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Technical Note

Quantitative losses on the mechanized harvesting of soy in the region of Cáceres, Mato Grosso

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Abstract

The mechanized harvesting is the final step of the production process and the losses must be maintained within acceptable patterns. This study aimed to characterize the quantitative losses during the mechanized harvesting of soy in a property of grain production, in function of dislocation speed and trail system of two harvesters. The harvesting was performed using experimental design of randomized blocks, in factorial scheme of 2x2, the treatments being composed by two harvesters (different brands and trail systems), operating in two dislocation speed levels, 5.5 km h^{-1} e 7.0 km h^{-1}, with four repetitions. We analyzed the natural losses, losses caused by the harvester (cut platform, separation system and cleaning) and total losses. The harvesters presented low loss rates, below the recommended (60 kg ha^{-1}), and the dislocation speed between them did not affect the losses caused by the harvester. The total losses in the harvesting were low, indicating that the regulation, the staff training and conservation condition of the harvester are important factors for minimizing losses.

Keywords: Trail mechanisms; grain production; *Glycine max*

Pérdidas cuantitativas en la cosecha mecanizada de soja en la región de Cáceres, Mato Grosso

Resumen

La recolección mecanizada es el paso final del proceso de producción y las pérdidas deben mantenerse dentro de los estándares aceptables. Este estudio tuvo como objetivo caracterizar las pérdidas cuantitativas durante la cosecha de soja en un área de producción de granos, en función de la velocidad de marcha y del sistema de trilla de dos cosechadoras. La cosecha se lleva a cabo utilizando un diseño de bloques completos al azar en un factorial 2x2, con tratamientos que consisten en dos cosechadoras (diferentes marcas y sistema de trilla), operando en dos velocidades, a 5,5 y 7,0 km h^{-1}, con cuatro repeticiones. Se analizaron las perdidas naturales, la pérdida causada por la cosechadora (plataforma de corte, sistema de separación y limpieza) y las pérdidas totales. Las cosechadoras tuvieron bajas tasas de pérdida inferiores a lo máximo aceptable (60 kg ha^{-1}), la velocidad de desplazamiento entre ellas no afectó a la pérdida causada por la cosechadora. Las pérdidas totales de los cultivos fueran bajas, lo que indica que la regulación, habilidad del operador y estado de conservación de la cosechadora son factores importantes para reducir al mínimo las pérdidas.

Palabras Clave: Mecanismos de trilla; la producción de granos; *Glycine max*

Perdas quantitativas na colheita mecanizada de soja na região de Cáceres, Mato Grosso

Resumo

A colheita mecanizada é a etapa final do processo produtivo e as perdas devem ser mantidas dentro de padrões aceitáveis. Este trabalho teve como objetivo caracterizar as perdas quantitativas durante a colheita mecanizada de soja em uma propriedade de produção de grãos, em função da velocidade de deslocamento e sistema de trilha de duas colhedoras.

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A colheita foi realizada utilizando delineamento experimental de blocos casualizados, em esquema fatorial 2x2, sendo os tratamentos compostos por duas colhedoras (marcas e sistema de trilha diferente), operando em duas velocidades de deslocamento, 5,5 km h^{-1} e 7,0 km h^{-1}, com quatro repetições. Foram analisadas as perdas naturais, perda provocada pela colhedora (plataforma de corte, sistema de separação e limpeza) e perdas totais. As colhedoras apresentaram índices baixos de perdas, abaixo do máximo aceitável (60 kg ha^{-1}), a velocidade de deslocamento entre elas não afetou as perdas causadas pela colhedora. As perdas totais na colheita foram baixas, indicando que a regulagem, treinamento do operador e estado de conservação da colhedora são fatores importantes para minimizar as perdas.

Palavras-chave: Mecanismos de trilha; produção de grãos; *Glycine max*

Introduction

The soybean (*Glycine max*) is a legume rich in proteins and vitamins that currently has a high demand and an expressive market value. The soy production has gradually grown in the past few years, both in planted area and productivity; these increases require better speed and quality during the harvesting (EMBRAPA, 2011).

In 2012 the soy was cultivated in more than 90 countries, covering an area of approximately 104 million acres, with grain production of 241 million tons and average production of 2.31 t ha^{-1}. Among the countries that most produce soy, the USA leads the world production with approximately 82 million tons, followed by Brazil, with 65,8 million tons and Argentina, with 40,1 million tons (FAO, 2012).

In Brazil, the states with higher soy production on the crop season of 2011/12 were Mato Grosso, with 21,849 million tons, Paraná, with 10,941,9 million tons and Goiás, with 8,251,5 million tons, harvested in a planting area of 6,980, 4,460 and 2,644 million acres, respectively (CONAB, 2012).

