of variation, ns: Not significant, Factors: SCL: Straw-covering seeding line, SLM: Seeding line soil mobilization, SD: Seeding depth, ES: Exposed seeding, ESR: Emergence speed rate and plants distribution (double, standard and failing)

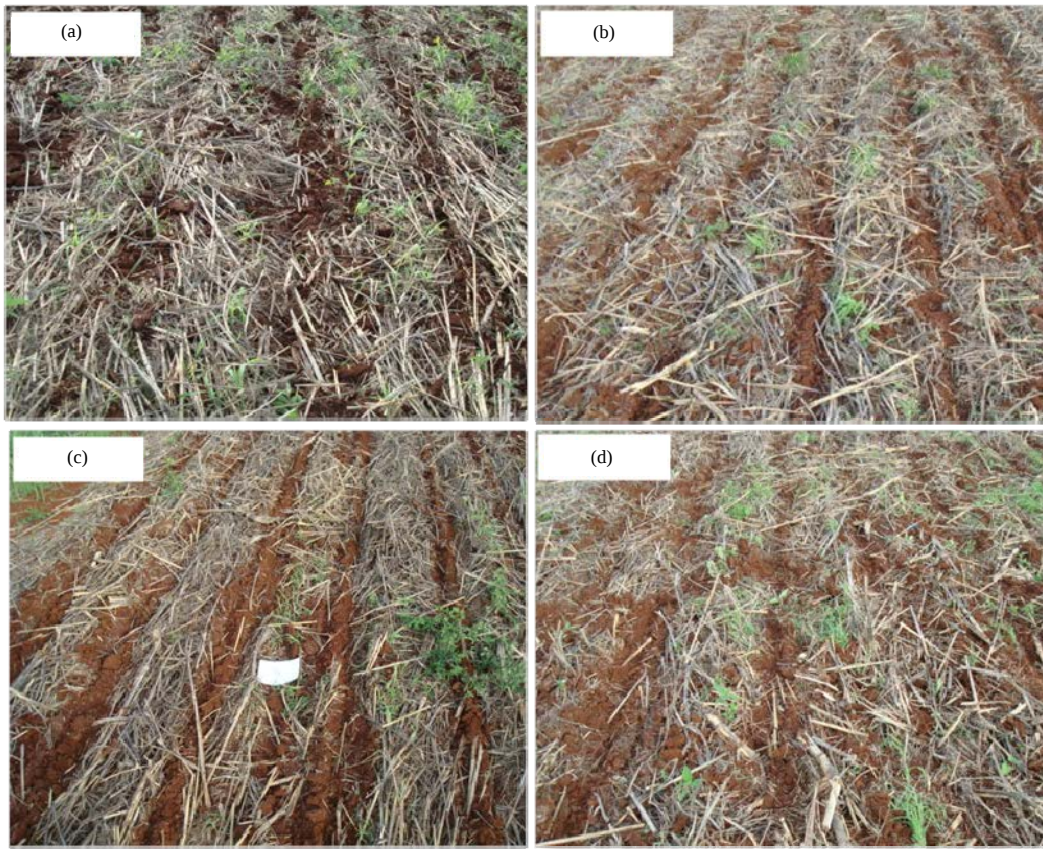


Fig. 2(a-d): Soil surface images after soybean sowing in no-till system with different seeder speeds, (a) 3.4 km h⁻¹, (b) 5.7 km h⁻¹, (c) 7.7 km h⁻¹ and (d) 9.2 km h⁻¹

Soil cover with straw, a strong characteristic of the no-till system, contributes for a suitable environment to germination and plants emergence due to its maintenance of water contents in the seeding line (Liu *et al.*, 2004b). In this context, Straw Covering seeding Line (SCL) reduced as sowing speed increased. As noticed on Table 1, sowing speed of 3.4 km h⁻¹ showed a SCS rate of 50.8% and this value was reduced to 31.25% as the sowing speed rate as increased to 9.2 km h⁻¹ showing a soil straw coverage reduction of 19.6%. Moreover, soil coverage reduced in 3, 4% to each increased speed kilometer.

It is also possible to observe that the sowing speed of 7.7 km h⁻¹ showed line soil mobilization similar to the lowest speed, indicating that besides greater operational results, may maintain conservation standards of soil equal to a lower seeding speed. This evaluation may be seen in Fig. 2.