The mechanized harvesting has improved more and more, aiming the grain loss decrease in field, performing the work faster (LOUREIRO et al., 2012). The harvesting being one of the main phases of the production chain, it must be carefully conducted, since it requires elevated costs and, generally, has the raw material compromised due to lack of maintenance and adjustments in the trail system, separation and cleaning of the harvesters.

In spite of the available high technology, considerable losses are accounted on the mechanized harvesting, decreasing the productivity and the farmers profit. These losses can be associated to several factors, such as: the machine's time of use, the cut platform height, grain humidity and dislocation speed; also being able to be caused by factors not derived from the mechanized harvesting process, such as: inadequate soil preparation, sowing season, occurrence of weeds and crop development (AMADEU, 2014).

One of the great problems of grain harvesting is related to quantitative and qualitative losses. Several studies point out that, depending on the harvesting conditions, the grain loss can exceed 10% of the total produced, the tolerable loss level being 3% (QUEIROZ, 2004).

According to MESQUITA et al. (2011), the dislocation speed recommended to a harvester varies from 4.0 to 6.0 km/h; by increasing or decreasing the speed, it must be verified if the losses are below the tolerated level of 60 kg.ha^{-1} sack.

The harvester's regulation affects the degree of loss that occurs during the soy harvesting. MESQUITA et al. (1998) states that the trail system of the harvester provokes the breaking of fragments on grains and these damages most times are not perceived on the crop residues or even in loss measurements. The losses with the breaking of grains represent 1.7% to 14.5% on the harvest loss. According to MESQUITA et al. (2002), the harvesters that have axial or longitudinal trail systems present less mechanic damages to the seeds when compared with radial trail system.

The lowest losses related to the new machines can be due to better technology employed, such as loss sensors and electric regulations, which facilitates the adjustment of the whole (SCHANOSKI et al., 2011). Another important factor that hinders the loss reduction on the crop is the low level of education of the operators and the lack of training.

Another quite relevant data is the elevated number of harvesters with more than 15 years of use with losses below 1 sack per acre, indicating that other factors also interfere on the harvesting, such as operator efficiency, crop conditions and machine conservation, which too have influence over the loss levels (MESQUITA, 2003).

Aiming to verify the quantitative losses derived from the soy mechanized harvesting, the present study aimed to quantify the grain loss during the mechanized harvesting in function of the dislocation speed and trail system of two harvesters.

Material and Methods

The experiment was conducted during the mechanized harvesting of the 2011/12 soy crop, in the farm of Bom Tempo, region of Cáceres-MT, with geodesic coordinates 16° 08′ 22″ S and 057° 29′ 42″ W and 118 m altitude. The climate according to the Köppen classification is hot and humid Tropical, with dry winter (Awa), with annual average temperature of 26.24ºC and rainfall of 1,335 mm a year. The lowest temperatures occur in the months of June and July with 23.39 and 23.36ºC, respectively, and the highest temperature occur in October (28.01ºC), being able to reach 40ºC (NEVES, 2011). The soil of the property is classified as Haplorthox (EMBRAPA, 2006).

The soy cultivar was the Tabarana, with average productivity of 1,400 kg ha^{-1}, presenting final population of 140,000 plants per acre. All cultivation treatments were conducted according to the crop's needs. During the harvesting the grains presented 14% humidity.

We used the experimental design of randomized blocks (DBC), in a factorial scheme of 2x2, being the treatments composed by two harvesters of different brands and trail systems (Table 1), operating in two dislocation speed levels at 5.5 and 7.0 km/h, with 4 repetitions for each treatment. Each parcel had 50 m length and 10 m width. We evaluated the soy grain loss caused by the trail system, separation, cleaning and total loss.

The pre-harvesting losses were determined before the passage of the harvester, positioning a frame with 1 m^2 area, placed transversally to the sowing rows, according to the methodology quoted by PORTELLA (2000).

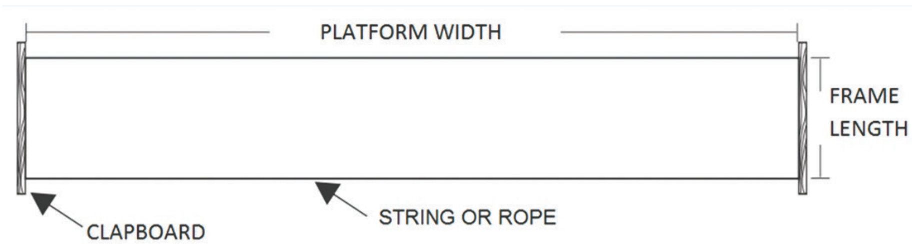
The losses provoked by the cut platform, trail system, separation and cleaning were evaluated with the use of a rectangular frame according to the cut platform width, totaling an area of 2 m^2, placed transversally to the sowing rows after the passage of the harvester (Figure 1), according to the methodology described by MESQUITA et al. (2011).