Sowing speeds also increase the seeding line soil mobilization (SLM) (Table 1 and Fig. 2a-d), being the lowest mean (9%) noticed at the lowest speed (3.4 km h⁻¹) and the highest mean (32.7%) at the highest speed (9.2 km h⁻¹) showing an increase of 23.7%. Moreover, seeding line soil mobilization increased in 4% to each increased speed kilometer.

Seeds depths were also affected by the sowing speeds. At the 3.4 km h⁻¹, seeds were placed at 4.6 cm of depth, which reduced to 3.5 and 3.1 cm to the 7.7 and 9.2 km h⁻¹ (Table 1). This tendency pattern of reduction of seeds depth with the increase of seeder-fertilizers work speeds was also reported by Da Silveira *et al.* (2011) and Casao *et al.* (2000) which attributed the results to the excessive soil movement at higher speeds, especially when furrow openers are used. Moreover, there was excessive soil movement outside the seeding line (Table 1 and Fig. 2a-d) what is possibly linked to the increase of mechanical energy of the furrow openers within the seeding line at greatest speeds, thus forcing out this energy by throwing the soil outside of the line.

According to Da Silveira *et al.* (2011), the lower seeds deposition depth at higher speed is the result of low efficiency on the part of the seeder' depth control, which leads to placement of seeds on the soil surface of the seeding line, reducing contact of seeds with the soil and preventing them from germinating because of a decrease in water absorption. Although, the seeder machine employed in the experiment had their lines with the pantograph system with angle-tuning control of furrow-making devices and contained depth control rods near the double-disc seed furrow openers (Fig. 1b),

however, the rods of depth control were fixed and did not have the rocker arm system, which possibly must have interfered negatively in the results.

Furthermore, the lack of vertical pressure on the double-disc furrow opener components tends to reduce seed depth, which gets worse as seeder speed increase once the contact of disks with soil surface increase, thus increasing the vertical force to penetrate the while maintaining the same pressure (Casao *et al.*, 2000). Seeder used has a pressure spring for each line, although the machine has only two places for employing adjustments (Fig. 1b), being this hard to handle due to the need to remove pressured pins. Regulation of lower pressure was used, as set by the manufacturer, which possibly led to lower pressure on the line and therefore in lower seeds depths, with got worse as seeder speed increased.

According to Casao *et al.* (2000), in loamy and humid soils with vegetation which make it difficult to close furrows, it is recommended to use a grounding device to improve soil cover over de line and a suitable plants emergence and in turn, good plants populations that will lead to maximum yield, although this was not set up on the evaluated seed drill.

Seeds exposure over the seeding line leads to loss of germination, due to the fact that the seeds do not find their adequate environment for absorbing water and because they are exposed to high temperatures. In this context, it is observed that a lower Seeding Depth (SD) contributes to an increase of seeds loss, named here as Exposed Seeds (ES) as observed in Table 1. This parameter increased from 3.4-17.4% as seed-drill speed increased from 3.4-9.2 km h⁻¹. These results are higher than those reported by Casao *et al.* (2000), who's values of exposed seeds varied from 0.9 and 0.7% at speeds of 4.5 and 8.0 km h⁻¹ respectively. Liu *et al.* (2004b) stated that using fast speeds can compromise the sowing quality.

These losses are not welcome once seed represent an expensive input into the productive system. Moreover, it may represent a reduction of plants population, which may result in lower grains yield and farm profitability. The cost by hectare for acquisition of soybean seeds is roughly R\$ 150.00, which represents 6% of total production costs (IMEA., 2014). Considering the Brazilian 2013/14 soybean crop area (30.17 million of hectares) (CONAB., 2014), this loss due to higher seed-drill speed would represent R\$ 633.57 million to the country, this without considering yield losses.

Emergence Speed Rate (ESR) shows indirectly, the germinative environment quality of seeds from inside the seeding line. Furthermore it shows that this parameter was affected by the seed-drill speeds, once emergence was of 24.9% day⁻¹ against 34.5% day⁻¹, respectively for the highest (9.2 km h⁻¹) in the lowest speed (3.4 km h⁻¹) (Table 1). This parameter is associated with the exposed seeds on the line of seeding, preventing germination and emergence.

Between cultivares, Nidera 5909 showed greater ESR values which is possibly linked to the seeds physiologic feature, which may be affect along its production and storage (MALS., 2009).

Regarding soybean plants distribution, averages were analyzed on the seeding lines. It was overall noticed that double and failed plants increased as seed-drill speed increased (Table 1). Plant uniformity along the seeding line is considered an important factor, once it may affect plants' architecture and capacity in capturing solar energy, affecting so crop yield (Tourino and Klingenstein, 1983). Based on these authors classification, seed-drill performance was considered regular only at the 3.4 km h⁻¹ speed, in which 51.5% of plants showed standard distribution and the remaining speeds showed unsatisfactory performance.