The total loss was defined after the machine's passage in a certain point, using the same methodology described and including the collecting of broken grains. After obtaining the average total loss of the crop we subtracted the pre-harvesting loss average, obtaining, so, the harvester's total loss.

The operation losses were quantified by collecting all grains on the soil, pods containing grains and plants that had pods with grains, inside the frame. The mass values of lost grains that were collected in the frame were weighed and converted in kg ha^{-1}.

Table 1. Specifications of the harvesters used on the experiment. Cáceres, Mato Grosso, 2012.

HARVESTER	AGE/YEAR	TRAIL SYSTEM	WIDTH/ PLATFORM(m)
John Deere 1550	2006	Radial	6.90
Valtra BC 7500	2011	Axial	9.10



(Platform width. Frame length. Clapboard. String or rope)

Figure 1. Frame of 2.0 m^2 for determining the grain loss on the soy harvesting.

The data were subjected to variance analysis by the F test, and the comparison of averages by the Tukey test, at 5% level, through the Sisvar statistical program, from the Federal University of Lavras (FERREIRA, 2012).

Results and Discussion

The interactions between the harvesters and dislocation speed were not significant, indicating that regardless of the harvester and speed, there is no influence among the treatments, as supported by MAGALHÃES et al. (2009), who evaluated two Massey Ferguson 5650 Advanced harvesters with distinct fabrication years, operating under two dislocation speeds, and also did not find interaction between treatments. BARROZO et al. (2010), in a study conducted with sunn hemp seeds and using a harvester SLC/John Deere model 1165, under two dislocation speeds and three rotations of the threshing cylinder, did not obtain any interaction between the evaluated factors.

It is possible to observe on Table 3 that the variable loss caused by the cut platform, separation and cleaning (PSL), differed in relation to the used harvester, whereas the Valtra 7500/2011 (C1) harvester presented lower loss rates. CAMPOS et al. (2005) found significant differences for the average grain loss with harvesters of axial flux, presenting lower losses when compared with the radial harvesters.

For the total grain loss (Table 3), differences were also found for the harvester factor, however, they presented an average below the recommended by MESQUITA et al. (2003) of one sack per acre for losses on the soy cultivation, evidencing that there is caution on the harvester's regulation. CAMPOS et al. (2005), evaluating losses on soy mechanized harvesting, in the State of Minas Gerais, noted values varying from 24 to 126 kg ha^{-1}.

At analyzing the averages of the speed factor (Table 3) for losses caused by the cut platform, separation and cleaning (PSL) and total loss (PT), we observed that there is no variation between the

Table 2. Descriptive variance analysis for the variable losses caused by the cut platform, separation and cleaning (PSL) and total loss (PT), in function of the dislocation speed and trail system of two harvesters. Cáceres, Mato Grosso, 2012.

F.V.	GL	PSL	PT
Harvester (C)	1	8.31*	7.96*
Speed (V)	1	0.67 ns	0.37 ns
C x V	1	2.09 ns	1.75 ns
RESIDUE	9	92.72	96.96
TOTAL	-	1927.62	1878.30
AVERAGE	-	45.67	47.72
CV (%)	-	21.08	20.63

*Non significant. * Significant at the level of 5% probability.*

Table 3. Synthesis of the variance analysis and average tests for the variable losses caused by the cut platform, separation and cleaning (PSL) and total loss (PT), provoked by the harvester in function of dislocation speed and trail system. Cáceres, Mato Grosso, 2012.

FACTORS	PSL	PT
	------------- kg ha^{-1} -------------	
Harvester (C)		
Valtra 7500/2011 (C1)	38.73 b	40.77 b
John Deere 1550/2006 (C2)	52.61 a	54.66 a
Speed (V)		
5.5 km/h (V1)	47.64 a	49.23 a
7.0 km/h (V2)	43.70 a	46.21 a

Averages followed by the same letter in the column do not differ by the Tukey test at 5% probability.

averages, indicating that, regardless of the speed, the losses are not significant and are below the acceptable levels for losses. Data that differ from FERREIRA et al. (2007), where they found differences regarding quantitative losses in function of the dislocation speed of a SLC 1165 harvester, where in lower speeds the greater losses occurred. CARVALHO FILHO et al. (2005) observed that when there is speed increase, the losses also increase and that the age of the harvester too interferes on the losses.

The grain losses before the harvest were inexpressive, there were no significant losses indicating that the used cultivar adapted to the climate and soil of the region.

Conclusions

Regardless of the harvester or the speed used, the losses are below the acceptable pattern, less than 1 sack per acre.

The dislocation speed did not affect the losses caused by the harvester. However, both harvesters presented low loss rates, although the Valtra 7500/2011 harvester presented lower rates.

The total losses on the soy harvesting were low, indicating that good conditions of cultivation process, harvester regulation, operating training may have contributed for the losses in acceptable levels.

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