Modolo *et al.* (2012), evaluating seeding quality related to seed-drill speeds, reported that the increase in operation speed was the major factor over the parameters of seeding quality. Authors report satisfactory outcomes for speeds between 3.5-4.0 km h⁻¹ and regular outcomes for the operation speed of 5.0 km h⁻¹.

Better seeding quality at lower seed-drill speeds are noticed due to increased time available to the seed to be lain down by dosing-devices allowing for better filling of disks alveolus, reducing entry of multiple seeds in the dosing-disks' orifices and allows better placement of the seeds into the soil due to lower unloading speeds what improves seeds distribution (Casao *et al.*, 2000).

De Castro Rocha *et al.* (1998) state that it is desirable that the seed dosing mechanism must be the nearest to the release of seeds inside the seeding line, once as the seed-drill speeds increase, the seed conducting tube vibration increase, affecting seed distribution.

Tourino *et al.* (2009) evaluating seeding density and seeders performance reported that worse soybean seed distribution are related also to the increase of seeds density per hectare, due to the increase of tangential speed in the center of dosing-disks cells (greater relation of transmission), reducing the exposure time of seeds/cells and hence affecting correct seeds selection.

Jasper *et al.* (2011), evaluating a seed-drill with pneumatic system at different speeds, in five intervals from 4-12 km h⁻¹ also reported an increase in multiple double seeds and reduction of the acceptable distances between seeds as the speed increased.

Analysis of variance and multiple comparison tests of soybean cultivar yield components and final yield at different sowing speeds are shown in Fig. 2a-d. Soybean Nidera 7000 cultivar showed better results probably due to its longer maturation cycle, further related to plant height.

Seed-drill speed affected soybean ramification, total number of legume pods, final plants population and grain yield

Table 2: Synthesis of analysis of variance by test F and multiple comparison test of soybean cultivar yield components and final yield at different sowing speeds

Factors	PH (cm)	NB (un. planta ⁻¹)	NLP (un. planta ⁻¹)	GP (un. planta ⁻¹)	WTG (g)	FPP (plants ha ⁻¹)	Yield (kg ha ⁻¹)
Cultivars (C)							
Nideira 5909	41.5 ^b	2.57 ^b	14.50 ^b	18.00 ^b	137.90 ^b	449.690 ^a	1.169.6 ^b
Nideira 7000	44.9 ^a	3.21 ^a	18.20 ^a	27.40 ^a	209.70 ^a	442.251 ^b	1.684.4 ^a
Speed (S)							
3.4 km h ⁻¹	43.9 ^a	2.67 ^b	14.60 ^b	21.00 ^a	160.80 ^a	490.848 ^a	1.482.3 ^a
5.7 km h ⁻¹	44.0 ^a	2.76 ^b	15.60 ^{ab}	20.70 ^a	158.10 ^a	463.410 ^{ab}	1.409.2 ^a
7.7 km h ⁻¹	43.4 ^a	2.91 ^{ab}	17.20 ^{ab}	24.90 ^a	190.60 ^a	426.825 ^b	1.329.7 ^a
9.2 km h ⁻¹	41.6 ^a	3.21 ^a	17.90 ^a	24.30 ^a	186.00 ^a	362.801 ^c	1.186.8 ^b
Test F							
C	14.2**	33.10**	22.68**	39.64**	39.89**	6.48*	55.06**
S	1.6 ^{ns}	4.40*	3.61*	2.15 ^{ns}	2.18 ^{ns}	26.40**	5.35*
C×S	4.0 ^{ns}	0.75 ^{ns}	0.41 ^{ns}	1.35 ^{ns}	1.37 ^{ns}	0.88 ^{ns}	3.12 ^{ns}
CV (%)	18.5	21.30	27.50	19.60	18.50	29.10	31.5

Means in the same row followed by different lowercase letters differ by Tukey test at 5% (*) and 1% (**) of probability, CV: Coefficient of variation, ns: Not significant, PH: Plant height, NB: Number of branches, NLP: Total number of legume pods, GP: Grain per plant, WTG: Weight of thousand grains, FPP: Final plant population and GY: Grains yield

Table 3: Simple correlation test among soybean parameters and seed-drill performance at different speeds

Correlation parameters	PH	NLP	GP	WTG	GY	FPP	ES	SD	ESR	SLM	ESR	DS	SS	FS
NR	0.37*	0.72**	0.71**	0.71**	0.47**	-0.54**	0.48**	-0.48**	-0.67**	0.35 ^{ns}	-0.29 ^{ns}	0.29 ^{ns}	-0.53**	0.64**
PH	-	0.55**	0.58**	0.58**	0.40*	0.01 ^{ns}	-0.16 ^{ns}	0.19 ^{ns}	-0.07 ^{ns}	-0.27 ^{ns}	0.02 ^{ns}	-0.34 ^{ns}	0.19 ^{ns}	0.03 ^{ns}
NLP	-	-	0.89**	0.89**	0.59**	-0.57**	0.48**	-0.44*	0.61**	0.27 ^{ns}	0.39*	0.30 ^{ns}	-0.51**	0.66**
GP	-	-	-	0.99**	0.77**	-0.46**	0.32 ^{ns}	0.27 ^{ns}	-0.54**	0.06 ^{ns}	-0.38*	0.12 ^{ns}	-0.38*	0.61**
WTG	-	-	-	-	0.77**	-0.46**	0.32 ^{ns}	-0.27 ^{ns}	-0.54**	0.06 ^{ns}	-0.38*	0.12 ^{ns}	-0.38*	0.62**
GY	-	-	-	-	-	0.62*	-0.02 ^{ns}	0.04 ^{ns}	0.57*	-0.20 ^{ns}	-0.19 ^{ns}	-0.20 ^{ns}	0.52*	-0.11 ^{ns}
FPP	-	-	-	-	-	-	-0.85**	0.74**	0.65**	-0.65**	0.43*	-0.81**	0.85**	-0.64**
ES	-	-	-	-	-	-	-	-0.88**	-0.73**	0.77**	-0.45*	0.89**	-0.91**	0.67**
SD	-	-	-	-	-	-	-	-	0.73**	-0.79**	0.40*	-0.84**	0.91**	-0.69**
ESR	-	-	-	-	-	-	-	-	-	-0.56**	0.34 ^{ns}	-0.61**	0.79**	-0.83**
SLM	-	-	-	-	-	-	-	-	-	-	-0.46**	0.79**	-0.74**	0.42*
SCL	-	-	-	-	-	-	-	-	-	-	-	-0.41*	0.48**	-0.41**
DS	-	-	-	-	-	-	-	-	-	-	-	-	-0.88**	0.52**
SS	-	-	-	-	-	-	-	-	-	-	-	-	-	-0.83**

*Significant at 5% probability, **: Significant at 1% probability, NS: Not significant. Contraction form stands for: NR: Number of branches, PH: Plants height, NLP: Number of legume pods, GP: Grain per plant, WTG: Weight of thousand grains, GY: Grains yield, FPP: Final plant population, ES: Exposed seed, SD: Seeding depth, ESR: Emergence speed rate, SLM: Seeding line soil mobilization, SCL: Straw covering the seeding line, DS: Double seedlings, SS: Standard seedlings and FS: Failing seedlings

(Table 2). Lower plant density at higher sowing speed was compensated by an increase on the number of branches and pods per plant, although, not sufficient to maintain crop yield. Simple correlation among soybean yield components, grain yield and seed-drill performance are showed on Table 3.

Data shows that at least 70% of the normal plants distribution is correlated negatively and significantly with exposed seeds and with the soil moved out the seeding line, stressing out the augmentation of seeders' speeds largely affect seed rate of emergence and as a result, the final population of plants.

According to Ford and Hicks (1992), corn growth and its yield is affected by uneven corn emerging stands. Soybean yield components and final yield showed different correlation among their variables (Table 3). Results demonstrated that at least 40% of grain yields (GY) are correlated positively and significantly with the variables such as Number of Branches (NB), Plants Height (PH), legumes pod number, Grain per plant (GP), Weight of Thousand Grains (WTG), Final Plant

Population (FPP) and Grains Yield (GY). These emphasize that soybean yield is dependent on its morphological traits and these may be affected to the seeding speed (Mellendorf, 2011).

CONCLUSION

Parameters such as soybean seed depth deposition, seeding line soil mobilization, seed emergence rate, exposed seeds, longitudinal distribution of plants and soybean yield components were affected as seeder speed increase from 3.4-9.2 km h⁻¹. Seed-drill best performance of the seeder device was noticed at the speed of 3.4 km h⁻¹, although, speed up to 7.7 km h⁻¹ showed similar soybean grain yield.

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